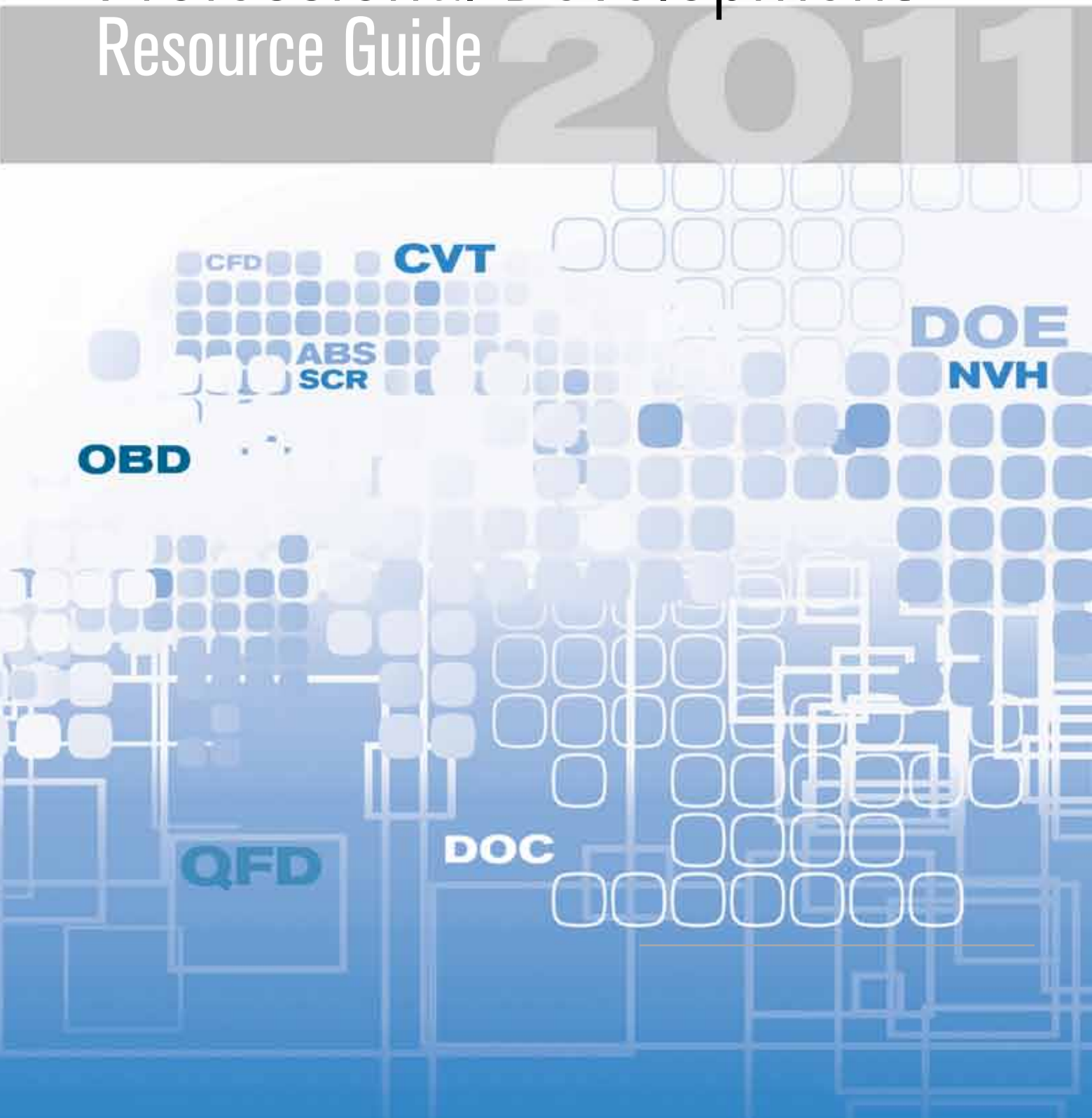
SAE International™

"The society dedicated to advancing mobility engineering worldwide"

Professional Development
Resource Guide

2011



SAE Professional Development

SAE provides high-quality training, with a learning format for every style including:

- **Seminars**
- **Engineering Academies**
- **e-Learning**
  - e-Seminars
  - Fast Tracks
  - Webinars
  - Telephone/Webcasts
- **Customized & Cost-Effective Onsite Training for Your Team**

MyLearn.sae.org

SAE International™

P90430

Professional Development
Resource Guide

2011

Corporate Learning Solutions

designed specifically to help companies address their learning needs through SAE Professional Development training solutions.

SAE International®

Corporate Learning Solutions
SAE Professional Development
400 Commonwealth Drive
Warrendale, PA 15096 U.S.A.
1-724-772-8529 • corplearn@sae.org • MyLearn.sae.org

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Catalog Key

The following symbols will be used throughout the catalog with course and learning product descriptions to designate the various delivery formats, certificate program courses, ACTAR approved courses, etc.

ACTAR approved

Part of a Certificate Program Curriculum

Instructor led programs

Online courses

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SAE International Corporate Learning Solutions

This catalog is designed specifically to help companies address their learning needs through a variety of SAE International Professional Development options.

Options

SAE has partnered with hundreds of companies to design and deliver training to the corporate site for groups of employees. Through SAE Corporate Learning Solutions you can:

- Select an existing SAE seminar for delivery to your site.
- Select an existing e-Learning product for delivery to your site.
- Customize a learning experience to address your specific business needs.

Advantages

With as few as eight employees who have the same learning need, SAE Corporate Learning Solutions provides multiple advantages:

- **Variety** — Choose from a comprehensive course list of over 120 titles.
- **Customization** — If you can't find the specific topic you need or if the course content does not exactly match your requirements, SAE can customize a training program. We can also integrate e-Learning for a "blended solution".
- **Quality** — SAE courses are conducted by leading academic and industry instructors. All courses and instructors are approved by at least two objective industry experts through our technical review process.
- **Convenience** — We make it easy for you by scheduling the instructor, supplying comprehensive handout materials for each attendee, and coordinating other administrative details.
- **Cost Effective** — Save time and money by having SAE learning solutions come to you. Your staff doesn't have to travel and there is no time away from the office. Also, our extensive network and existing course list makes our pricing extremely competitive!
- **Timeliness** — For over 100 years SAE has been on the cutting edge of mobility technology. We have access to the newest and most current industry information.

What is included in a Corporate Learning Solutions Program?

- **Customization** —Most seminars can be tailored to address your company's specific business or training objectives. Often this involves incorporating company data, generating case problems, or developing completely new content.
- **Administrative Coordination** — SAE staff contracts with the instructor, supplies all course materials, and provides attendance and post-course evaluation forms. All you do is provide the facility and audio-visual equipment!
- **Pre-training Conference Call** —SAE arranges a conference call with the instructor and relevant company representatives to ensure that everyone understands the training that is to be provided and the desired learning outcomes. This is also a great opportunity to discuss customization.
- **Continuing Education Units** — SAE awards Certificates of Completion with IACET approved Continuing Education Units (CEUs) to all attendees. One CEU is granted for every 10 learning contact hours.

What determines the Corporate Learning Solutions cost?

- The length of the program (number of days or hours of learning contact time)
- The learning materials. Some courses include textbooks or other learning aids
- The number of attendees
- Any customization required
- The instructor's travel expenses

These variables are used to calculate a base fee, which is typically based on 10 attendees. The fee increases proportionally as more attendees are added. Companies are additionally responsible for instructor travel, transfer fees, and living expenses.

What amenities does your company provide?

- A suitable meeting room or classroom
- Audio-visual equipment and computers (if required)
- Refreshment breaks and meals (if desired)
- Information on local hotels and airports along with directions to your facility

SAE Corporate Learning
1-724-772-8529
Corplearn@sae.org

SAE Training Vouchers

Create an Effective Training Plan for Your Organization – and Save

Training is an invaluable means of facilitating growth in your organization and increasing the skills and knowledge of your employees.

SAE Training Vouchers are a cost-effective and flexible solution for organizations whose training requirements vary from a single course, to an entire series of courses, to onsite training for a group. They can be used to register various people in different courses or to train a group, or use them to purchase an onsite seminar program; training 8-30 people per presentation, to purchase e-seminars or online training. We can even provide reports detailing your monthly Training Voucher usage.

Planning and controlling training and your training budget has never been easier!

In-house Seminar Options

When contracting for an in-house seminar using the SAE Training Voucher, you can save an additional 10%* from the already discounted in-house seminar presentation fee.

*Additional discount applies to in-house seminar programs based on established courses and program content and includes the instructor's presentation and handout material. The additional discount does not apply to textbooks, software, or customized program solutions.

Find out how SAE Training Vouchers can help you!

- Contact SAE Corporate Learning Solutions for a no-obligation consultation at1-724-772-8529 or corplearn@sae.org
- Complete and submit the Corporate Learning Solutions Request web-form at MyLearn@sae.org

To take advantage of the SAE Training Voucher program, visit http://www.sae.org/corplearning , then complete and submit the Training Voucher Application form.

SAE Training Vouchers - Buy Now and Use Later:

- Avoid losing your training budget dollars
- Vouchers are valid for two years from the date of purchase
- Vouchers are fully transferable throughout your organization
- Vouchers are valid for all SAE open enrollment seminars as well as in-house seminars, e-seminars, etc.
- Vouchers can be purchased in amounts ranging from $10,000 to $100,000 or more (U.S. Dollars).

Are there any restrictions?

- A few. Voucher payments must be through an organization, not an individual. Vouchers are valid for two years from the date of purchase and are non-refundable. Cancellation and rescheduling policies apply when using vouchers. Training vouchers may be redeemed for SAE Professional Development programs only (does not include conferences, meetings, sessions, and exhibits).
- Academies, hands-on driving courses and certain online, self-study workbooks and software tools are not eligible for the 10% discount.
- Training Voucher minimum purchase is $10,000.00 US.

Explore State Resources for Training Dollars

Research local workforce economic development groups to find out if training monies may be available for your organization's use.

For example, Michigan residents can visit www.michiganworks.org and enter their zip code to find local offices and *Michigan Works!* contacts in the area.

Another great resource is your state's Department of Labor – many have a wealth of resources for workers and employers.

Learning Formats

A Learning Format for Every Style

SAE offers a variety of learning formats to accommodate diverse learning styles.

Seminars

Each year, SAE schedules more than 200 open-enrollment seminar offerings that span nearly 100 separate technology and business skill topics. Seminars range from one to three days, are taught by highly-qualified, industry or academic experts, and include comprehensive handout materials.

Nearly all topics are offered at SAE Automotive Headquarters in Troy, MI. In addition, some seminars are scheduled at select SAE International meetings and conferences as well as some other cities.

Engineering Academy℠

SAE's award-winning Engineering Academy format is an intensive "boot camp" experience that enables attendees to immerse in a focused technology area. Whether a week-long, classroom event or a multi-week, series of two-hour webinar sessions, the Academy is a comprehensive and immersive training experience on core engineering topics. Multiple instructors team up to provide interactive lecture, discussion, and practice – all designed to aid learning and application.

The Engineering Academy℠ is perfect for newly hired engineers or those changing technical disciplines who need to quickly develop a new skill set in order to become productive on the job. The Engineering Academy format earned the prestigious Award of Excellence from the American Society of Association Executives.

For a current schedule of upcoming Academies, visit www.sae.org/academies.

SAe-Learning℠

Take advantage of the convenience and cost savings offered through e-Learning. SAE maintains a growing menu of learning products delivered through a variety of electronic media. These programs are listed throughout the catalog in the respective technical area of the program content.

Online Courses – Avoid travel expense, and access one of our e-Seminars or other online courses right from your desktop through the internet! Check out the growing selection of online courses through www.MyLearn.sae.org. Online courses can be identified by the icon throughout this Resource Guide. Site licenses are available for the entire online collection or select groupings of the online courses. Please contact the Corporate Learning Solutions hotline, 1-724-772-8529 for additional information.

e-Seminars — self-paced seminars available via CD-ROM or Online delivery – these programs are listed in the catalog immediately following the respective instructor-led seminar from which they are based. The description, learning objectives, content and instructor information can be found easily with the instructor-led seminar listing or online at www.sae.org/e-seminars. The minimum requirements for all e-Seminars are listed below.

Minimum Equipment Requirements for e-Seminars

- Pentium III PC
- Adobe Flash Player 8.0 & above
- Minimum 128 MB RAM; recommended 256 MB RAM
- IE 6 & above browser recommended
- Broadband-128Kbps and above
- Windows 2000, XP (Not currently supported by Windows Vista)
- 1024 X 768 Screen Resolution
- Sound Card/Speakers

Fast Tracks – Designed to address the growing demand for a faster, more efficient way to learn, SAE offers a series of short duration online courses for you, the engineering professional on the move. Presented in a 10-120 minute format, these chunks of learning combine audio, video, graphics, photos and text to capture the essence of a topic and drive a defined set of outcomes. Knowledge checks are scheduled as "pit stops" to ensure that you are equipped to achieve successful results. What's more, they're built to be easy-to-use, available on demand 24/7, and enable you to learn what you need to know fast. Visit www.sae.org/fasttracks to see our menu of topics.

Equipment Requirements for Fast Tracks

- Pentium PC 300 MHZ
- Minimum 128 MB RAM
- Internet Explorer 6.0 & above browser recommended
- Adobe Flash Player 8 or above required
- Broadband-128Kbps and above (Minimum: Cable or DSL connection)
- Windows 2000, XP, Vista
- 1024 X 768 Screen Resolution
- Sound Card/Speakers

Mac operating systems and browsers other than IE are not supported.

Accreditations

SAe-Learning (continued)

Telephone/webcasts – SAE Telephone/Webcasts are 90-120 minutes programs that focus on current and emerging technologies and the related issues, challenges and perspectives. A panel of subject matter experts sets the stage for engaging, interactive discussion with participants. Quick, convenient, cost-effective, and travel-free, the format features audio delivered by telephone, web-based presentations, and interactive question-and-answer and open discussion – direct to the participant's home, office or conference room. Bookmark this URL to check for upcoming telephone/webcasts: www.sae.org/telewebcasts/.

Webinars – Informative and content-rich, SAE Webinars are instructor-led seminars delivered over the web. You've told us your travel budgets have been cut, so SAE has developed this alternative format to deliver technical courses directly to you. You can log in to the live event from anywhere you have a telephone and a PC with Internet access. Delivered in one or a series of 90 to 120-minute sessions, webinars feature audio delivered by telephone, web-based presentations, interactive question-and-answer, and course-specific online forums for posting of supplemental materials, networking and course activities. CEU's are awarded when course requirements have been met. Registrants to an SAE International webinar can participate live or at a more convenient time through the recorded sessions. The list of scheduled webinars are posted at www.sae.org/webinars.

Visit MyLearn.sae.org today.

To find out more about corporate learning solutions or to purchase programs to accommodate multiple learners within your company, call 1-724-772-8529.

The IACET CEU

SAE International is recognized as an Authorized Provider by the International Association for Continuing Education and Training (IACET). All SAE Professional Development seminars, e-Seminars, webinars, and engineering academies meet eligibility requirements for IACET Continuing Education Units (CEUs) according to the ANSI/IACET 1-2007 Standard. To receive CEUs, attendees are required to be engaged in the entire class and demonstrate mastery of the learning objectives by successfully completing a knowledge assessment.

Many organizations offer some form of continuing education credit, but only the IACET CEU is held to the strict, research-based IACET Criteria and Guidelines for Continuing Education and Training. Only IACET Authorized Providers, who undergo a strict application and site-review process, can award the IACET CEU. IACET Authorized Providers are required to re-apply and be reauthorized every five (5) years.

The Continuing Education Unit (CEU) was created by IACET as a measurement of continuing education. One (1) IACET CEU is equal to ten (10) contact hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction. Under IACET's care, the IACET CEU has evolved from a quantitative measure to a hallmark of quality training and instruction. For more information on IACET, visit www.iacet.org.

To obtain official transcripts, please contact SAE Customer Service at 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada)

ACTAR Approved SAE Seminars

Some SAE courses have been approved by the Accreditation Commission for Traffic Accident Reconstruction (ACTAR) for Continuing Education Units (CEUs). These are identified throughout the catalog with the ACTAR symbol to the left. In addition, the ACTAR CEUs are also listed with the course description.

Upon completion of any of these courses, accredited reconstructionists should contact ACTAR, 1-800-809-3818, to request CEUs. As an ACTAR approved course, the fee for the CEUs for each course is $5.00.

RABQSA Approved Training Provider

SAE International is pleased to be a recognized training provider of the classroom component of the IAQG-Sanctioned Aerospace Auditor Transition Training (AATT). As an approved training provider, SAE is committed to providing the highest level of quality training using the most qualified instructors in the industry. The course description can be found on page 114 of this catalog or by visiting www.sae.org/pdevent/C1034.

SAE International Certificate Programs

SAE has developed programs that package together existing seminars to allow attendees the opportunity to receive an SAE "Certificate of Achievement" for completing a defined collection of knowledge courses within a given content area. SAE currently offers the following Certificates:

- **Diesel Technology Certificate**
- **Fundamentals of Drivetrain Systems Certificate**
- **General Management & Leadership Certificate**
- **Professional & Legal Issues Certificate**
- **Vehicle Dynamics Certificate**

All courses are offered regularly at SAE Automotive Headquarters in Troy, Michigan. There is no formal application process. Courses may be taken at your convenience.

For more detailed course information, please check online at www.sae.org/training for the certificate programs under the Additional Resources tab. Certificate courses can also be conducted at a company site for groups of employees. For a price quote, please contact the Corporate Learning Solutions hotline at 1-724-772-8529.

Fundamentals of Drivetrain Systems Certificate Program

A four-course package that familiarizes engineers with key drivetrain components and how those components function as a system. By completing the Certificate, engineers can increase their expertise within the drivetrain body of knowledge and, at the same time, earn the SAE Certificate of Achievement worth 4.6 CEUs. The following courses are required (their equivalents or substitutes are indented below the required course) and include:

- **Familiarization of Drivetrain Components – I.D. #98024**
  - Fundamentals of All-Wheel Drive Systems – I.D. #C0305
  - A Familiarization of Drivetrain Components e-Seminar – I.D. #PD130555 (CDROM)
  - A Familiarization of Drivetrain Components e-Seminar – I.D. #PD130555ON (online)
- **The Basics of Internal Combustion Engines – I.D. #C0103**
  - Diesel Engine Technology – I.D.#93014
  - Diesel Engine Technology e-Seminar – I.D.#PD130812ON (online)
  - The Basics of Internal Combustion Engines e-Seminar – I.D.#PD130944ON (online)
- **Fundamentals of Modern Vehicle Transmissions – I.D. #99018**
  - Fundamentals of Truck & Off-Highway Transmission Systems – I.D.#C0024
  - Fundamentals of Modern Vehicle Transmissions e-Seminar – I.D.#PD130419 (CDROM)
  - Fundamentals of Modern Vehicle Transmissions e-Seminar – I.D.#PD130419ON (online)
- **Powertrain Selection for Fuel Economy & Acceleration Performance – I.D. #C0243**

General Management and Leadership Certificate Program

This certificate program focuses on four core management and leadership competencies: *management capability, team leadership, project management, and finance*. The following courses are required:

- **Managing Engineering & Technical Professionals – I.D. #C0608**
- **Engineering Project Management - I.D. #99003**
- **Principles of Cost and Finance for Engineers - I.D. #C0828**
- **Leading High Performance Teams - I.D. #C0410 OR Successfully Working in Virtual Teams - I.D. #C0943**

Professional and Legal Issues Certificate Program

This certificate program focuses on some of the core legal and risk management issues that are critical for engineers to master in successfully designing and deploying products from a safety and reliability perspective. Courses address patent law, product liability, risk management, and expert witness testimony. The required courses include:

- **Patent Law for Engineers- I.D. #88007**
- **Product Liability and The Engineer- I.D. #82001**
- **The Role of the Expert Witness in Product Liability Litigation- I.D. #92054**
- **The Role of the Expert Witness in Product Liability Litigation- I.D. #92054**

Diesel Technology Certificate

This five-course package is designed to equip engineers with a solid understanding of diesel engines, emissions and after treatment strategies, and related components including fuel injection, and air management. The program design requires completion of courses that address these areas and then allows for further depth in after treatment technologies through a menu of electives. The required courses are:

- **Diesel Engine Technology – I.D.#93014**
- **Diesel Engine Technology e-Seminar – I.D.#PD130812ON**
- **Diesel Emissions and Control Technologies – I.D.#C0206**
- **Common Rail Diesel Fuel Injection – I.D.#C0920**
- **Turbocharging Internal Combustion Engines – I.D.#C0314**

Electives (Select one)
- Advanced Diesel Particulate Filtration Systems (2 days) – I.D.#C0502
- Catalytic Converters: Design and Durability (2 days) – I.D.#98017
- Catalytic Converters: Design and Durability e-Seminar – I.D.#PD130405 (CDROM)
- Exhaust Flow Performance and Pressure Drop of Exhaust Components and Systems (1 day) – I.D.#C0235
- Selective Catalytic Reduction for Diesel Engines (2 days) – I.D.#C0913

Diesel Academy substitution
Individuals completing the ***Diesel Engine Technology Engineering Academy*** may use it as a substitute for the ***Diesel Engine Technology*** seminar and one elective in the Diesel Technology Certificate. The other three Required Courses must still be completed.

Vehicle Dynamics Certificate

This five-course package is designed to equip engineers with key vehicle dynamics and handling theory and application from a systems perspective. The objective is for engineers to understand the interaction and performance balance between the major vehicle subsystems including powertrain, brakes, steering, suspensions, and wheel/tires. The program design requires completion of both fundamental and advanced-level vehicle dynamics theory and application courses followed by three elective courses that best suit an individual's interest areas or engineering emphasis.

Required Courses
- Vehicle Dynamics for Passenger Cars and Light Trucks (3 days) I.D.#99020
  - Vehicle Dynamics for Passenger Cars and Light Trucks e-Seminar –I.D.#PD130702
- Fundamentals of Heavy Truck Dynamics (3 days) – I.D.#C0837
- Advanced Vehicle Dynamics for Passenger Cars and Light Trucks (3 days) I.D.#C0415

Electives (Select three courses)
- Applied Vehicle Dynamics (3 days) - I.D.#C0414
- Chassis & Suspension Component Design for Passenger Cars & Light Trucks (3 days) I.D.#95025
- Commercial Vehicle Braking Systems (3 days) - I.D.#C0233
- Commercial Vehicle Braking Systems e-Seminar - I.D.#PD130611
- Fundamentals of Steering Systems (2 days) - I.D.#C0716
- Heavy Vehicle Ride Comfort Engineering (1 Day) - I.D.#C0948
- Hydraulic Brake Systems for Passenger Cars and Light Trucks (3 days) - I.D.#C0509
- High-Performance Brake Systems (2 days) - I.D.#C0718
- Introduction to Brake Control Systems: ABS, TCS, and ESC (2 days) - I.D.#C0315
- Introduction to Brake Control Systems e-Seminar – I.D.#PD130501
- The Tire as a Vehicle Component (1 day) - I.D.#C0101
- Tire and Wheel Safety Issues (1 day) - I.D.#C0102

Additional elective courses
Courses no longer offered by SAE but eligible to be used as electives for this program, providing they were completed within five years of the date the Certificate is requested, include:
- Applying Brake Controls to Vehicle Dynamics (2 days) - I.D.#C0551
- Automobile Vehicle Dynamics (3 days) - I.D.#91034
- Concurrent Engineering Practices Applied to the Design of Chassis Systems (3 days) - I.D.#96016
- Sensors and Actuators: Chassis Applications (1.5 days) - I.D.#97020
- Tires and Handling for Racing and High Performance Vehicles (1 day) - I.D.#C0517
- Vehicle Dynamics Applied to Racing (2 days) - I.D.#C0249

Here's how you obtain your SAE Certificate of Achievement

Here's how you obtain your SAE Certificate of Achievement Once you complete all required courses in any of the certificate programs, simply contact SAE Customer Service, 1-877-606-7323 (or 1-724-776-4970 outside U.S. & Canada) or email: customerservice@sae.org and request your Certificate. Your SAE transcript will be reviewed to verify completion of required courses and your Certificate will be mailed to you within 30 days.

SAE Certificate Programs can also be conducted at your company site for groups of employees. For a price quote, call our **Corporate Learning Solutions hotline, 1-724-772-8529.**

www.MyLearn.sae.org

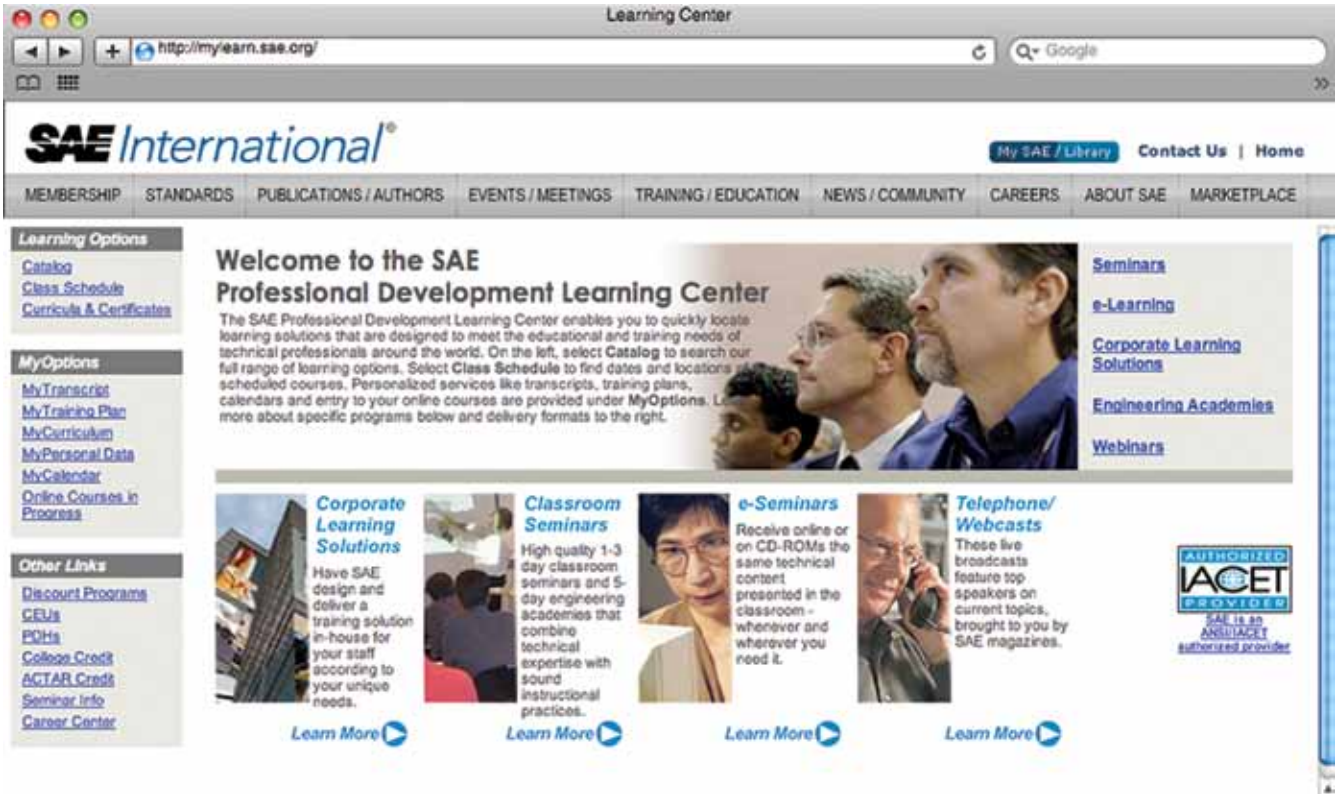
The SAE Professional Development Learning Center houses all of SAE's professional development learning opportunities including instructor-led classes, e-Seminars, online courses, etc.

Visit MyLearn.sae.org and see how SAE can be your one-stop shop for your ongoing professional development needs!

The SAE Professional Development Learning Center enables you to quickly locate learning solutions that are designed to meet the educational and training needs of technical professionals.

MyLearn.sae.org also provides SAE learners the opportunity to:

- get their own transcript
- plan and schedule their training
- enroll in certificate programs or curriculums of study
- register or purchase any of the learning opportunities
- check out what's new in SAE professional development activities
- download a full catalog of programs



Fees listed with course descriptions are for open enrollment classes only.
For a no obligation price quote to bring a course to your company, contact
SAE Corporate Learning, 1-724-772-8529.

Fundamentals of Commercial Vehicle Aerodynamics.....1

Fundamentals of Commercial Vehicle Aerodynamics

2 Days
I.D.# C0919

Aerodynamic considerations in the design and operation of commercial vehicles have significant implications to fuel economy, engine cooling, handling, and safety. Aerodynamic drag, in particular, is an important customer concern due to its significant influence on the fuel operating cost of heavy trucks. The airflow around the vehicle and through the engine compartment produces pressure distributions that result in aerodynamic forces and moments. The aerodynamic characteristics are determined by the overall shape of the vehicle, the detail shape of each body panel, the design and location of tires, the underbody, and cooling components. Integrating drag-reducing features into the vehicle design requires an understanding of the basic principles and their application. This seminar will detail the fundamentals of aerodynamics and the tools (wind tunnels, track testing, and airflow visualization) used in the design of commercial vehicles. Testing of scale models, measurement methods, and data interpretation will be covered, as well as the influence of crosswinds and interpretation of surface pressures.

Attendees will receive a copy of the SAE J1252: *Wind Tunnel Test Procedure for Trucks and Buses.*

Learning Objectives

By attending this seminar, you will be able to:
- Describe the fundamentals of road vehicle aerodynamics with specific application to heavy duty trucks
- Analyze drag, lift, aero pressures, and air flow
- Describe the basics of flow visualization and the instrumentation needed to measure aerodynamic data
- Identify appropriate testing methods and opportunities to reduce drag
- Describe wind tunnel and on-road testing methods
- Identify some of the major sources of aerodynamic drag and related shape parameters

Who Should Attend

Engineers, product designers, and managers who are associated with projects where vehicle aerodynamics will likely play a role will benefit from this course.

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

DAY ONE
- Review of Basic Information on Fluid Dynamics
  - Definitions
  - Fluid classification
  - Ideal gas law
  - Properties of fluids
  - Laminar and turbulent flow
- Fluid Statics
  - Fluid statics
  - Hydrodynamics equation
  - Manometry
  - Standard atmosphere
- Fluid Dynamics and the Bernoulli Equation
  - Aerodynamics and the Laws of Physics
  - Mass flow rate and the Continuity Equation
- Internal Flow
  - Laminar and turbulent
  - Friction factor and pressure loss
  - Flow measuring techniques
  - Applications
- External Flow
  - Fluid motion and kinematics
  - Ideal flow (inviscid)
  - Viscous effects & separation
  - External flow characteristic features and examples
  - Pressure drag and forces on immersed bodies
  - Euler's Equation and Bernoulli's Equation
  - Streamlines
  - Applications
- Dimensional Analysis and Aero Models
  - Dimensional analysis
  - Similitude
  - Examples

DAY TWO
- Flow Visualization
  - Techniques and interpretation
  - Smoke flow videos
- Truck Aerodynamics
  - Drag and fuel economy
  - SAE J1252: Wind Tunnel Test Procedure for Trucks and Buses
  - Truck aerodynamic features
  - Effect of crosswinds and wind averaged-drag coefficient
  - Add-on devices
  - Operational considerations
  - Cooling drag
- Wind Tunnels and On-Road testing
  - Types of test sections
  - Wind tunnels
  - Blockage corrections
  - Ground simulation
  - Correlation
  - ABCD coast down method
  - Wind tunnel-to-road drag correlation
  - SAE J1321: Fuel Consumption Test Procedure Type II
- CFD in Product Development
  - Overview
  - Benefits
  - Verifying results
  - CFD quality
- Course Assessment and Summary

Instructor: Jack Williams
Fee $1285 1.3 CEUs

Digital Avionics Fiber Optics Technology and Standards for Aerospace 2
Introduction to AS5553 and Counterfeit Electronic Parts Avoidance Training 2

Digital Avionics Fiber Optics Technology and Standards for Aerospace

1 Day
I.D.# C0924

Once used only sparingly in select digital avionics air vehicle interconnect applications, fiber optics technology has gained widespread acceptance and is becoming increasingly prevalent as standard equipment on modern aerospace platforms. As such, most new aerospace platform or retrofit programs include a fiber optic trade study in its conceptual and system design and development process. This comprehensive seminar introduces participants to aerospace fiber optics technology. Additionally, this seminar provides an overview of important standards that are available to them during the system design and development process.

This one-day seminar begins with a discussion on the basic physics of light and its application to fiber optics. Following a fundamental overview of fiber optic cable, connector, and transceiver technologies, participants learn about supportability, maintainability, manufacturing quality, and installation concerns, with emphasis given to design interface controls and life cycle cost parameters. Prior lessons learned are summarized with an emphasis on aerospace fiber optic design engineering and support principles. The seminar concludes with an in-depth description of relevant military and aerospace standards along with an example digital fiber optic system design and development methodology case study.

Learning Objectives

By attending this seminar you will be able to:
- Explain the basic physics of light and how light couples into and out of an optical fiber
- Identify the benefits of fiber optics technology applied to aerospace platforms
- Define the construction and performance of aerospace fiber and fiber optic cable
- Identify how fiber optic connections are made on aerospace platforms
- Identify how fiber optic cables and connectors are selected for aerospace applications
- Appraise digital fiber optic transmitter and receiver parameters
- Identify digital fiber optic link characteristics and design principles, and avionics fiber optic interface control parameters
- Recognize the key underlying elements of aerospace fiber optic supportability, reliability and maintainability and their relationship to life cycle cost
- Identify fiber optic cable termination best practices for aerospace
- Relate the content and application of SAE and MIL standards to avionics fiber optic system design and specification
- Recognize future directions for avionics fiber optics and photonics technology

Who Should Attend

This seminar will benefit any aerospace contractor residing in the aerospace fiber optics supply chain including component manufacturers, subsystem providers, system integrators, engineers, research scientists, instructors, technicians, logisticians, and students

Prerequisites

Basic understanding of physics and electronics.

Topical Outline

- The Basic Physics of Light and its Application to Fiber Optics
- Introduction to Fiber Optics Technology
  - Singlemode fiber
  - Multimode fiber
- Avionics Fiber Optic Cable Assemblies
  - Fiber optic cable
  - Fiber optic termini
  - Fiber optic connectors
  - Fiber optic cable assembly testing
- Digital Fiber Optic Transmitters and Receivers (Transceivers)
- Digital Fiber Optic Transmitter and Receiver Packaging Technology
- Digital Fiber Optic Link Design and Testing Principles
  - Interface control document
  - Link loss power budget
  - Fiber optic cable optical testing and fiber optic link bit error rate testing
- Fiber Optic Cable Assembly Qualification
- Aerospace Fiber Optic System Supportability and Maintainability
- Relevant Standards Organizations
- SAE and MIL Fiber Optic Standards
- System Design and Development Case Study
- Future Directions for Avionics
- Closing and Evaluations

Instructor: Mark Beranek

Fee $725 .7 CEUs

Introduction to AS5553 and Counterfeit Electronic Parts Avoidance Training

1 Day
I.D.# C0950

Counterfeit electronic parts have been found in almost every sector of the electronics industry and continue to be an increasing threat to electronic hardware. This threat poses significant performance, reliability and safety risks. Aerospace industry organizations, in particular, must produce and continually improve safe and reliable products that meet or exceed customer and regulatory authority requirements. The SAE AS5553 standard was created in response to the significant and increasing volume of counterfeit electronic parts entering the aerospace supply chain and standardizes

requirements, practices and methods for counterfeit parts risk mitigation. The resulting document presents solutions to address counterfeit electronic parts issues across a large cross-section of the electronics industry. This comprehensive one-day seminar introduces participants to AS5553 and specifically addresses counterfeit part risk mitigation methods in electronic design and parts management, supplier management, procurement, part verification, material control, and response strategies when suspect or confirmed counterfeit parts are discovered. The seminar will provide information and guidance in each of these key requirement areas. The latter part of the course will highlight counterfeit detection techniques and part compliance verification methods.

Several examples of counterfeit parts will be reviewed in detail. The course will conclude with a hands-on learning exercise in identifying, under a microscope, characteristics that can be found in counterfeit electronic parts. To accomplish this, attendees are encouraged to bring a personal laptop computer. The instructors will provide a limited number of digital microscopes and electronic parts.

In addition to the seminar handout, a copy of the AS5553-Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition standard is provided to each registrant.

Learning Objectives

By attending this seminar, you will be able to:
- Characterize and describe the threat of counterfeit electronic parts
- Identify the characteristics of an effective Counterfeit Parts Control Plan
- Demonstrate one of the first steps in verification of purchased product (inspection techniques for counterfeit parts)
- Recognize suspect counterfeit parts

Who Should Attend

This seminar will benefit a wide range of individuals and experience levels across the electronics industry and supply chain. Anyone who designs, specifies, buys, receives, assembles and tests electronic hardware will benefit from this seminar. This includes electronic design engineers, parts engineers, quality assurance engineers, buyers, auditors, inspectors, assemblers, electronic test engineers, microelectronic non-destructive test engineers, destructive test analysts, and supplier managers. Additionally, this seminar will benefit individuals in various levels of management that influence electronic hardware.

Prerequisites

None

Topical Outline

- Introduction
- AS5553
  - Terms and definitions
  - Magnitude and impact of counterfeiting
  - Counterfeit electronic part examples
  - G-19 Committee and its challenges
  - AS5553 structure
  - Requirements
  - Counterfeit electronic parts control plan
  - Parts availability
  - Purchasing processes
  - Procurement contract requirements
  - Verification of purchased product
  - Control of suspect or confirmed counterfeit parts
  - Reporting
  - Future G-19 plans
- Counterfeit Parts Recognition
  - Terms and definitions
  - Types of counterfeits
  - E-Waste
  - Documentation review
  - Slides of counterfeit parts and their features
  - Non-destructive and destructive testing for counterfeits
  - Hands-on inspection with microscopes
- Closing
  - Assessment
  - Evaluations

Instructor: Phil Zulueta and Katherine Whittington
Fee $785 .7 CEUs

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Emissions-Related OBD Systems: A Design Overview ... 12
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Fundamentals of Shielding Design for EMC Compliance ... 13
In-Vehicle Networking with LIN and FlexRay Applications ... 14
Power Electronics for EV, HEV and PHEV Applications ... 15
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Accessing and Interpreting Heavy Vehicle Event Data Recorders

4 Days
I.D.# C1022

Recent advances in commercial vehicle equipment have increased the potential for incident-related data to be recorded surrounding a collision event. What some have called a "black box" is more properly referred to as a Heavy Vehicle Event Data Recorder (HVEDR) as defined by the SAE J2728 HVEDR Recommended Practice. The term HVEDR is used to describe any type of electronic function that has the capability of storing data surrounding a defined event within an electronic control module found on a heavy truck or bus and that communicates on the SAE J1939 or J1587/J1708 data communications protocol. This course highlights the various vehicle systems and triggering events that may provide data useful in a collision investigation. Guided by recognized industry experts, techniques for preservation and interpretation of HVEDR data will be explored. This highly interactive workshop includes in-class instruction, demonstrations and practical hands-on experiences for acquiring and analyzing data from commercial vehicles.

Learning Objectives

Upon completion of this workshop, you will be able to:
- Identify the potential sources of HVEDR data available on commercial vehicles
- Utilize various methodologies for accessing and imaging data from HVEDRs while preserving the data in its original electronic format within the control module
- Compile documentation of the vehicle and the imaged HVEDR data to properly establish foundational facts that tie the data to the vehicle and to ensure the reliability of incident specific data
- Properly interpret data from HVEDRs and understand the limitations of this data
- Analyze HVEDR data in the context of collision reconstruction

Who Should Attend

This course is a must for anyone involved in the investigation and analysis of commercial vehicle crashes who needs to understand the types of event data that are available on commercial vehicles, how it is generated, how it is accessed from the vehicle, and how to apply it in a collision reconstruction. In addition, this course can be valuable to the motor carrier safety manager, independent adjusters, claims managers or attorneys handling commercial vehicle collisions.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. A basic knowledge of college physics and calculus, as well as a familiarity with commercial motor vehicles is expected.

Topical Outline

DAY ONE
- Primer on Multiplexed Vehicle Electronics Systems and Vehicle Data Networks
  - Network architecture -- SAE J1587/J1708; SAE J1939
  - Industry standards for EDR devices -- SAE J2728; TMC RP1210; Other industry standards; Potential government regulations
- HVEDR Devices and Data Currently Available on Heavy Vehicles
  - Engine control systems --Detroit Diesel; Mercedes-Benz; Cummins; Caterpillar; Mack; Volvo; International; PACCAR; Hino; UD; Isuzu; Mitsubishi
- Antilock brake and stability control systems -- Bendix/Knorr-Bremse; Meritor WABCO; TRW
- GPS/telematics systems -- Qualcomm; CADEC; Xata
- Collision avoidance systems -- Bendix VORAD
- Video recorders -- DriveCam; iWitness

DAY TWO
- Inspecting the Vehicle
  - Chassis & powertrain identification
  - Chassis & powertrain health
  - Vehicle configuration
  - Collision damage
- Accessing and Imaging Data
  - Through in-cab diagnostic port
  - Direct to module (benchtop)
  - Truck-in-box simulators

DAY THREE
- Validation Studies and the Accuracy/Reliability of HVEDR Data
- Interpreting and Applying HVEDR Data
  - Determining whether data imaged from a HVEDR is related to an incident of interest
  - Determining where impact occurred in dataset
  - Comparing vehicle speed to engine speed
  - Determining gear selection
  - Determining travel distance
  - Determining acceleration/deceleration
  - Determining driver inputs
  - Rollover signatures
  - Rear impacts

DAY FOUR
- The Future of HVEDR
- Hands-on Workshop

Instructor: Timothy Cheek and John C. Steiner
Fee $1995 2.6 CEUs

Acquiring and Analyzing Data from Sensors and In-Vehicle Networks

2 Days
I.D.# C0522

The acquisition of test data is required throughout the product's life cycle - in prototype performance evaluation, reliability/durability testing, duty-cycle analysis, end of line testing, and service and aftermarket product areas. Both lab and on-road testing is needed for components, sub-systems and entire vehicles.

As in-vehicle networks become increasingly more sophisticated in terms of the number of controllers, the speed at which they communicate, and the number of parameters available, they are a virtual goldmine for the test engineer. If the data is already available on the vehicle network, the engineer may only need to add any missing sensors (or possibly none at all).

After reviewing the traditional approach of acquiring data directly from sensors, the course will focus on the newer approach of obtaining data from the in-vehicle network. Attention is given to the complications of taking data from the in-vehicle network and how to overcome them, current trends and applications, wireless data acquisition (Wi-Fi and cellular), GPS, relevant technical standards, and how to simultaneously acquire network data with direct sensor measurements. Both PC-based and logger (flight recorder) data acquisition will also be covered. In addition, a practical guide for analysis and presentation techniques will be covered along with examples.

Learning Objectives

By attending this seminar, you will be able to:
- Acquire data from both in-vehicle networks and sensors
- Avoid common pitfalls of acquiring and analyzing good data
- Request messages and decode them to acquire engineering parameters using various network protocols such as: CAN (controller area network), J1939, ISO15765, J1708, SAE J1850, KWP2000 and ISO9141
- Choose the best analysis techniques to better understand and present test data
- Compare benefits of acquiring data with a PC vs. a stand-alone data logger (without a PC in the vehicle)
- Discover what a PC or stand-alone logger is capable of doing for real-time data acquisition, analysis, display and storage of data
- Identify an unknown network protocol
- Reverse engineer data on the network

Who Should Attend

Any engineer, scientist or technician who needs to acquire test data will benefit from this course. Testing is required throughout the product's life cycle from prototype performance evaluation, to reliability/durability testing, end of line testing and service. This includes testing of components, sub-systems and entire vehicles done in both the lab and in-vehicle road testing.

Prerequisites

Some test experience is preferred and knowledge of college algebra is recommended.

Topical Outline

DAY ONE:
- Acquiring Data Directly from Sensors
  - Sensor Inputs: Sensor overview, single-ended vs. differential inputs, proper ranging of the channels, zeroing offsets and signal conditioning.
  - Data Acquisition: Analog-to-digital converters (A/D), time and amplitude resolution, pre- and post-triggering, time synchronous averaging, sample rate, aliasing, frame length and number of frames in a data file.
- Frequency Domain
  - Analyzing data in the frequency domain with the Fast Fourier Transform (FFT) is a valuable tool to optimize sample rate, which affects many factors such as data quality (aliasing), time and frequency resolution, digital filtering, integration and differentiation. Analyzing and displaying the data in the revolution (angular) domain and order domain offer valuable insights into the data.
- In-Vehicle Data Acquisition
  - Comparison of in-vehicle data acquisition with sensor data acquisition.
  - Explanation of OBD-II and what it can and cannot do for you
  - Examination of files containing hex messages. Learn the steps required to convert to useful engineering parameters (e.g. engine RPM, wheel speed, ambient temperature). Message files will be shown from both heavy duty and automotive vehicles

DAY TWO:
- In-Vehicle Data Acquisition - continued
  - Step-by-step procedure to acquire parametric data for both a PC and stand-alone loggers.
  - Explanation of why the database relating parameters and messages is the key and how to get this database information.
  - Demonstration of acquiring data from both an in-vehicle network and sensors
  - Review of applicable standards and references.
  - Identify unknown automotive protocols and learn about the various network protocols
  - Define wireless data acquisition options, the advantages and disadvantages of them and the practical throughput rate for real-time data acquisition.
- Data Analysis Techniques
  - How to select the best numerical techniques and how to optimize their performance for digital filtering (including IIR and FIR filters), integration, differentiation, and correlation.
  - How combining logic, statistics and Z transform provides a powerful technique to find key points along a waveform to make decisions such as pass/fail or perform intelligent monitoring that only stores the data of interest to optimize data storage and minimize your time required to review the data.

Instructor: Richard Walter
Fee $1265 1.3 CEUs

A Holistic Introduction to Commercial Telematics

2 Days
I.D.# C0947

The technical difficulty, time, and costs associated with deploying a successful telematics system are often underestimated. This seminar provides participants a comprehensive overview of the various technologies that make up a telematics system as a whole and provides the information necessary to help drive intelligent decisions that have long-term benefits. This two-day seminar will begin with a review of the origins, technologies, and systems used in creating and operating modern-day telematics systems. The main technologies will be broken down into five categories, all of which are required to operate in unison in order for the system to be successful. This will include automotive technologies necessary to gain access to vehicle operating data, wireless technologies to establish communications, navigation technologies to introduce location, antennas that enable wireless, and data management to manage and make data useful. A series of practical examples will allow attendees the opportunity to work through each of the functional technologies and implement a simple telematics solution. The seminar will conclude with a discussion of the issues that drive a cost vs. buy decision on the specific elements in the telematics value chain, as well as various applications currently being deployed and the exploration of future applications within the telematics market. Attendees are encouraged to bring a laptop computer with a dual-boot Linux operating system installed.

Learning Objectives

By attending this seminar, you will be able to:
- Distinguish the various technologies used in telematics systems
- Assess the difficulty, time, and costs required to deploy a functional telematics solution
- Evaluate alternatives and make decisions on where to spend development dollars, and when to rely on outside resources
- Construct and demonstrate a simple telematics system
- Recognize the role current and future telematics technologies will play in our collective future

Who Should Attend

Engineers at all levels wanting to gain a better understanding of the fusion of technologies involved in telematics systems will benefit from this seminar. Also benefiting are OEMs looking for a competitive advantage and field data that will improve their product development system. Fleet operators looking to increase business productivity, better manage their assets, meet regulatory requirements more efficiently, and improve asset utilization will also benefit from the technical information presented.

Prerequisites

A technical background will greatly simplify the understanding and absorption of the material presented. Additionally, any working knowledge of the C programming language will also be of benefit to attendees during the practical portion.

Topical Outline

DAY ONE
- Telematics Overview
  - Definition
  - Historical Origins -- One size does not fit all
- Telematics Technologies
  - Overall System Architecture
  - Automotive -- Vehicle Bus architecture; Protocols; Power requirements; Regulatory requirements; Proprietary barriers
  - Wireless -- Providers/ISP's; Terrestrial; GSM; CDMA; FM-RDS; WAN/PAN; 802.11; Zigbee; WiMax; Bluetooth; SATCOM; LEO; GEO
- Navigation -- GPS; Galileo; Everything Else
- Antennas -- The black magic
- Data Management -- Hosting/Servers; Databases; Scalability; NOC; Availability; Backup; Security; ASP
- Getting Started -- Basic System Architecture; Environment Setup; Powering up and getting familiar with the system

DAY TWO
- Practical Example #1
  - Vehicle Bus -- Standard messages; Capturing all data; Filtered messages; Capturing specific messages
- Practical Example #2
  - Navigation -- Capturing GPS stream; Combining GPS data with bus data
- Practical Example #3
  - Establishing network communications -- Basic communication setup; Terminal monitoring of network communication; Sending GPS/Bus data to server
- Practical Example #4
  - Send a formatted message to back-end application -- Display results on map
  - Receive and decode formatted message from server -- Send specific vehicle bus data (request)
- Cost-Value / Cost-Performance
- Make vs. Buy: Hardware; Software; Back office
- Future Implications and Applications
  - Insurance -- Black Boxes; Usage based insurance
  - Safety & Security -- People; Products; RFID
  - Compliance/Regulation -- Intelligent highways; Sarbanes-Oxley
- Closing and Evaluation

Instructor: Emad Isaac
Fee $1155 1.3 CEUs

Controller Area Network (CAN) for Vehicle Applications

2 Days
I.D.# C0120

The Controller Area Network has become the standard of choice for most automotive manufacturers. Approved for use as an ISO and EPA diagnostic network, its usage continues to grow. This seminar covers the theory and use of the CAN protocol, and its applications in the automotive industry. Details on how the CAN protocol and other standards (J2411, J2284, J1939, ISO 11898, etc.) complement each other will be presented. Attendees will learn about CAN application layers; the latest J1939, J2284, J2411, and IDB standards, regulations, and implementation requirements; and details of device hardware and software interfaces. Also presented will be demonstrations using system development tools. The SAE standard, J1939 Recommended Practice for a Serial Control and Communications Vehicle Network, is included in the course materials.

Learning Objectives

By attending this seminar, you will be able to:
- Explain CAN protocol.
- Demonstrate how CAN is used in various automotive applications.
- Employ CAN-related standards and specifications.

Who Should Attend

This seminar is geared toward validation engineers, test engineers, embedded programmers, and those who are currently working (or will be in the future) with applications using CAN. Participants should have an undergraduate engineering degree.

Topical Outline

DAY ONE
- In-vehicle market overview
- General network topology overview
- CAN protocol
- CAN controller programming
- CAN physical layers
- Overview of J2411, J2284, IDB, J1939, Diagnostics on CAN, etc.

DAY TWO
- J1939 in-depth review
- IDB in-depth review
- Demonstrations

Instructor: Mark Zachos
Fee $1285 1.3 CEUs

Controller Area Network (CAN) for Vehicle Applications e-Seminar

I.D.#PD130557ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this 10.5 hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. This course offers an introduction, six modules, and a Gryphon demonstration on video, accompanied by a handbook with exercises.

View the complete program brochure and online demo at http://www.sae.org/eseminars/can.

What You Will Receive:

- 365 day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (Downloadable .pdf's subject to DRM)
- The SAE standards, J1939 Recommended Practice for a Serial Control and Communications Vehicle Network and J1939/71 Recommended Practice for Vehicle Application Layer (bound, paperback)
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Mark Zachos
Fee $575 1.1 CEUs

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Control Systems Simplified

2 Days
I.D.# C0525

The advent of digital computers and the availability of ever cheaper and faster micro processors have brought a tremendous amount of control system applications to the automotive industry in the last two decades. From engine and transmission systems, to virtually all chassis subsystems (brakes, suspensions, and steering), some level of computer control is present. Control systems theory is also being applied to comfort systems such as climate control and safety systems such as cruise control or collision mitigation systems.

This seminar begins by introducing the highly mathematical field of control systems focusing on what the classical control system tools do and how they can be applied to automotive systems. Dynamic systems, time/frequency responses, and stability margins are presented in an easy to understand format. Utilizing Matlab and Simulink, students will learn how simple computer models are generated. Other fundamental techniques in control design such as PID and lead-lag compensators will be presented as well as the basics of embedded control systems. During this interactive seminar, attendees will utilize case studies to develop a simple control design for a closed loop system. And, with the aid of a simple positioning control experiment, students will learn the major components and issues found in many automotive control applications today.

Learning Objectives

By attending this seminar, you will be able to:
- Determine performance characteristics of open and closed loop systems such as time and frequency responses and stability margins
- Analyze compromises and select the best compromised solution between stability and closed loop performance metrics
- Model simple physical systems in MatLab/Simulink environment
- Analyze and design simple compensators in MatLab/Simulink environment
- Evaluate issues associated with digital control systems including effects of sampling time, word length, and throughput
- Explain the functions of various components found in today's automotive embedded control systems including ECU I/O section, software/algorithm, power electronics, and sensors and actuators
- Communicate with control systems designers more effectively in terms of technical issues as well as toolsets, and functional needs

Who Should Attend

This introductory course is designed for individuals with little or no background in control systems. Engineers, managers, and technical managers with backgrounds in systems, mechanical, electrical, or industrial engineering who work with vehicle chassis (suspension/brakes/steering), powertrains, comfort systems, vehicle dynamics, sensors/actuators, and diagnostics will find the seminar beneficial. Test engineers and technicians, patent attorneys, and business executives may also find this course valuable.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. Basic knowledge of college algebra, college physics, and a familiarity with vehicle systems is required.

Topical Outline

DAY ONE
- Background Information
  - Examples and block diagrams -- Open and closed loop systems
  - Dynamic systems (time and frequency domains)
  - Stability
  - Compromises of a closed loop system
- Model Development
  - Modeling philosophies
  - Case study -- Problem description; Governing equations; Create a model based on transfer function; Create a model based on Simulink blocks
- Model Analysis
  - Case study -- Simulation issues (numerical integration); Linear analysis - frequency domain; Nonlinear analysis - time domain
- Compensation (Controller Design) Methods
  - On-Off
  - Gain
  - PID
  - Lead-Lag

DAY TWO
- Control System Design
  - Case study -- Design philosophies; Time domain based design; Frequency domain based design
- Embedded Systems
  - Elements of embedded control systems
  - Experiment
  - Digital control
  - Implementation issues
- Design Implementation
  - Case Study -- Digital issues; Experiment; Sensors and estimation; Software architecture;
- Advanced Subjects
  - Nonlinear/adaptive control
  - Robust control
  - Trends, tools and references

Instructor: Farhad Bolourchi
Fee $1265 1.3 CEUs

Designing On-Board Diagnostics for Light and Medium Duty Emissions Control Systems

3 Days
I.D.# C0707

On-board diagnosis of engine and transmission systems has been mandated by government regulation for light and medium vehicles since the 1996 model year. The regulations specify many of the detailed features that on-board diagnostics must exhibit. In addition, the penalties for not meeting the requirements or providing in-field remedies can be very expensive. This course is designed to provide a fundamental understanding of how and why OBD systems function and the technical features that a diagnostic should have in order to ensure compliant and successful implementation.

Fundamental design objectives and features needed to achieve those objectives for generic on-board diagnostics will be covered. The course will also include a review of the California Air Resources OBD II regulation, providing students with a firm foundation for reading and understanding the requirements, including the in-use rate portion of the regulations and how to properly calculate and output the required rate information. Relationships between the regulation and various SAE and ISO recommended practices will be reviewed. The course will also explore the relationship of the OBD system with the underlying control system.

Note that because of proprietary considerations, this class does not provide details of algorithm design, algorithm performance, or algorithm application. The class will cover general OBD algorithm designs and the features required to promote sound OBD system design.

Learning Objectives

By attending this seminar, you will be able to:
- Articulate the underlying design objectives of on-board diagnostic systems
- Use the latest California Air Resources Board On-Board Diagnostic Regulation for Light and Medium Vehicles to find and apply OBD requirements
- Apply the design features that all diagnostics need for successful implementation
- Design diagnostics to comprehend variation
- Successfully implement algorithms to track in-use rates in accordance with the CARB OBD II Regulation
- Use SAE J1979 to implement generic scan tool support in diagnostic design
- Implement OBD design requirements in control system design

Who Should Attend

This course is designed for engineers involved in either the design or control of on-board diagnostic systems for engines or transmissions for light and medium duty on-road vehicles. Individuals working in the heavy duty industry may also find the information interesting, but should note that the examples will be geared towards spark ignition engines and light and medium duty regulations. In addition, engineers involved in engine and transmission hardware will benefit by obtaining a better understanding of the design of OBD systems. Engineers new to the area of OBD system design and engineers involved in the design of control systems wishing to obtain a better understanding of OBD requirements will also find the course valuable.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. A basic knowledge of college algebra, college physics, and a familiarity with modern engine or transmission systems is required.

Topical Outline

DAY ONE
- Fundamental Design Objectives for OBD Systems
- Basic Design Features for OBD Systems
- Exercise: “Customers” and their OBD Requirements
- Overview of the World Wide OBD Regulatory Structure
- California Air Resources Board (CARB) Regulatory Process
- How to use the CARB Light/Medium Regulation
  - Malfunction and diagnostic system requirements
  - Enforcement of malfunction and diagnostic system requirements

DAY TWO
- CARB Regulation - an in-depth look at:
  - In-use rates
  - Comprehensive component requirements
- Introduction to a Diagnostic Design Process (Box, Graves, Bisgaard, Van Gilder, et al)
- Defining “Good” vs. “Bad” Systems
- Exercise: Defining Good vs. Defective Systems

- Anatomy of an On-Board Diagnostic
- Diagnostic Modeling
- Exercise: Induction System Modeling
- Understanding and Dealing with Variation
  - Decision making processes
  - Design guidelines for Exponentially Weighted Moving Averages (EWMA)

DAY THREE
- SAE J1979 - An Overview
- Exercise: Finding Information in J1979
- System Design for Diagnosibility
- Overview of Regulatory Requirements Related to OBD
  - In-use Enforcement
  - Emissions warranty
- OBD Certification Process
- The Relationship between the Control and OBD System Design

Instructor: John Van Gilder
Fee $1605 2.0 CEUs

Distributed Automotive Embedded Systems

2 Days
I.D.# C0306

The need for in-vehicle communication systems has increased rapidly in recent years due to technological advances and customer demand. This seminar provides background on the most important issues related to automotive embedded systems operating in a network environment. While the widely-used CAN protocol is primarily cited in examples and applications, emerging protocols such as TTP/C and FlexRay will be also discussed.

Attendees will be able to analyze different automotive applications in terms of their communication requirements and will develop skills to assess the advantages and disadvantages of competing communication technologies. New trends in automotive communication systems and the growing demands for safe, reliable, real-time, and secure networks will also be covered.

After an overview of the fundamental requirements for communication systems, this seminar provides in-depth coverage of: event-based and time-triggered computing and communications; the typical automotive applications of in-vehicle networks; CAN protocol; characteristics of TTP/C and FlexRay; and the design, analysis, and implementation of distributed automotive embedded systems using CAN.

Learning Objectives

By attending this seminar, you will be able to:
- Organize, differentiate and interpret the fundamental concepts, features, and applications (as well as the physical, logical, and functional architectures) of Distributed Embedded Systems
- Contrast and differentiate the concepts of event-driven and time-driven communications
- Design software that takes into account timing constraints
- Evaluate requirements for safe and reliable software in automotive applications
- Contrast and differentiate the fundamental features and applications of the CAN, TTP/C, and FlexRay protocols
- Compare and appraise the various application software architectures: process and state-based, cyclic executives.

Who Should Attend

This seminar is targeted to engineers responsible for the design, analysis, and implementation of in-vehicle communications systems (and those involved with automotive functions that need communications technology). Some familiarity with microprocessors and/or micro-controllers and an engineering degree is recommended. Previous background or basic knowledge of communications or networking is beneficial but not required.

Topical Outline

DAY ONE
- Introduction
  - Definitions: Embedded system, real-time system, communication system, computing system, control system, distributed control system, distributed embedded system.
  - Functions of an embedded system
  - Functions of a distributed embedded system
  - Event based computing
  - Time triggered computing
- Typical applications of distributed automotive embedded systems
  - Chassis: Steer-by-wire
  - Body: Windows and door control
  - Engine control: Ignition control
  - Motor control (engine counterpart for hybrid and electric vehicles): VFC Induction motor drive
  - Infotainment: Audio and video vehicle distribution
- Real-time local embedded software
  - Importance of embedded automotive software
  - Automotive computing environment (Sensors, controllers, and actuators)
  - Software development process (Manual versus automatic code generation)
  - Software architecture and related architectures
  - Software architecture patterns and models
  - Application software development
  - Safe and reliable software
  - Embedded coding standards: MISRA-C
- Real-time networks and protocols
  - Event based versus time triggered communication
  - Communication architectures and protocols
  - CAN
  - Time triggered CAN
  - TTP/C
  - FlexRay
  - Comparison of CAN, TTP/C, and FlexRay
  - Applications of CAN, TTP/C, and FlexRay

DAY TWO
- Real-time distributed systems
  - Distributed functions and variables
  - Distributed message scheduling
  - Distributed computing
- Design of distributed embedded systems
  - Event based versus time triggered applications
  - Distributed functions
  - Function partitioning and allocation
  - Processor and message scheduling
- Implementation of distributed systems
  - Development cycle
  - V-cycle Rapid prototyping
  - HIL (Hardware in the loop) Simulation
  - System integration
  - Tools

Instructor: Juan R. Pimentel
Fee $1225 1.3 CEUs

Electrohydraulic Controls for Mobile Equipment & Vehicles

3 Days
I.D.# C1011

Electrohydraulic technologies have been utilized in aerospace and industrial applications for well over fifty years. Already mature in such applications as ABS and traction control, electrohydraulics continues to be used in newer applications such as electronic stability control and active and semi-active suspensions. In off-highway applications, designers are using electrohydraulics in a wide range of applications, from simple pump control to complex brake systems found on agricultural tractors and construction equipment. Additionally, with the acceptance of digital engine controllers for emissions control, engineers are increasingly looking to utilize electrohydraulics to improve vehicle ease of use, safety, and performance. As more electronics are used in mobile applications, there is a greater need for engineers, managers, and technicians to understand electrohydraulic technologies.

This three-day seminar examines the systems and component level details needed to better understand how the cross-functional disciplines of electrical, mechanical, and fluid power engineering are utilized to offer performance and functional advantages through electrohydraulic technologies. Using a systems engineering block diagram approach, key components covered in this seminar include electromechanical actuation, electronic controllers, networks, valves, and sensors. In each section, examples of existing products are shown and elements of risk are discussed. This course also examines environmental specifications and fluid issues that are specific to electrohydraulics.

Learning Objectives

By attending this seminar, you will be able to:
- Identify the key building blocks of electrohydraulic systems
- Specify important characteristics of electrohydraulic valves, sensors, and electronic controllers
- Read and create hydraulic schematics using electrohydraulic symbols
- Recognize the critical issues in designing and troubleshooting electrohydraulic systems
- Identify the risks associated with electrohydraulic systems and means to overcome them.

Who Should Attend

This course is designed for individuals engaged in mechanical, electrical, and fluid power engineering that are new to the technical field of electrohydraulics. Additionally, technicians, program managers, and sales engineers requiring knowledge of electrohydraulic components and systems will benefit from attending this seminar.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. A basic knowledge of college algebra, college physics, and familiarity with hydraulics is also recommended but not required.

Topical Outline

DAY ONE
- What is Electrohydraulics?
- Power Density
  - Hydraulics comes out on top
- Review Physical Principles
  - Inductance
  - Electromotive Force
  - Pascal's law
  - Hall Effect
  - Resistive elastic properties used in strain gauges
  - Magnetostrictive Principle
  - Fluid Viscosity
- Control of Power
  - Mechanical Power
  - Hydraulic Power
  - Electrical Power
- Block Diagrams - System Approach
  - Simple mechanical system
  - Simple hydraulic system
  - Simple electric System
  - Electrohydraulic system (Open Loop)
  - Electrohydraulic system (Closed Loop)
- Actuators
  - Linear actuators
  - Rotary actuators
- EH Control Devices
  - EM Devices -- Solenoids; Torque motors; Stepper motors; DC motors
  - Valves -- Pressure relief; Pressure reducing; Flow control
  - Pumps
  - Motors
  - Rheological Fluids
  - Fluid Issues -- Viscosity; Tribology - Friction, lubrication & wear; Cleanliness - ISO ratings; Hygroscopic vs Hydrophobic properties; Special issues water-based fluids

DAY TWO
- Feedback Devices
  - Position Transducer -- Linear Pot; LVDT (Linear Variable Differential Transformer); Magnetostrictive; Encoder; Resolver; Infrared & Radar
  - Speed Sensors -- Hall Effect; Variable Reluctance; Ground Speed Radar
  - Force Sensors
  - Torque Sensors
  - Accelerometers
  - Yaw Rate
  - Pressure Transducers
  - Pressure Switches
  - Flow Meters
  - Fluid Level Sensors
  - Temperature Sensors
- Controller
  - Valve drivers
  - Pulse width modulation of solenoids
  - Dither
  - Digital controllers -- Microprocessors vs Microcontrollers
  - Safety Integrity Level (SIL)
  - Inputs -- Power; Analog; Discrete; Frequency
  - Outputs -- Regulated Power; PWM Drivers; Discrete Devices
  - Networks -- ISO Seven Layer Model; Common Protocols

DAY THREE
- Environmental Considerations
- Electrical
  - EMC/EMI
  - ESD -- Electrostatic Discharge
  - Voltage transients
  - Wiring considerations
  - Connectors
- Mechanical
  - Temperature

- Shock & vibration
- Humidity
- Fluid compatibility
- Altitude
- IP rating system
- Submersion
- Cleaning
- Suppliers
  - Off-Highway Controllers
- Command Devices
  - Joysticks
  - Foot pedals
  - Switches
  - Operator input controls
- ISO Symbols for EH Devices
- EH Examples
  - Proportional valves and servo valves
  - Pumps
  - Pressure reducing valves
  - 6 DOF motion simulators
  - Hydrostatic drive control
  - Hydrostatic regenerative braking
  - Suspension product
  - X by wire

Instructor: David E. Ewel
Fee $1545 2.0 CEUs

Embedded Control Systems Design Workshop

2 Days
I.D.# C0922

This highly interactive and entertaining seminar - featuring the Robocar Hands-on Team Project - will help you learn fundamental concepts needed to design, implement, and calibrate a control function using a microcontroller model car. Overviews of engine, transmission, hybrid control functions and related sensors and actuators including electronic control signals will be presented, as well as microcontroller functions, control algorithms and software, and calibration of the system.

This embedded control system design seminar will focus on designing an embedded system by teaching each focus area and then showing how all areas connect. The focus areas include control system architecture; control algorithms; sensors and actuators; microcontroller; software; and calibration. The discussion will be based on engine, transmission, and electric drive propulsion system functionality. Participants will be involved in both a lecture format and a 'hands on' lab to design, implement and calibrate a control function using a microcontroller Robocar.

Learning Objectives

By attending this seminar, you will be able to:
- List the major embedded control functions for an engine, transmission, electric drive and battery, and vehicle electronic interface
- Explain the use and function of the sensors/actuators and electrical signals used for a vehicular embedded control system
- Select the typical microcontroller architecture used for embedded control
- Describe the type of control algorithms used in embedded control functions and alternative choices
- Generate a sample calibration in the lab
- Explain the types of hybrid electric drives and the electronic controls
- Use a microcontroller model car to design and implement a simple control function and calibration to demonstrate a task assigned in the lab

Who Should Attend

Embedded controls are found in each major vehicle sub-system and the manufacturing system has robotics and autonomous assembly, making it essential for automotive engineers and leaders to have core knowledge of embedded systems. This course is designed for engineers and management who design, develop, service, or plan embedded control systems. This includes individuals working on elements of the embedded system who want to understand a mechatronics and systems view. (Architecture, Software, Algorithms, Microcontroller, Sensors/Actuators, Calibration)

Prerequisites

This course will contain technical material in the presentations. A degree in electrical or mechanical engineering is recommended, however those working in labs, manufacturing, service or management will benefit from an overview perspective. This course is for anyone working on embedded systems but will focus on automotive propulsion control system examples.

Topical Outline

DAY ONE
- Engine, Transmission, Hybrid Electronic Control Functions
  - Fuel control
  - Ignition
  - Aftertreatment
  - Clutch control
  - Torque converter control
  - Electric drive: motor control and battery control
  - Network control: vehicle, engine, transmission, electric drive
- Sensors and Actuators used for Engine, Transmission, and Hybrid Controls
  - Actuators - injectors, pumps, solenoids, motors, battery
  - Sensors - pressure, temperature, position, combustion, detonation, current with feedback, massflow, level, switches, torque, fuel composition, humidity, acceleration
  - Communication - types of serial data; interactive with vehicle
- Electronic Control Signals for Sensors and Actuators
  - pwm, frequency, analog, pulse, complex combination
- Microcontroller
  - Typical elements
  - Memory
  - Timers and signal generation
  - Timers and program flow (interactive)
  - External interrupts
  - Analog to digital conversion
  - Input capture
  - Serial communications
- Control Algorithms and Software
  - Need for well defined requirements
  - Types of control algorithms - feedback, adaptive, estimation, learning
- Example of a Fuel Control System Embedded Design Control System Architecture
- Software Design Based on Control System Architecture
  - "V" development and test concept
  - Derive software requirements for design and test
  - Software partitioning for reuse and team design
  - Autocode
  - AutoSAR

DAY TWO
- Hybrid Electric Drive Alternatives and Electronic Control
- Calibration of the System
  - What is calibration ?
  - Types of calibration in embedded systems
  - Advanced calibration methods using robots and automation
- Virtual sensors for fail soft diagnostics and control
  - Torque estimation
  - Fuel composition
  - Airflow
  - Derived temperature
  - Mechanical position (engine and throttle)
- Robocar Demonstration Project
  - Use of robocar to demonstrate design to requirements, architecture, control signals, control algorithm, software, and calibration
  - Robocar architecture, computer, development tools, sensors, actuators
  - Robocar control tasks
  - Key control design algorithms
- Team "hands-on" Project using Robocar
  - Design a control function, implement and test
  - Calibrate this function and calibrate other existing embedded algorithms
- Robocar Team Demonstration
- Wrap-up of seminar

Instructor: Dennis Bogden
Fee $1265 1.3 CEUs

Emissions-Related OBD Systems: A Design Overview

1 Day
I.D.# C0708

On-board diagnostics, required by governmental regulations, provide a means for reducing harmful pollutants into the environment. Since being mandated in 1996, the regulations have continued to evolve and require engineers to design systems that meet strict guidelines. This one day seminar is designed to provide an overview of the fundamental design objectives and the features needed to achieve those objectives for generic on-board diagnostics. The basic structure of an on-board diagnostic will be described along with the system definitions needed for successful implementation.

Please note that because of proprietary considerations, this class does not provide details of algorithm design, algorithm performance, or algorithm application. The class will cover general OBD algorithm designs and the features required to promote sound OBD system design.

Individuals desiring a more in-depth look at On-Board Diagnostics should consider attending SAE seminar ID# C0707, *Designing On-Board Diagnostics for Light and Medium Duty Emissions Control Systems*.

Learning Objectives

By attending this seminar, you will be able to:
- Articulate the underlying design objectives of on-board diagnostic systems
- Apply the design features that all diagnostics need for successful implementation
- Apply basic design techniques to deal with variation
- Use a diagnostic design template in the development of an on-board diagnostic

Who Should Attend

This course is designed for engineers involved in either the design or control of on-board diagnostic systems for engines or transmissions for light and medium duty on-road vehicles. Individuals working in the heavy duty industry may also find the information interesting, but should note that the examples will be geared towards spark ignition engines and light and medium duty regulations. In addition, engineers involved in engine and transmission hardware will benefit by obtaining a better understanding of the design of OBD systems. Engineers new to the area of OBD system design and engineers involved in the design of control systems wishing to obtain a better understanding of OBD requirements will also find the course valuable.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. A basic knowledge of college algebra, college physics, and a familiarity with modern engine or transmission systems is required

Topical Outline

- Fundamental Design Objectives for OBD Systems
- Basic Design Features for OBD Systems
- Defining "Good" vs. "Bad" Systems
- Exercise: Defining Good vs. Defective Systems
- Anatomy of an On-Board Diagnostic
- Diagnostic Modeling
- Understanding and Dealing with Variation
  - Decision making processes
  - Design guidelines for Exponentially Weighted Moving Averages (EWMA)

Instructor: John Van Gilder
Fee $785 .7 CEUs

Energy-Efficient Motor Drives for EV, HEV, and PHEV Applications

2 Days
I.D.# C1028

Electric motor drives have emerged as one of the differentiating technologies in electric vehicles (EV), hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV). As a result, it is critical for engineers and technical decision-makers to understand the various energy-efficient motor drive technologies and how to apply them.

This seminar begins by defining energy-efficient motors and EV/HEV/PHEV motors. Following an in-depth study of induction motor drives, permanent magnet (PM) brushless motor drives, and switched reluctance (SR) motor drives, attendees will understand the core motor drive technology for EVs, HEVs and PHEVs. The course concludes with information on in-wheel motors, emerging motor technologies, and electric variable transmission (EVT) motor systems.

Learning Objectives

By attending this course, you will be able to:
- Identify energy-efficient motors
- Identify EV/HEV/PHEV motors
- Explain the differences between induction, brushless, and SR motor

drives for EVs/HEVs/PHEVs
- Explain the differences between various in-wheel motors
- Indentify a sound methodology for sizing EV/HEV/PHEV motors
- Describe how to approach finite element and thermal analyses of motors
- Describe EVT motor systems and various emerging motor technologies

Who Should Attend

This course is designed for those who work in engineering, marketing, or manufacturing of powertrain systems or other electrical and mechanical aspects of EVs, HEVs, and PHEVs. In addition, this course can be valuable to those involved in transportation systems that utilize electric motors. Individuals new to the field of electric motors and drives will benefit most from the material. This course is not intended for individuals with significant experience with motors or drives.

Prerequisites

An undergraduate degree in engineering or a strong technical background is highly recommended. Attendees should have taken an undergraduate or graduate course in basic electric circuits and/or basic electric machines.

Topical Outline

DAY ONE
- Overview of Energy-Efficient Motors
  - What is efficiency?
  - What is an energy-efficient motor?
  - How to achieve high efficiency?
- Overview of EV/HEV/PHEV Motors
  - What is an EV/HEV/PHEV motor?
  - Types of EV/HEV/PHEV motors
  - Classifications of EV/HEV/PHEV motors
- Induction Motors
  - Types of induction motors
  - Operation principles of induction motors
  - Performances of induction motors
- PM Brushless AC (BLAC) Motors
  - Types of PM BLAC motors
  - Operation principles of PM BLAC motors
  - Performances of PM BLAC motors
- PM Brushless DC (BLDC) Motors
  - Types of PM BLDC motors
  - Operation principles of PM BLDC motors
  - Performances of PM BLDC motors
- SR Motors
  - Types of SR motors
  - Operation principles of SR motors
  - Performances of SR motors
- Design and Analysis of Motors
  - Sizing of motors for EV/HEV/PHEV
  - Finite element analysis of motors
  - Thermal analysis of motors
  - Computer-aided design tools
- Power Converters for AC and SR Motors
  - Converter topologies
  - PWM switching schemes
  - Losses due to PWM supply

DAY TWO
- Induction Motor Drives
  - Variable-voltage variable-frequency control of induction motor drives
  - Vector control of induction motor drives
- PM BLAC Motor Drives
  - Constant-torque operation of PM BLAC motor drives
  - Constant-power operation of PM BLAC motor drives
- PM BLDC Motor Drives
  - Constant-torque operation of PM BLDC motor drives
  - Constant-power operation of PM BLDC motor drives
  - Sensorless control
- SR Motor Drives
  - Current chopping control of SR motor drives
  - Angular position control of SR motor drives
- In-wheel Motors
  - Planetary-geared high-speed motors
  - Gearless low-speed motors
  - Magnetic-geared high-speed motors
- Emerging Motor Technologies
  - Doubly salient PM motors
  - PM hybrid motors
- EVT Motor Systems
  - Planetary-geared motor systems
  - Double-rotor motor systems
  - Magnetic-geared motor systems
- Learning Assessment

Instructor: K. T. Chau and Chris Mi
Fee $1225 1.3 CEUs

Fundamentals of Shielding Design for EMC Compliance

1 Day
I.D.# C0835

It is important for electronic and hardware engineers to be knowledgeable not only of a product's intended function and performance, but also its ability to perform within electromagnetic compatibility (EMC) limits. This seminar introduces practical shielding theory, design fundamentals, and configurations, including shielding products, common and differential modes, electromagnetic fields, and enclosure shielding. A segment on enclosure testing is presented in conjunction with an aperture attenuation modeling program (which is used to model attenuation characteristics at various frequencies and aperture size prior to expensive FCC/CE compliance or MIL-STD 461 testing). Honeycomb vent panels, plating attenuation comparisons, and galvanic compatibility per MIL-STD 1250 will also be discussed.

Learning Objectives

By attending this seminar, you will be able to:
- Identify the basic characteristics of Common and Differential Mode
- Recognize E,H, and Plane wave fields, Surface current and "Skin effect" based on increased frequency
- Specify Galvanic compatibility of various metal plating
- Specify industry standard shielding products for EMC compliance
- Evaluate waveguide effect of EMI/RFI shielded honeycomb ventilation panels
- Analyze aperture attenuation modeling for EMC design

Who Should Attend

This seminar will benefit engineers requiring an understanding of their electronic product or system's electromagnetic impact on meeting commercial EMC and MIL-STD 461 requirements, as well as those engineers needing to incorporate shielding products into new or current product improvement designs.

Prerequisites

Attendees should have knowledge of electrical and electronic products and proficiency in mathematics at an algebra level.

Topical Outline

- EMC Fundamentals
  - Definitions
  - Maxwell equations
  - EMI and apertures
  - EMI environment and characteristics
- Practical Shielding Theory
  - Common / Differential modes
  - BLS Crosstalk / Radiated fields
  - Reciprocity
  - Emitter location effects
  - Partial shields
  - H, E, and PW fields
  - Shielding material testing
  - Absorption and reflection
- Shield Apertures
  - Skin depth
  - EM Leakage
  - Aperture calculation
  - Multiple apertures
  - RF current flow
- Aperture Attenuation Modeling Program
  - Aperture Calculations
  - PCB test data comparisons
  - Attenuation Modeling and Test Factor
- Honeycomb Vent Panels
  - Design - waveguide effect
  - Attenuation of various panels
  - Galvanic compatibility
- EMC Shielding Products and Materials
  - Board Level Shields (BLS)
  - Gaskets (BeCu fingerstock, conductive fabric, conductive elastomer, wire mesh)
  - Ferrites Materials
  - RF Absorber
  - Shielding principles
- EMC Shielding Specifications and Applications
  - MIL-STD 461 / 464 test specifications
  - Shielding applications
- Question/Answer Session
  - Learning assessment
  - Group discussion on specific EMC design concerns and applications

Instructor: Michael J. Oliver
Fee $725 .7 CEUs

In-Vehicle Networking with LIN and FlexRay Applications

2 Days
I.D.# C0136

This two-day seminar covers the theory and practices of in-vehicle multiplex networking. Attendees learn about FlexRay and LIN SubBus, and other network standards. Attendees explore the latest OBD II regulations and implementation requirements, along with device hardware and software interfaces. Proprietary applications are discussed and system development tools are demonstrated.

Learning Objectives

By attending this seminar, you will be able to:
- Describe in-vehicle multiplex network architecture.
- Explain how multiplex networks are used in a wide range of automotive applications.
- Identify and use various standards and specifications related to in-vehicle networks.

Who Should Attend

Engineers who will be or currently are working with applications using multiplex networks, including validation engineers, embedded programmers, and test engineers.

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

DAY ONE
- Introduction
- Overview of In-Vehicle Network Systems
  - On Board Diagnostics (OBD) Networks -- CARB, EPA, EURO
  - Control System Networks -- CAN Protocol
  - Deterministic System Networks -- FlexRay Protocol
  - Input/Output Device Networks -- LIN Protocol
- OBD Communications Specifications
  - SAE J1979
  - SAE J2012
  - SAE J1699-3
  - SAE J2534
  - SAE J1939-73
  - ISO 15765-4
  - ISO 14229
- CAN Bus Specifications
  - SAE J2284
  - ISO 15765
  - ISO 27145
  - SAE J1939

DAY TWO
- FlexRay Networks
  - SAE, ISO, Other Specifications
  - Designing FlexRay Networks
  - Implementation of FlexRay Networks
- LIN SubBus
  - SAE J2602 Specification
  - LIN 2.x Specification
  - Designing LIN Networks
  - Implementation of LIN Networks
- Emerging Technology & Future Networks
  - Wireless
  - GbE
  - DSRC
- Vehicle Application Examples
  - LIN
  - FlexRay
- Session Review and Summary

Instructor: Mark Zachos
Fee $1225 1.3 CEUs

Power Electronics for EV, HEV and PHEV Applications

2 Days
I.D.# C1029

Power electronics is one of the key enabling technologies propelling the shift from conventional gasoline/diesel engine powered vehicles to electric vehicles (EVs), hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs). Of particular importance are the power electronics converters used in EVs, HEVs, and PHEVs, which include rectifiers, unidirectional and bidirectional DC-DC converters, inverters, and battery chargers.

This course begins with an introduction to the principle of power electronics followed by a thorough coverage of various converters. The unique aspects of power converters in EVs, HEVs, and PHEVs are addressed, including vehicle to grid technology and battery chargers. Distinctive characteristics of the operation of EV converters, such as uncontrolled rectification of permanent magnet motors, are covered in detail. Modeling and simulation of different power converters are demonstrated with hands on examples and hardware-in-the-loop concepts are briefly covered.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the basic principle of power electronics and the operation principle of different converters
- Describe the uniqueness of EV/HEV/PHEV power converters
- Identify the appropriate power converter topology for different powertrain applications
- Identify passive components for power converters
- Model power converter circuits used in an EV/HEV/PHEV
- Select the semiconductor devices for major power converters in an EV/HEV/PHEV
- Describe vehicle to grid and battery charger technology
- Explain the implementation principle of hardware in the loop tools
- Identify emerging power electronics technologies

Who Should Attend

This course is designed for those who work in engineering, marketing, or manufacturing of powertrain systems or other electrical and mechanical aspects of EVs, HEVs, and PHEVs. In addition, this course can be valuable to those involved in renewable energy and transportation systems. Individuals new to the field of power electronics and motor drives will benefit most from the material. This course is not intended for individuals with significant experience with power electronics or motor drives.

Prerequisites

An undergraduate degree in engineering or a strong technical background is highly recommended. Attendee should have taken an undergraduate or graduate course in basic electric circuits and basic electronics or be familiar with resources such as:
- *Electric Circuits*: J David Irwin: Basic Engineering Circuit Analysis, John Wiley & Sons
- *Electronic Circuits* (chapter 1 to 5 of Sedra and Kenneth C. Smith, Microelectronic Circuits, Oxford University Press

Topical Outline

DAY ONE
- Introduction to Power Electronics
  - Concept of power electronics
  - Major types of power converters
  - Unique aspects of power electronics in EV/HEV/PHEV
  - e-CVT and the role of power electronics
- Modeling of power electronics
  - Modeling principle and importance of modeling
  - Modeling tools – Simplorer and Matlab Simulink
  - Modeling example
- Rectifiers
  - Principle
  - Single-phase and three-phase rectifiers
  - Voltage regulation
  - Voltage ripple
  - DC side current and AC side harmonics
- Unidirectional DC-DC converters
  - Buck converter
  - Boost converter
  - Buck-boost
  - Cuk Converter
- Bidirectional DC-DC converters
  - Two-quadrant chopper
  - Four-quadrant DC-DC converter
  - Energy management converter for HEV batteries
- Thermal Management of Power converter
  - Power losses of semiconductor devices
  - Cooling choices
  - Thermal circuit design
  - Heat sink selection
- Power electronics building blocks
  - Inductors
  - Isolation transformers
  - Capacitors
  - Diodes
  - MOSFTS
  - IGBTs
- Hardware in the loop (HIL)
  - Closed loop control of power electronics converters
  - HIL tools
  - HIL Example

DAY TWO
- Isolated DC-DC converter
  - Isolation needs
  - Method of isolation
  - Isolated unidirectional DC-DC converters (feed forward and flyback)
  - Isolated bidirectional DC-DC converters – phase shift and dual phase shift
- Inverter
  - Single-phase inverter
  - Three-phase inverter
  - Vector control
  - Boost rectification
- Introduction to motor drives
  - Induction motor drives
  - PM motor drives
  - V/f control
  - Vector control
- Special Operations
  - Uncontrolled rectification in PM motors
  - Fault-tolerant operation of EV converters
- Battery Charger
  - SAE standards
  - Unidirectional charger
  - Bidirectional charger
  - Inductive charger
  - DC charger
  - Power factor correction
- Vehicle to Grid (V2G)
  - V2G basics

- Isolated and non-isolated
- Impact of vehicle on the power grid
- Emerging Power Electronics Technologies
  - Silicon carbide devices
  - Power electronics in renewable energy
  - Power electronics in battery management systems
  - Power electronics in high speed rail
- Learning Assessment

Instructor: Chris Mi and K. T. Chau
Fee $1225 1.3 CEUs

Understanding and Using the SAE J2534-1 API to Access Vehicle Networks

1 Day
I.D.# C0733

With the increase in vehicle electronics, the need to gather data from the vehicle has never been greater. From vehicle development, through vehicle test to vehicle validation, engineers are required to collect data from the vehicle's network. The SAE J2534-1 API (Recommended Practice for Pass-Thru Vehicle Programming) gives engineers the tool to collect vehicle data from multiple network types including CAN, ISO15765, J1850, ISO9141 and Chrysler SCI, using standard J2534 interface devices. In addition, the aftermarket can access the vehicle's OBDII information from the diagnostic connector. Using the SAE J2534-1 API, an engineer can write a single program that communicates on multiple protocols, uses an off-the-shelf interface device and is scaleable.

This course is designed to give you an understanding of the J2534-1 API, enabling you to create your own programs that accomplish your vehicle communication needs. In addition to learning how to use each of the J2534-1 functions, you will have the opportunity to write a program that collects messages off of the CAN vehicle bus and another program that reads trouble codes off of a J1850 vehicle. Note that because of the proprietary nature of the information, this class does not provide details on reprogramming algorithms or proprietary data collection. Attendees will receive a copy of the SAE J2534-1 Recommended Practice for Pass-Thru Vehicle Programming.

Learning Objectives

By attending this seminar, you will be able to:
- Write programs that use the SAE J2534-1 compliant hardware to communicate with vehicles
- Reduce your dependency on proprietary vehicle communication hardware
- Increase your productivity by collecting the specific vehicle information you need when you need it
- Solve vehicle integration problems by capturing events from the vehicle network
- Protect your software investments by writing your application using a standard API

Who Should Attend

This seminar is designed for engineers involved with automotive design and development who need to write programs that interact with vehicles through the in-vehicle network. This includes engineers who validate OBDII, engineers developing and validating new electronic control modules, engineers writing reprogramming application, test engineers who log vehicle data, system integrators who need to validate system operation, and after-market engineers who add new functionality to vehicles. The seminar would also be helpful for people who develop end-of-line tests, service diagnostics or inspection and maintenance cells for vehicles.

Prerequisites

Participants should have an undergraduate degree in computer programming or equivalent experience including the ability to write programs in the "C" programming language. A basic knowledge and understanding of vehicle networks (CAN, J1850, ISO9141, ISO14230 or ISO15765) and familiarity with the Windows or Linux operating system are essential.

Topical Outline

- What is the SAE J2534-1 PassThru API
  - Why use the SAE J2534-1 PassThru API
  - Overview of the SAE J2534-1 PassThru API
  - Overview of vehicle communication
  - History of the SAE J2534-1 PassThru API
  - Future of SAE J2534-1, J2534-2, J2534-3
- PassThru PC Setup
  - Using the registry to find devices
  - Loading the SAE J2534-1 DLL
- PassThru Open and Close
- PassThru Connect and Disconnect
  - PassThruConnect: protocols, connect flags, baudrates
  - PassThruDisconnect
- Lab 1: PassThru on the PC: Simple SAE J2534-1 Program
- PassThru Read Messages and Write Messages
  - The PassThru message structure
  - PassThruReadMsgs: read, loopback and indication messages
  - PassThruWriteMsgs
- PassThru Start Message Filter and Stop Message Filter
  - PassThruStartMsgFilter: pass, block and flow control filters
  - PassThruStopMsgFilter
- PassThru Other Functions
  - PassThruSetProgrammingVoltage
  - PassThruReadVersion
  - PassThruGetLastError
- Lab 2: A Complete SAE J2534-1 Program
- PassThru Start Periodic Message and Stop Periodic Message
- PassThru I/O Control
  - GET_CONFIG and SET_CONFIG
  - Other parameters
- ISO15765 in J2534-1
  - Flow control filters
  - Indication messages
- Lab 3: Enhancing your PassThru Program
  - Changing device configuration
  - ISO15765 message reader

Instructor: Mark Wine
Fee $825 .7 CEUs

Design FMEA Update: What's New in J1739 Webinar 17
Design for Manufacturing & Assembly (DFM/DFA) 18
Design Reviews for Effective Product Development 19
Failure Modes and Effects Analysis (Product & Process) in Aerospace 19
Fault Tree/Success Tree Analysis 20
Finite Element Analysis for Design Engineers - Hands-on FEA Workshop 21
Fundamentals of Geometric Dimensioning & Tolerancing (GD&T) Webinar 21
Geometric Dimensioning & Tolerancing 22
Geometric Dimensioning & Tolerancing - Level I 23
Geometric Dimensioning & Tolerancing - Level II 24
Ground Vehicle Systems Engineering: A Practical Approach 25
Introduction to Failure Modes & Effects Analysis for Product Design (Design FMEA) 26
Introduction to Failure Modes & Effects Analysis for Product Design & Manufacturing Process Design (Product & Process FMEA) 27
Mechatronics: Introduction, Modeling and Simulation 27
Model Based Design: Delivering Quality Electronic Products Faster 28
Process FMEA Update: What's New in J1739 Webinar 29
Quality Function Deployment 30
Reverse Engineering: Technology of Reinvention 30
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Design FMEA Update: What's New in J1739 Webinar

6 Hours
I.D.# WB0955

The new J1739 has been revised to address common problems with the application of Design FMEA today. Such problems include the time spent debating ranking systems, potential problems hidden in the Risk Priority Number, false starts and rework of FMEA because of a lack of understanding of product and process functions, and a lack of emphasis on prevention controls or early detection of problems. This course is not intended to cover all of the details of completing a Design FMEA. Rather, its focus is on recent changes from the former J1739 FMEA Recommended Practice to the new J1739 FMEA Standard and how those familiar with performing Design FMEA should adjust their approach.

Similarities in content exist between this course and the Process FMEA Update: What's New in J1739 Webinar, however each is uniquely designed to address what's new for each type of analysis.

Learning Objectives

By connecting with this webinar, you will be able to:
- Identify new DFMEA requirements that must be fulfilled by management
- Find answers to most DFMEA questions in J1739
- Align ideas within the logical framework of the DFMEA worksheet
- Apply new risk assessment evaluation criteria to the DFMEA
- Compare the differences between using Risk Priority Number thresholds with using other risk assessment criterion such as the use of Severity and Occurrence when prioritizing actions for risk mitigation

Who Should Attend

Product engineers, manufacturing engineers, quality engineers, supplier quality engineers, validation and test engineers, and FMEA facilitators, trainers and consultants primarily in, but not limited to, the automotive industry may be interested in the update this webinar offers. Beginning engineers and advanced/senior engineers who must participate in FMEA, as well as those that manage FMEA activity, will also gain valuable insights. If you have a copy of the SAE J1739 standard, we recommend that you have it at hand for all three sessions of the webinar. If you do not own the standard and wish to purchase a copy, go to SAE J1739 Standard

Topical Outline

Session 1
- Introduction and Potential Failure Analysis
  - Concerns about FMEA usage
  - Key change points applicable to Design FMEA
  - Terms and definitions
  - Pre-Analysis Preparation
  - DFMEA product functions and requirements
  - Failure Modes and Effects
  - Failure Causes
  - Current design controls - prevention
  - Current design controls - detection

Session 2
- Risk Assessment
  - Severity ranking criteria - emphasis on vehicle level
  - Occurrence ranking criteria - emphasis on what's known and unknown about design
  - Detection ranking criteria - emphasis on method and timing of evaluation
  - Risk Priority Numbers - secrets RPN won't tell
  - Severity x Occurrence - back to the beginning
  - Severity AND Occurrence - go for a meaning, not a number
  - Other risk assessment criteria

Session 3
- Risk Mitigation
  - FMEA general requirements
  - DFMEA outputs
  - DFMEA form and example
  - Special characteristics and DFMEA
  - Writing effective action plans to mitigate risk

Instructor: Bill Haughey
Fee $515 .7 CEUs

Design for Manufacturing & Assembly (DFM/DFA)

1- Day – I.D.#95032
2 Days – I.D.#92047

This seminar is available in one-day or two-day formats. The two-day format includes an in-class workshop project which consumes most of the second day.

Design for Manufacturing and Assembly (DFM+A), pioneered by Boothroyd and Dewhurst, has been used by many companies around the world to develop creative product designs that use optimal manufacturing and assembly processes. Correctly applied, DFM+A analysis leads to significant reductions in production cost, without compromising product time-to-market goals, functionality, quality, serviceability, or other attributes. In this two-day seminar, you will not only learn the Boothroyd Dewhurst Method, you will actually apply it to your own product design!

This seminar will include information on how DFM+A fits in with QFD, concurrent engineering, robust engineering, and other disciplines. In addition, there will be a brief demonstration of computer software tools, which simplify the DFM+A analysis.

Each participant will receive and use the hard-bound authoritative reference textbook, *Product Design for Manufacture and Assembly*, written by Geoffrey Boothroyd, Peter Dewhurst and Winston Knight.

Learning Objectives

By attending this seminar, you will be able to:
- Perform Design for Assembly (DFA) Analysis using the BDI Manual (Worksheet) Method
- Perform DFM Analysis (manufacturing cost estimation)
- Apply Design for Service (DFS) Principles
- Reduce your company's production costs by analyzing and eliminating the factors that greatly affect the time, cost, and quality of manufacturing, assembly and service processes
- Utilize effective analysis, brainstorming, and trade-off techniques for redesigning assemblies and subassemblies

Who Should Attend

Product designers, product engineers, or manufacturing engineers will benefit by attending this seminar. Individuals involved in a new or ongoing product development process will also benefit by learning how to help synchronize and optimize fabrication and assembly activities. This course is most effective when attended by product development team members; however, this is not a requirement for attendance. NOTE: You are strongly encouraged to bring a sample or drawing of one of your own designs to analyze during the workshop on Day Two. You are also asked to bring a calculator capable of making simple calculations.

Prerequisites

An engineering undergraduate degree in any discipline would be beneficial.

Topical Outline

- What is DFM+A
  - The history of DFM+A
  - The various "Design fors"
  - Why companies are using DFM+A
  - DFM+A success stories
  - DFM+A benefits
  - Key factors in ensuring DFM+A success
- DFA Good Design Principles
  - The Boothroyd Dewhurst Design for Manual Assembly Method
  - Using the manual handling and insertion tables
  - Determining theoretical minimum part count
  - Filling in the BDI DFA worksheet
  - Computing the DFA Index
- DFA Baseline Analysis Exercise (Pneumatic Piston)
- Redesign Project (Pneumatic Piston Assembly)
  - Developing design concepts
  - Identifying conservative and "stretch" designs
  - Selecting the best DFA concept
  - Analysis of redesign
  - Presentation of team results
- General Approach to Manufacturing Cost Estimation
  - Manufacturing cost drivers
  - Estimating piece cost
  - Cost calculation exercise
- BDI Design for Manufacture (DFM) Cost Estimation
  - Injection molding cost algorithms
  - Sample calculation
  - Exercise (analyzing part from pneumatic piston)
- BDI DFM Cost Estimation (continued)
  - Review of die casting and/or sheet metal stamping cost algorithms
- Design for Service (DFS) Assessment
  - Two main approaches
  - Life cycle considerations
  - DFS exercise
- BDI DFM/A Software Toolkit Demonstration
  - DFA module
  - Injection molding or other module
- DFM+A Workshop Checklist
- Brainstorming Guidelines
- DFM+A Workshop Project (approximately 4 hours)
  - Project selection (from those brought to class)
  - Team identification
  - Baseline analysis
  - Redesign development
  - Development of project reports (illustrations, action plan, possible roadblocks, etc.)
  - Presentations of team results
- Institutionalizing DFM+A in Your Organization
  - How DFM+A fits in with other strategies
  - Lessons learned from other companies
  - Ideal workplace implementation plan
- Video Presentation on Goal Setting (time permitting)
- Wrap Up
- Course Evaluation

Instructor: Kevin Zielinski

1 Day Fee $895	.7 CEUs
2 Day Fee $1395	1.3 CEUs

Design Reviews for Effective Product Development

1 Day
I.D.# C0004

Design reviews are required for ISO 9001:2000 compliance and compatible automotive and aerospace specifications. They are becoming increasingly important in product liability litigation and are accepted as a cost-effective best practice and an effective application of knowledge management, valuable for accelerating the maturity of new products.

This seminar describes how formal design reviews can improve products by uncovering potential problems before they are discovered at a later stage of development or application, when the costs of correction are much higher. A broad range of effective techniques for organizing and conducting design reviews will be presented. Specific guidance and tools to assist attendees in structuring design reviews tailored to their own company, specification, or contract requirements will also be provided. Material covered will be applicable to all types of development programs, ranging from components to complete vehicles, and for both OEMs and suppliers.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the relationship of the process to concurrent engineering and knowledge management
- Establish the requirements for a successful design review process
- Describe the types and timing of reviews
- Organize a typical design review
- Conduct a review and get positive results

Who Should Attend

The seminar is designed for individuals who are involved in the development of new products and who seek to improve that process. Product development team members including, but not limited to, directors, managers, project and program managers, design, development, process, product, quality, and application engineers will find the course valuable. It is aimed primarily at engineers and managers who would be facilitating or leading such reviews, but will also benefit manufacturing, marketing and purchasing personnel.

Prerequisites

An engineering education and experience with product development is desirable but not necessary.

Topical Outline

- Why Design Reviews are Widely Used Today
  - Market drivers
  - Quality drivers
  - Schedule and cost drivers
  - Litigation considerations
- What Design Reviews Are and Are Not
- Current Specification Requirements
  - ISO 9001
  - QS9000
  - AS9000
- Outline of the Design Review Process
  - Relation of design reviews to:
    - concurrent engineering
    - integrated product development teams
    - knowledge management
- Types and Timing of Reviews
  - Concept reviews
  - Preliminary reviews
  - Critical reviews
  - Production readiness reviews
  - Other types of reviews
- Scope of Design Reviews
- Formal and Informal Reviews
- The Key Ingredients for a Successful Review
- How to Organize an Effective Design Review
  - Participants
  - Invitations
  - Preparation for a review
  - Duration of a review
  - Physical arrangements
- How to Conduct a Design Review
  - Importance of a positive tone
  - Some proven procedures, check lists, comment sheets
  - Handling problem participants
- Closure and Follow-up
- Reports
- Implementation
- Review of Experiences of Participants

Instructor: Angelo Mago
Fee $725 .7 CEUs

Failure Modes and Effects Analysis (Product & Process) in Aerospace

2 Days
I.D.# C0939

This interactive Failure Modes and Effects Analysis (FMEA) product and process seminar introduces the participant to the analytical process by which potential failure modes, failure effects and causes of failure are identified. Engaging in a systematic method of studying failure can improve future outcomes. The severity, occurrence and probability of detection of a failure mode are used to prioritize which failure modes are most critical. Methodology is introduced for dealing with the effects of failure. The Design FMEA link to manufacturing is explained and amplified in terms of downstream Process FMEA. This course is based on "learning by doing" with interactive, in-class Design and Process FMEA generation and analysis in a lively team environment. This course will also detail relevant portions of the SAE Aerospace Recommended Practice for FMEA, ARP 5580 which is included in the course materials.

Learning Objectives

By attending this seminar, you will be able to:
- List the benefits, requirements and objectives of an FMEA (both Product Design & Process)
- Explain the steps and methodology used to analyze a Design or Process FMEA
- Demonstrate the application of a variety of tools utilized in conjunction with performing an FMEA
- Identify corrective actions or controls and their importance in minimizing or preventing failure occurrence
- Interpret the objectives of the SAE Aerospace Recommended Practice for FMEA, ARP5580

Who Should Attend

This seminar is designed for the design engineer, process assurance engineer, reliability engineer, test engineer, quality engineer,

development engineer, logistics/support engineer, manufacturing engineer and their management or anyone responsible for the design and development of design or manufacturing, assembly or service processes in the completion of a Design or Process FMEA.

Prerequisites

Attendees should possess a basic understanding of the design principles/process and manufacturing/assembly process.

Topical Outline

DAY ONE

- Introduction and Overview
  - Definition
  - Requirements for an FMEA (both Design & Process) - Who drives the requirements?
  - FMEA detail
  - Design and Process FMEA similarities and differences
    - Performing an FMEA
  - Prerequisites
  - Basic analysis methodology -- approach; sequence
  - Prioritization of failure modes
  - Typical forms used: examples and recommendations
- Other Quality Tools to Aid in FMEA Development
  - Pareto chart
  - Fishbone diagram
  - Design review
  - Checklists
  - Lessons learned
  - Design of Experiments (DOE)
  - Statistical process Control (SPC)
  - Fault Tree Analysis(FTA)
  - Monte Carlo simulation
- Design FMEA: Class Exercise
  - What's the requirement?
  - Forming the team
  - Process flow
  - Brainstorm design failure modes
  - Use FMEA form to document failure modes, severity, occurrence, detection
  - Prioritize failure modes
  - Work corrective actions
  - How good are these corrective actions?
  - Redo prioritization to compare to requirement
  - Modify product based on analysis, for objective testing

DAY TWO

- Complete Design FMEA exercise (continued)
- Process FMEA: Class Exercise
  - What's the requirement?
  - Forming the team
  - Process flow/Value Stream map
  - Brainstorm process failure modes
  - Use FMEA form to document failure modes, severity, occurrence, detection
  - Prioritize failure modes
  - Work corrective actions
  - How good are these corrective actions?
  - Redo prioritization to compare to requirement
  - Control Plan development
  - Modify product based on analysis, for objective testing
- FMEA software overview
- FMEA and Product Liability

Instructor: Jim Breneman

Fee $1225 1.3 CEUs

Fault Tree/Success Tree Analysis

1 Day
I.D.# 92028

Sharpen your skills with this no-nonsense program that will show you practical ways to implement popular tools in your product/process design, manufacturing, reliability assurance and safety operations. Fault tree/success tree analysis are proven devices for improving the design of a product or process by revealing logical failure paths and appropriate actions for implementing design changes or controls.

Learning Objectives

By attending this seminar, you will be able to:

- Define Fault Tree and Success Tree Analysis
- Identify the terminology and methodology used in Fault Tree/ Success Tree Analysis
- Compare the benefits of Fault Tree/Success Tree Analysis to the product/ process design and development process
- Appraise Fault Tress/Success Tree Analysis in relation to other tools
- Demonstrate Qualitative and Quantitative Analysis using the Fault Tree/Success Tree approach

Who Should Attend

You will profit from this detailed seminar if you...

- Are a product/process design or development engineer
- Are involved in manufacturing/process/industrial engineering
- Are a quality/reliability engineer
- Have product/process assurance responsibility
- Are a safety or service engineer
- Manage any of the above
- You and your company want to observe the new automotive supplier quality requirements

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

- Exposure to Fault Tree Analysis - Basic Concepts
- Uncovering Basic Elements of a Fault Tree
- Focusing on Fault Tree Construction
- Tackle Boolean Algebra and its Application to Fault Tree Analysis
- Zero in on Success Tree/RFT Concepts
- Reveal the Relationship between Fault Tree/Success Tree Analysis
- Mastering Block Diagrams
- Reliability Prediction Using Fault Tree/Success Tree Analysis

Instructor: E. Harold Vannoy

Fee $725 .7 CEUs

Finite Element Analysis for Design Engineers - Hands-on FEA Workshop

2 Days
I.D.# 93006

The Finite Element Analysis (FEA) has been widely implemented by automotive companies and is now used by design engineers as a design tool during the product development process. Design engineers analyze their own designs while they are still in the form of easily modifiable CAD models to allow for quick turnaround times and to ensure prompt implementation of analysis results in the design process. When used properly, the FEA becomes a tremendous productivity tool helping design engineers reduce product development time and cost. On the contrary, misapplication of FEA may lead to erroneous design decisions, which are very expensive to correct later in the design process.

This seminar provides design engineers with skills necessary for proper use of FEA in the design process and to ensure that this powerful tool is implemented in the most efficient and productive way.

The seminar offers hands-on exercises focusing on the analysis of FEA errors and proper modeling techniques. Attendees study different types of analyses typically performed by design engineers, discuss common misconceptions and traps in the FEA and review Implementation of Management of FEA in the design environment. The seminar provides opportunities to discuss and exchange FEA experiences. The seminar layout allows for some customization so problems of particular interest to students can be discussed in class. All topics are illustrated by hands-on examples using FEA software SolidWorks Simulation. However, acquired skills are not software specific and no prior exposure to any FEA software is required.

The SAE book, *Finite Element Analysis for Design Engineers*, by Paul Kurowski is included in the course materials.

Learning Objectives

By attending the seminar, you will be able to:
- Select preferable modeling approaches
- Analyze errors inherent to FEA results
- Identify FEA advantages and shortcomings
- Avoid mistakes and pitfalls in FEA
- Produce reliable results on time
- Request FEA project and use FEA results
- Provide effective FEA project management
- Ensure quality and cost-effectiveness of FEA projects

Who Should Attend

Mechanical engineers in research and development, designing or project management that wish to upgrade their skills in FEA will benefit by attending this seminar. The seminar also addresses the needs of managers in charge of FEA projects performed by design engineers.

Prerequisites

Attendees should have background in mechanical or industrial engineering. No previous exposure to FEA is required.

Topical Outline

DAY ONE
- Basic concepts in the FEA and their influence on FEA accuracy
- Origins and types of FEA errors
- Influence of mesh on quality of results
- Types of finite elements
- Types of boundary conditions
- Useful modeling techniques
- Linear static analysis
- Modal analysis

DAY TWO
- Thermal analysis
- Buckling analysis
- Nonlinear analysis
  - nonlinear geometry
  - nonlinear material
  - contact stresses
- Interfacing between CAD and FEA
- FEA implementation
- FEA project management
- FEA traps and misconceptions
- FEA assessments

Instructor: Paul Kurowski
Fee $1325 1.3 CEUs

Fundamentals of Geometric Dimensioning & Tolerancing (GD&T) Webinar

I.D.# WB0933

Geometric dimensioning and tolerancing (GD&T) is used as a symbolic way of showing specific tolerances on drawings. GD&T is a valuable tool that effectively communicates the design intent to manufacturing and inspection. It is governed by the technical standard ASME Y14.5M-1994, which was updated earlier this year. This course introduces participants to the GD&T system, providing a working knowledge of the correct interpretation and application of each symbol, general rules, the datum system, and 'bonus' tolerance and highlighting some of the changes in the updated Y14.5 standard. The material is reinforced with many practice exercises.

Learning Objectives

By connecting with this webinar, you will be able to:
- Explain the benefits of geometric tolerancing
- Identify datum features and determine their order of precedence
- Identify and interpret each of the characteristic symbols
- Describe the material condition modifers and how "bonus" tolerance occurs
- Correctly interpret GD&T feature control frames, and explain the impact on manufacturing and inspection

Who Should Attend

This course is ideal for anyone who has a need to apply or interpret geometric tolerances on a product print. Product engineers, manufacturing engineers, CAD designers, quality inspectors, and other engineering and manufacturing personnel will all benefit from a better understanding of design requirements; improved communication with customers and suppliers; and improving designs by taking advantage of bonus tolerance and other GD&T benefits. Participants should have an understanding of basic blueprint reading.

Topical Outline

Session 1
- Why Use GD&T?
  - Review of traditional dimensioning
  - Benefits of GD&T
  - Technical standards
  - Definitions
  - Basic dimensions
  - How to read the feature control frame

Session 2
- Rules and the Form Symbols
  - Rule #1: Size controls form
  - Rule #2: Assume RFS
  - Flatness
  - Surface straightness
  - Circularity
  - Cylindricity

Session 3
- Bonus Tolerance
  - GD&T applied to a feature of size
  - Bonus and the MMC modifier
  - Virtual conditon
  - Gaging and inspection of GD&T

Session 4
- Datums
  - Datum vs. datum feature
  - The datum reference frame
  - Primary, secondary, and tertiary datums

Session 5
- Profile and Orientation
  - General definition of profile
  - Profile of a line
  - Profile of a surface
  - Use of datums with profile
  - Perpendicularity
  - Angularity
  - Parallelism

Session 6
- Position Tolerance I
  - True position
  - Position tolerance RFS
  - Using MMC or LMC
  - The "boundary" concept
  - The pitch diameter rule

Session 7
- Position Tolerance II
  - Projected tolerance zone
  - Inspecting parts for position
  - Calculating tolerance values
  - Composite position tolerance

Session 8
- Symmetry and Coaxial Controls
  - Concentricity
  - Symmetry
  - Circular runout
  - Total runout
- Wrap-up

Instructor: John-Paul Belanger

Fee $915 1.6 CEUs

Geometric Dimensioning & Tolerancing

3 Days
I.D.# C0133

This in-depth course covers the GD&T system, including why it reduces costs, how to interpret the symbols, and how to apply these tolerances correctly. Participants will learn the basic definitions and rules, the importance of datums, the meaning of each tolerance, and sample ways of gaging geometric tolerances. The class is mainly lecture, with many practice exercises. Participants are encouraged to bring sample parts and/or prints (with or without GD&T already applied) to class for questions. Time is reserved for discussing the application of GD&T to your parts/prints.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the tolerance zones defined by each symbol
- Determine when to use Rule #1 to control form and when other controls are appropriate
- Recognize correct syntax for feature control frames
- Relate common gaging and inspection methods to geometric tolerance zones and feature control frames
- Correctly apply and interpret the MMC modifier
- Assess various datum schemes against product functionality and manufacturing and inspection performance
- Recognize the need for product-specific GD&T guidelines and list the steps required to create them

Who Should Attend

This course is ideal for anyone who has a need to apply or interpret geometric tolerances on a product print. Product engineers, manufacturing engineers, CAD designers, quality inspectors, and other engineering and manufacturing personnel will all benefit from becoming fluent in GD&T.

Prerequisites

Participants should have knowledge of basic blueprint reading.

Topical Outline

- Drawings and Dimensioning
  - Importance of engineering drawings
  - Fundamental dimensioning rules
  - Review of coordinate dimensioning and tolerancing
  - The need for geometric dimensioning and tolerancing
  - Benefits of using GD&T
  - History of GD&T
  - Quality issues - ISO/QS 9000, need for standards
  - GD&T standards
- Introduction to GD&T Symbols and Terms
  - Definitions
  - Material conditions -- MMC, LMC, RFS
  - Radius and controlled radius
  - Reading a feature control frame
- Rules and Concepts of GD&T
  - Rule #1
  - Inspecting a part for size limits
  - Rule #2
  - Virtual condition
  - Bonus tolerance
  - Gaging GD&T-fixtures; special gages; CMMs
- Form Tolerances
  - Flatness

- Straightness applied to a surface
- Circularity
- Cylindricity
- Straightness applied to a feature of size
- Composite straightness control

Datums
- Purpose of datums in GD&T
- Single planar datum
- The datum reference frame
- Datum targets
- Datum features of size
- Compound datums
- How to select datums for a part
- Simulating datums on gage fixtures and CMMs

- Orientation Tolerances
  - Perpendicularity
  - Angularity
  - Basic dimensions
  - Parallelism
  - Tangent plane application
  - The pitch diameter rule
- Location Tolerances
  - Location control with coordinate dimensions
  - Definition of position tolerance
  - Application of position at RFS
  - Using position with MMC or LMC
  - Application of MMC and RFS on datum features
  - Inspecting parts for position
  - Composite position control
  - Projected tolerance zone
  - Calculating tolerance values
  - Concentricity
  - Symmetry
- Runout Tolerances
  - Definition of runout-TIR, FIM, coaxiality
  - Difference between runout and other circular controls
  - Circular runout
  - Total runout
- Profile Tolerances
  - General definition of profile
  - Profile of a line
  - Profile of a line with datums
  - Profile of a surface
  - Composite profile control
  - Tolerance stacks; calculating min/max wall thickness
- Wrap-up
  - Review sample drawings
  - Special application exercises using actual drawings

Instructor: John-Paul Belanger or John Stolter
Fee $1605 2.0 CEUs

Geometric Dimensioning & Tolerancing - Level I

3 Days
I.D.# 86020

Save time and money, while increasing quality and productivity by mastering this important and internationally-accepted engineering communication system. Geometric Dimensioning and Tolerancing (GD&T) is based on ISO standards and the ASME Y14.5M-1994 Dimensioning and Tolerancing Standard. Seminar attendees will have a unique opportunity to meet one-on-one with the instructor, with time to discuss problem drawings in a focused setting, and will receive a copy of the ASME Y14.5M-1994 Dimensioning and Tolerancing Standard and handout material specially prepared for this program.

Attendees are encouraged to bring problem drawings as they will have several opportunities during the workshop to meet with the instructor individually.

Learning Objectives

By attending this seminar, you will be able to:
- Learn effective use of the standardized accepted symbolic design/engineering language
- Enhance your ability to communicate and interpret specifications on engineering drawings and to replace instructions that are often misunderstood
- Improve communications and relations among design, engineering, manufacturing, and quality control personnel
- Eliminate translation errors with international affiliates
- Save time, reduce costs, and increase productivity

Who Should Attend

This workshop is designed for those who are involved in any area of engineering, drafting, design, quality control, inspection, tool or gage design, machining, or estimating where communication by engineering drawings is involved. The workshop is designed to teach the beginner the fundamentals of the system while giving the experienced user a better understanding of the more difficult applications.

Topical Outline

- Introduction to Geometric Dimensioning & Tolerancing & Geo-Metrics - Background, origin; basis ASME Y14.5M-1994, ISO standards; Why use it? What is it?; geometric characters; symbols; advantages; limits of size Rule 1; MMC, RFS, LMC; terms; definitions; application; tolerance zones; "feature" description; symbol methodology
- Form Tolerances - Flatness, straightness, circularity, cylindricity; definitions; application; when and how to apply; relationship to "size"; virtual condition; evaluation & verification; individual vs. related features; Rule 3
- Orientation Tolerances - Perpendicularity, parallelism, angularity; definitions; related features; datums-surfaces, plans, axes, cylinders; MMC & RFS; relationship to position controls; virtual condition; application; evaluation & verification; functional principles
- Profile Tolerances - Profile of a surface & profile of a line; definitions; relationship to size; general rules; when to apply; datum relationship; total surface control vs. line element control; application; evaluation & verification principles
- Runout Tolerances - Circular & total runout; definitions; differences & similarities (circular & total runout); when to apply; coaxial features; datums; double datums; datum precedence; comparison with position & concentricity; FIM; application; evaluation & verification principles
- Location Tolerances - Position; concentricity; symmetry; definitions
- Position Tolerances-Cylindrical features - Hole & Pin patterns; Position tolerance theory; comparison between position & coordinate tolerances; advantages; conversion-position vs. coordinate tolerances; the "bonus" tolerance; mating parts-calculations; applications; use of MMC, RFS, LMC; relationship to datums; datum precedence & methodology; functional gaging; Rule 2; composite position tolerancing; composite position tolerancing with secondary datum; selection of datums (features); "Size" datums; paper gaging; open setup verification; projected tolerance zone; datum, virtual condition rule
- Position Tolerances-Non-Cylindrical Features - Application, MMC, RFS; symmetrical features; calculations; relationship to datums (non-cylindrical); evaluation & verification principles; functional gaging
- Position Tolerances-Coaxial Features - Application, MMC, RFS; coaxial features; calculations; relationship to datums (coaxial/cylindrical); evaluation & verification principles; functional gaging

- Concentricity - Definition; comparison to runout & position; evaluation & verification principles; application
- Datums - Kinds, definitions; datum features; selection; datum reference frames; datum precedence; datum targets; extended datum principles; precision
- Current Status of National Standard - ASME Y14.5
- Question & Answer Session
- Problem Solving Session
- Discussion Session

Instructor: Barry W. Heathcotte

Fee $1745 2.0 CEUs

Geometric Dimensioning & Tolerancing - Level II

3 Days
I.D.# 92048

This is not an introductory course. This course is designed to give practitioners of GD&T a more thorough knowledge of the concepts of the system. Misunderstandings and areas of weakness in your knowledge base will be identified through the use of a proficiency examination. Based on the results of the exam, the class is modified to suit the needs of the participants. Class time is then devoted to clarifying and expanding on concepts and advancing your knowledge base. Emphasis is on thinking about parts in the manner that GD&T provides for you. As a result, attendees will gain a better understanding of the function of their manufactured parts and how it relates to these concepts.

You are encouraged to bring with you ASSEMBLY DRAWINGS AND SUPPORTING PIECE PART AND DETAIL DRAWINGS. Drawings will be used at the end of the class to help solidify the knowledge gained. At the end of class, groups will view and analyze drawings to determine proper datums, necessary relationships and correct methods of control. Use of submitted drawings will be dependent upon the instructor's determination of relevance and usefulness for discussion.

The following textbooks and study materials will be provided: *Geo-Metrics III*, *Pocket Guide*, *ASME Y14.5M-1994 Dimensioning & Tolerancing Standard*, workbooks and answerbooks.

Learning Objectives

By attending this seminar, you will:
- identify any areas of weakness or misunderstandings you may have in interpreting or applying the GD&T system
- clarify and expand your knowledge base of GD&T
- view and analyze actual drawings to apply what you've learned
- receive valuable textbooks, standards, and reference materials that can be used for future day-to-day reference

Who Should Attend

If you apply or interpret GD&T and have had training in the subject, this course will give you a better understanding of the thought processes necessary to do your job. To receive maximum benefit from this course, you should...
- Be committed to the use of GD&T and be aware of its value and benefits
- Have an understanding of the fundamental principles of the system

Prerequisites

This is not an introductory course. Participants should have prior training (minimum of 16 hours of formal classroom training recommended) and experience in GD&T.

Topical Outline

DAY ONE
- GD&T Exam
  - Pinpoints attendees' needs
  - Exam results overview
- Review of Basics
  - MMC, RFS, LMC
  - Limits of size
  - Datums
  - General rules
  - Virtual condition
- Form Tolerances
  - Straightness
  - Relationship to size
  - Virtual condition
  - Evaluation & verification
- Datums
  - Size features as secondary & tertiary datums
  - Understanding orientation datums
  - Equalizing datums
  - Manufacturing datums vs. functional datums
  - Swapping datums
  - Understanding datum shift
  - Size datums; non-size datums
  - Datum features
  - Selection of datums
  - Extended principles
- Orientation Tolerances
  - Perpendicularity; angularity; parallelism
  - Datum relationship
  - Relationship to size
  - Virtual condition
  - Functional gaging
  - Evaluation & verification

DAY TWO
- Profile Tolerances
  - Co-planarity
  - Composite profile
  - Loss of tolerance zone
  - Controlling & locating cones
  - Profile as location control
  - Profile of a surface; profile of a line
  - General rules
  - Datum relationship
  - Evaluation & verification
- Runout Tolerances
  - Circular runout; total runout
  - Datum relationship
  - Comparison with position & concentricity
  - Composite nature
  - Virtual condition
  - Evaluation & verification
- Position Tolerances (Cylindrical Features)
  - Hole and pin patterns
  - Position tolerancing theory
  - Mating parts--calculations; applications
  - Use of MMC, RFS, LMC
  - Projected tolerance zone
  - Relationship to datums, datum precedence and methodology
  - Selection of datums
  - Datum/virtual condition rule
  - Functional gaging and open set-up verification
  - Inspecting with a coordinate measuring machine

- Paper gaging
- Position Tolerancing (Non-Cylindrical Features)
  - Symmetrical features
  - Mating parts--calculations; applications
  - Use of MMC, RFS, LMC
  - Relationship to datums, datum precedence and methodology
  - Selection of datums
  - Datum/virtual condition rule
  - Functional gaging and open set-up verification
  - Inspecting with a coordinate measuring machine
- Position Tolerancing Extended Principles
  - Different size holes
  - 3-part assemblies
  - Reversible parts
  - Resultant condition
  - Datum shift & the "mother duck"
  - Composite position tolerancing for single patterns
  - Composite position tolerancing for holes in line
  - Using dowels and holes for datums
  - Separate requirements for patterns
  - Paper gaging composite position tolerancing
  - Hole patterns as datums
  - Zero tolerance at MMC
  - Composite position vs. two single segments

DAY THREE
- Concentricity
  - When and how to apply
  - Comparison with runout and position tolerancing
  - Evaluation & verification
- Current Status of National and International Standards
  - ASME Y14.5M
  - ISO
- Evaluations of Company Drawings
  - Exercise on choosing datums
  - Review of current use and interpretation of GD&T on company drawings
  - Review of company drawings with regard to further use of GD&T where warranted

Instructor: Barry W. Heathcotte
Fee $1745 2.0 CEUs

Ground Vehicle Systems Engineering: A Practical Approach

3 Days
I.D.# C0703

Competitive pressures are demanding vehicle designs that better satisfy customer wants and needs over the entire vehicle life cycle and, especially, are less expensive to build and operate. This can only be accomplished by understanding the translation of customer wants and needs to engineering requirements and then ensuring every vehicle produced conforms to these requirements for its entire life, even in the presence of a wide variety of customer usage and operational environment variations. The application of systems engineering techniques is a key success factor in accomplishing this task - higher quality products at lower cost.

The course goal is to enable the student to apply key systems engineering tools to practical vehicle problems. The basic three-step systems engineering process, comparison of the two different systems viewpoints and key methods and tools in each of these domains will be presented. Student exercises, drawn from practical vehicle problems, will be conducted and evaluated during this class. Integration of the two different systems viewpoints to create a vehicle conceptual design that fully satisfies customer requirements for the entire vehicle life cycle will be illustrated. Finally, translation of vehicle requirements to the manufacturing domain and how systems engineering methods and tools enable reliable and robust design will be described.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the basic systems engineering three-step process and the important inputs and outputs of each step
- Describe the vehicle architecture viewpoint and indicate why it is critical to vehicle commercial success
- Describe the vehicle functional viewpoint and indicate why it is critical to vehicle customer satisfaction
- Create hierarchical functional diagrams
- Employ physical and functional models to create p-diagrams in support of ensuing FMEA as well as reliability and robustness engineering (Design for Six Sigma)
- List the four types of verification that can be employed to ensure complete conformance to customer and commercial requirements and discuss the advantages and disadvantages of each type

Who Should Attend

The systems approach is useful to engineers who already know the basic function and design of their subsystem. Any engineer responsible for ensuring excellent physical or functional interaction with neighboring subsystems should attend. In addition, engineers responsible for understanding customer wants and needs and subsequently translating them into engineering requirements will learn specific methods that enable this difficult translation to succeed. Engineers responsible for creating a vehicle architecture and managing the subsystems that fully respond to vehicle requirements will benefit from this course, and finally engineers responsible for specifying allowable part variations to the manufacturing and supplier communities will understand how these specifications link to critical customer, vehicle and subsystem requirements.

Prerequisites

Participants should have a bachelor's degree in engineering or science and some professional experience working on a specific vehicle program or subsystem.

Topical Outline

DAY ONE
- Overview of Systems Engineering
  - Three-step process
  - Introduction to the two systems viewpoints
  - Introduction to data-based decision making and systems verification
- Architecture Viewpoint - Overview
  - Vehicle and subsystem levels; interface implications
  - Architecture diagrams (introduction)
  - Ensuring interface traceability from level to level
- Choosing a Vehicle Architecture
  - Importance of vehicle architecture to commercial success
  - Relation of vehicle architecture to platform engineering
  - Concept-level engineering decision making process
  - Classroom exercise - vehicle architecture selection
- Architecture Diagrams
  - Templates
  - Interface reconciliation process
  - Interface diagram class exercises (vehicle & subsystem)

DAY TWO
- Functional viewpoint - Overview
  - Customer level
  - Vehicle and subsystem levels
- Translating from customer wants and needs to vehicle engineering requirements
  - Methods for discovering the customer - engineering translation
  - Customer translation exercise
- Functional Diagrams
  - Templates
  - Requirements decomposition
  - Requirements allocation to subsystems-connecting functional and architecture viewpoints
  - Functional decomposition exercise (including requirements allocation)
- State Analysis - Introducing the Control Element
  - State transition diagrams
  - State analysis exercise

DAY THREE
- Connection to Reliability and Robustness
  - How the two systems viewpoints lead to p-diagrams
  - P-diagram template
  - P-diagram exercise
- Verification
  - Overview and types of verification
  - Detailed design optimization using verification techniques
  - How verification confirms customer and commercial success
  - Verification for reliability and robustness
  - Capstone exercise -- Customer translation; Vehicle functional analysis; Vehicle and subsystem interface diagramming; Supplier/manufacturing communication
- Key learning Points and Class summary

Instructor: Paul Berry

Fee $1545 2.0 CEUs

Introduction to Failure Modes & Effects Analysis for Product Design (Design FMEA)

1 Day
I.D.# 90034

This seminar introduces the participant to the analytical process in which potential failure modes, failure effects, and causes of failure are identified. Criticality and risk analysis concepts are also covered for dealing with the effects of failure. Analysis is used to identify corrective actions that may be used to eliminate failure modes or minimize the effect of failure. Additionally, the analysis may be used to identify controls necessary to prevent failure occurrence. This seminar is designed to assist individuals responsible for design and development activities in the completion of a Design FMEA. Individuals attending the seminar should have a basic understanding of the product design process and product design principles. This course covers the AIAG standardized format for FMEA and the succeeding SAE Standard for FMEA, J1739, which is included in the course materials. During the class, the instructor will review the updates to standard J1739 (revised Jan 2009).

Learning Objectives

By attending this seminar, you will be able to:
- List the benefits, requirements and objectives of an FMEA
- Learn the steps and methodology used to analyze a Process FMEA
- Expand their knowledge of a variety of tools utilized when performing an FMEA
- Identify corrective actions or controls and their importance in minimizing or preventing failure occurrence
- Summarize the objectives of the SAE Standard for FMEA, J1739

Who Should Attend

- This seminar is designed for the manufacturing engineer, product design engineer, reliability engineer, test engineer, quality engineer, development engineer, logistics/support engineer, product assurance/design assurance engineer, materials engineer, and their management or anyone responsible for the design and development of manufacturing, assembly or service processes in the completion of a Design FMEA.

Prerequisites

Individuals attending the seminar should have a basic understanding of the manufacturing/assembly process and design principles.

Topical Outline

- Introduction & Overview
  - Definition
  - General discussion -- requirements for analysis; uses/objectives of analysis; benefits
  - Timing & relationships -- level of analysis (detail); design FMEA versus Process FMEA
- Performing a Design FMEA
  - Pre-analysis activities -- determine customer requirements -- quality function deployment (QFD); environmental conditions/considerations; determine required function; develop block diagrams
  - Basic analysis methodology -- approach; sequence
  - Criticality/risk analysis (prioritization)
  - Typical forms used & examples
- Problems Encountered
  - Application
  - Timing
  - Prioritization
- Fault Tree Analysis as a Supportive Tool
  - Introduction -- approach; FMEA relationship
  - FTA sequence
  - Analysis overview -- symbols; examples; workshop
  - Limitations
  - Benefits
- Application
  - Combined FMEA/FTA examples
  - Detained FMEA examples
  - FMEA/FTA comparisons
- Using the Results
  - Logistics support analysis (LSA)
  - Failure prevention analysis (FPA)
  - Test planning
- Other Related Methods/Tools
  - Design review
  - Checklists
  - Lessons learned
  - Design of Experiments (DOE)
  - SPC
  - Value engineering
  - FMEA software
- Keys for Successful Implementation
  - Activity as a process versus a task
  - Analysis by group/team versus individual -- roles & responsibilities; use of facilitators
- FMEA & Product Liability

Instructor: E. Harold Vannoy
Fee $785 .7 CEUs

Introduction to Failure Modes & Effects Analysis for Product Design & Manufacturing Process Design (Product & Process FMEA)

2 Days
I.D.# 92002

Designed to assist individuals responsible for design and development activities in the completion of a Design FMEA and Process FMEA, this course introduces participants to the analytical process in which potential failure modes, failure effects, and causes of failure are identified. Criticality and risk analysis concepts for dealing with the effects of failure will be covered. Analysis is used to identify corrective actions and controls necessary to eliminate failure modes or minimize the effect of failure. Attendees will also receive the SAE Standard for FMEA, J1739, which is covered in the course materials. During the class, the instructor will review the updates to standard J1739 (revised Jan 2009).

Please note this seminar combines course material covered in ID# 90034, Introduction to Failure Mode & Effects Analysis for Product Design (Design FMEA) and ID# 90033, Introduction to Failure Mode & Effects Analysis for Manufacturing Processes, Assembly Processes & Service (Process FMEA).

Learning Objectives

By attending this seminar, you will:
- Know the benefits, requirements and objectives of an FMEA
- Learn the steps and methodology used to analyze a Process FMEA
- Expand your knowledge of a variety of tools utilized when performing an FMEA
- Identify corrective actions or controls and their importance in minimizing or preventing failure occurrence
- Know the objectives of the SAE Standard for FMEA, J1739

Who Should Attend

This seminar is designed for the product/design engineer, process design engineer, manufacturing engineer, development engineer, materials engineer, product assurance, design assurance, process assurance engineer, reliability engineer, test engineer, quality engineer, logistics/support engineer, and their management.

Prerequisites

Individuals attending the seminar should have a basic understanding of the product design process and product and manufacturing process design principles.

Topical Outline

- Introduction & Overview
  - Definition
  - General discussion -- requirements for analysis; uses/objectives of analysis; benefit
  - Timing & relationships -- level of analysis (detail); Design FMEA versus Process FMEA
- Performing a Design FMEA & Process FMEA
  - Pre-analysis activities -- determine customer requirements [Quality Function Deployment (QFD) and Environmental Conditions/Considerations]; determine required functions; develop block diagrams; process flow diagrams
  - Basic analysis methodology -- approach; sequence
  - Criticality/risk analysis (prioritization)
  - Typical forms used & examples
  - Problems Encountered
    - Application
    - Timing
    - Prioritization
- Fault Tree Analysis as a Supportive Tool
  - Introduction -- approach; FMEA relationship
  - FTA sequence
  - Analysis overview -- symbols; examples; workshop
  - Limitations
  - Benefits
- Application
  - Combined FMEA/FTA
  - Detained FMEA examples
  - FMEA/FTA comparisons
- Using the Results
  - Logistics Support Analysis (LSA)
  - Failure Prevention Analysis (FPA)
  - Test planning
- Other Related Methods/Tools
  - Design review
  - Checklists
  - Lessons learned
  - Design of Experiments (DOE)
  - SPC
  - Design for assembly (DFA)
  - Value engineering
  - FMEA software
- Keys for Successful Implementation
  - Activity as process versus a task
  - Analysis by group/team versus individual -- roles & responsibilities; use of facilitators
- FMEA & product liability

Instructor: E. Harold Vannoy
Fee $1285 1.3 CEUs

Mechatronics: Introduction, Modeling and Simulation

2 Days
I.D.# C0949

Modern engineering challenges and their solutions are often multidisciplinary in nature. Systems in today's vehicles integrate mechanical, electronic, hydraulic, as well as various other components all working together in a synergistic manner. While progress is being made in lowering the barriers between traditional engineering disciplines and formal education programs, this seminar is designed to provide engineers with mechanical or electrical engineering backgrounds the knowledge to effectively interact with colleagues from the other discipline in an efficient and productive manner.

This two day seminar is designed for the engineer with little or no mechatronics systems experience and will begin with an introduction to mechatronics principles and components, including sensors, actuators, control strategies, and instrumentation. The instructor will then guide the participants through the analysis, synthesis and design of mechatronics systems through the use of modeling and simulation tools. Emphasis will be given to a unified energy flow approach to model mechatronics systems that are comprised of multidisciplinary components. A key element of this seminar is the use of computer simulation exercises to enhance and reinforce the learning experience. The instructor will conduct modeling and simulation exercises for this class using commercial vehicle and automotive mechatronics systems examples. Attendees desiring

a more direct hands-on learning experience are encouraged to bring a personal laptop computer with the demonstration version of the 20-sim modeling simulation software installed prior to arrival (available at http://www.20sim.com/downloads/downloadform.)

The text, *Mechatronic Modeling and Simulation Using Bond Graphs*, authored by Shuvra Das is included with the seminar.

Learning Objectives

By attending this seminar, you will be able to:
- Identify multidisciplinary principles and applications of mechatronics systems
- Apply appropriate use of sensors, actuators and mechanisms in mechatronics applications
- Implement a structured approach to modeling mechatronics systems
- Select and utilize appropriate software modeling tools
- Simulate system dynamic behavior for different input conditions
- Interpret simulation results to determine system behavior in physically meaningful terms
- Identify and overcome barriers that can interfere with collaborative work across engineering disciplines on mechatronics projects

Who Should Attend

Mechanical and electrical engineers needing to develop a fundamental understanding of the other discipline, especially in the context of the synergistic design of products that are multi-disciplinary in nature, will benefit most from this seminar. Also benefiting are engineers in leadership positions that require a fundamental understanding of mechatronics systems and how the engineering disciplines must work together to ensure efficiency and productivity.

Prerequisites

An undergraduate degree in either electrical or mechanical engineering is highly recommended.

Topical Outline

DAY ONE
- Introduction to Mechatronics
  - System dynamics
  - Components -- Mechanisms; Sensors; Actuators
  - Signal conditioning
  - Microcontrollers
  - Control strategies
- Introduction to Mechatronic Modeling and Simulation
  - Modeling techniques
  - Bond graphs as a modeling technique
  - Drawing of power flow diagrams (bond graphs) and their meaning
  - Generalized basic elements
  - Representation of systems in terms of basic elements
  - Deriving system models from bond graphs

DAY TWO
- Modeling of Electrical, Mechanical, and Magnetic Systems
  - Modeling basics
  - Use of software tools to draw the bond graph model
  - System types and their behavior
  - Simulation -- Results and interpretation
- Mechatronics Modeling Examples
  - Sensors, actuators and systems
  - Examples and cases from: Earth moving equipment; Automotive; Machine tools
  - Other mechatronics applications
- Course Assessment and Summary

Instructor: Shuvra Das
Fee $1345 1.3 CEUs

Model Based Design: Delivering Quality Electronic Products Faster

2 Days
I.D.# C0806

As new technologies proliferate, as change happens faster and faster, and as customers demand the latest electronic features "NOW", a new paradigm for product development has emerged. Recent advances in the capabilities of software tools now make possible an entire product development process in a virtual environment, with more speed and power than will ever be possible on a bench. This two-day course will provide you with math-based tools to greatly accelerate electronic product development, and to simultaneously deliver a more robust design. Participants will learn the basic theory of finite state machines with a heavy emphasis on simple, real-world examples. Through a series of hands-on learning modules, attendees will gain the understanding and experience to build an executable spec simulation environment. Tools and techniques will be provided so that the attendees can bring these skills back to work and implement the process immediately. Companies which use the executable spec methodology will soon dominate the market for mobile mechatronics.

Learning Objectives

By attending this seminar, you will be able to:
- Work smarter - leverage brainpower with software tools to design more robust products
- Work faster - bring products to market more quickly, and start the next product sooner
- Improve schedule confidence - fewer surprises, less risk of late re-design
- Facilitate collaborative engineering design work through a common methodology
- Create a re-use library of executable specs
- Implement the verification process concurrently with the design process
- Improve quality of the design from the start

Who Should Attend

This course is valuable to both managers and engineers who want to improve product time-to-market, quality, and overall development costs. Systems/controls, electrical, mechanical and software engineers will learn specific skills to amplify their capabilities and help ensure their future value to the company.

Prerequisites

A basic familiarity with computer-based tools and fluency with keyboard and mouse are essential. The course material is suitable for anyone with a bachelor's degree in engineering.

Topical Outline

DAY ONE
- Executable Specs and Model Architecture
  - Model-based methodology and work flow
  - Requirements and model-based development
  - High-level design with UML and Simulink®
  - State machines and event-driven applications
  - Model and simulation libraries
  - Hands-on Exercise 1: Creating a Re-use Library
- Product Design and Implementation
  - Requirements management and traceability
  - The data dictionary
  - Verification and validation strategies and metrics
  - Hardware/software design and development
  - Operating system modeling
  - Hands-on Exercise 2: Home Automation Project

- Integration Testing and System Validation
  - Hardware-in-the-loop using MATLABÂ®
  - Automated test coverage
  - Communications strategies for models
  - Rapid prototyping of automotive electronics
  - General topics in the reduction to production
  - Hands-on Exercise 3: Algorithm Development and Operating System

DAY TWO
- Examples of Automotive Systems Development
  - Comparison of manual software coding to autocode
  - Body computer specification modeling
  - Passenger presence sensor for airbag disable
  - Audio playback controller program
  - Hands-on Exercise 4: The Window-Open Volume Modulator
- Metrics and Program Management
  - Estimation of effort
  - Hands-on Exercise 5: Sensor Modeling
  - Case study of rollover simulation environment
  - Hands-on Exercise 6: Quasi-random Testing for Non-Compliance
  - How to manage an executable spec project
  - Hands-on Exercise 7: Model Validation of Executable Specs
- Corporate Challenges to Model-Based Development and Executable Specs
  - Classic reprints in model-based development
  - Important patents in MBE, CAE and executable specs
  - Source code for select tools, metrics and scripts

Instructor: Peter J. Schubert
Fee $1365 1.3 CEUs

Process FMEA Update: What's New in J1739 Webinar

6 Hours
I.D.# WB0956

The new J1739 has been revised to address common problems with the application of Process FMEA today. Such problems include the time spent debating ranking systems, potential problems hidden in the Risk Priority Number, false starts and rework of FMEA because of a lack of understanding of process functions, and a lack of emphasis on prevention controls or early detection of product defects. This course is not intended to cover all of the details of completing a Process FMEA. Rather, its focus is on recent updates to the J1739 standard and how those familiar with performing Process FMEA should adjust their approach.

Similarities in content exist between this course and the Design FMEA Update: What's New in J1739 Webinar, however each is uniquely designed to address what's new for each type of analysis.

Learning Objectives

By connecting with this webinar, you will be able to:
- Identify new PFMEA requirements that must be fulfilled by management
- Find answers to most PFMEA questions in J1739
- Align ideas within the logical framework of the PFMEA worksheet
- Apply new risk assessment evaluation criteria to the PFMEA
- Compare the differences between using Risk Priority Number thresholds with using other risk assessment criterion such as the use of Severity and Occurrence when prioritizing actions for risk mitigation

Who Should Attend

Manufacturing engineers, product engineers, quality engineers, supplier quality engineers, validation and test engineers, and FMEA facilitators, trainers and consultants primarily in, but not limited to, the automotive industry may be interested in the update this webinar offers. Beginning engineers and advanced/senior engineers who must participate in FMEA, as well as those that manage FMEA activity, will also gain valuable insights.

If you have a copy of the SAE J1739 standard, we recommend that you have it at hand for all three sessions of the webinar. If you do not own the standard and wish to purchase a copy, go to SAE J1739 Standard

Topical Outline

Session 1
- Introduction and Potential Failure Analysis
  - Concerns about FMEA usage
  - Key change points applicable to Process FMEA
  - How to use J1739
  - Terms and definitions
  - Pre-Analysis preparation
  - PFMEA product and process functions and requirements
  - Failure Modes and Effects
  - Failure Causes
  - Current process controls - prevention
  - Current process controls - detection

Session 2
- Risk Assessment
- Severity ranking criteria - emphasis on vehicle level
- Occurrence ranking criteria - the change that impacts the RPN immediately
- Detection ranking criteria - emphasis on method and location of evaluation
- Risk Priority Numbers - secrets RPN won't tell
- Severity x Occurrence - back to the beginning
- Severity AND Occurrence - go for a meaning, not a number
- Other risk assessment criteria

Session 3
- Risk Mitigation
  - FMEA general requirements
  - PFMEA outputs
  - PFMEA form and example
  - Special characteristics and PFMEA
  - Writing effective action plans to mitigate risk

Instructor: Bill Haughey
Fee $515 .7 CEUs

Quality Function Deployment

2 Days
I.D.# 92029

Quality Function Deployment (QFD) is an excellent technique for determining and understanding customer requirements and then translating these requirements into your company's internal technical language for use in product design through final assembly. QFD is a method for converting customer requirements into company requirements. The first day of this two-day program provides practical strategies and benefits of the successful QFD technique. On the second day, you will receive additional details to enhance the QFD technique. You will also strengthen your QFD skills during monitored practice sessions and thought-provoking question and answer periods.

Learning Objectives

By attending this seminar, you will be able to:
- Define Quality Function Deployment (QFD)
- Identify the terminology and methodology used in QFD
- Recognize the workable benefits of QFD to the product/process design and development process
- Review methods for determining and monitoring the "Voice of the Customer"
- Describe two accepted approaches to QFD
- List the requirements for QFD's success

Who Should Attend

You should attend if you:
- Are a product/process design or development engineer
- Are a sales/marketing engineer
- Are a quality/reliability engineer
- Are an engineer involved in product/process assurance
- Manage any of the above
- And your company wants to conform to the new automotive supplier quality requirements

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

- Capturing the Concept of Quality
  - Targeting the Kano model
  - Branching out with the quality success tree
- How to Determine Customer Requirements ("Voice of the Customer")
- Establishing Designing Requirements
- Constructing the Product Planning Relationship Matrix
- Making Cascading Matrices Work for You
  - Design alternative selection
  - Determine subassembly and part characteristics
  - Ascertain manufacturing processes
  - Targeting quality controls
- Comparing the Relationship of QFD and Other Product and Process Design Tools

Instructor: E. Harold Vannoy
Fee $1225 1.3 CEUs

Reverse Engineering: Technology of Reinvention

2 Days
I.D.# C0559

During the past decade reverse engineering has become a common and acceptable practice utilized by many original equipment manufacturers and suppliers. This course focuses on the application of modern technologies used to decode the design details and manufacturing processes of an existing part in the absence of the original design data. It emphasizes the real-life practice of reverse engineering in the aerospace industry from both scientific and legal points of view. Attendees will learn the applicability and limitations of reverse engineering through case studies and hands-on exercises.

Various measurement instruments, ranging from traditional micrometers to computer-aided laser probes, will be compared for their merits and shortcomings. The statistics of dimensional measurements and the acceptable tolerance of variations, with emphasis on industrial standards in real-life practice will be discussed. Material identification, manufacturing process verification and the system compatibility of the subject part to be reverse engineered will be covered in substantial detail. In addition, the materials specifications will be exemplified as useful supporting documents for substantiation data.

Note: Participants should bring a calculator for in-class exercises.

Learning Objectives

By attending this seminar, you will be able to:
- Define the critical elements of reverse engineering
- List the measurements and analyses required to duplicate/reproduce an OEM part by reverse engineering
- Recognize if an OEM part can be duplicated/reproduced by reverse engineering
- Judge if a "duplicated" part will meet the design functionality of the OEM part
- Evaluate the feasibility of a reverse engineering proposal/project
- Describe and implement a process to duplicate/reproduce a part by reverse engineering

Who Should Attend

This seminar is designed to assist individuals in various industries including, but not limited to, automotive, aerospace, off-highway, motorsports and parts brokerage firms. Corporate senior executives, engineering managers, engineers, technicians, government inspectors, sales managers, salespersons, lawyers and legal counselors will find the course relevant and informative.

Prerequisites

Participants should have an undergraduate degree or equivalent experience/knowledge.

Topical Outline

DAY ONE
- Introduction
  - Historical background
  - Reverse engineering vs. machine design
  - Three basic requirements: form, fit and function
- Geometrical Form
  - Dimensional measurement

- Precision instruments of measurement
- Tolerance
- Virtual exercise of geometrical modeling
- Material and Process Identification
  - Chemical composition identification
  - Manufacturing process verification
  - Materials specification substantiation
  - Machining process identification
- Data Process and Analysis
  - Statistical analysis
  - Statistical exercise
  - Case study of statistical confidence
  - Reliability

DAY TWO
- Demonstration and Exercise
  - Demonstration of scanning
  - Hands-on exercise of reverse engineering
  - Case study
- Regulations and Certifications
  - Government regulations
  - Industrial standards
  - Certification requirements
- Fit and Function
  - System compatibility
  - Critical performance
  - Vendor substantiation
  - Safety and damage tolerance
- Acceptance and Legality
  - Evolving industry trends
  - Moral and legal issues
  - Examples - legal precedents

Instructor: Wego Wang
Fee $1225 1.3 CEUs

Statistical Tolerance Design

1 Day
I.D.# 88033

This seminar will include a review of statistical theory and present statistical methods, which are used to better select and/or analyze Tolerance Stack-ups. The Probability (RMS) Method, the Monte Carlo Simulation Technique and tolerance optimization techniques will be discussed along with guidelines on which method(s) to use in given situations. Attendees will also view a demonstration of a microcomputer Monte Carlo Simulation program that analyzes the effects of form and assembly variation on the quality of a finished product. This seminar will provide an overview of Design of Experiments (DOE) methods, which enable effective analysis of critical product dimensions and tolerances. Note: Participants should bring a scientific calculator for several in-class exercises.

Learning Objectives

By attending in this seminar, you will be able to:
- Apply worst case, root-mean-square, and Monte Carlo simulation methods for the allocation of analysis of simple-to-intermediate complexity tolerancing schemes
- Use the "Risk of Misassembly" approach for tolerance allocation, and the "Main Effect" approach for determining dimensional variables tolerance which exhibit the greatest impact on build variation
- Understand and be exposed to various computer tools which can greatly improve their statistical tolerancing efforts, given the intricacies of GD&T, plus-minus tolerancing, and various datum schemes

Who Should Attend

This seminar is intended for engineers and educators who would like to have a good working knowledge of applying statistics to product design in order to better predict and improve product quality.

Prerequisites

An engineering undergraduate degree in any discipline would be beneficial.

Topical Outline

- Review of Tolerancing Methods, Tolerance Stack-Ups and the Relationship between Tolerancing and Quality. A High-Level Overview of Geometric Dimensioning & Tolerancing (GD&T) and Process Capability Measurement is Provided
- Tolerance Synthesis (Allocation) Versus Tolerance Analysis
- Overview of the Worst Case (non-statistical) Tolerancing Method for Comparison with Statistical Tolerancing Results
- Probability & Statistics Concepts Required for Statistical Tolerancing Methods
- Tolerance Allocation Based on «Risk of Misassembly»
- Statistical Tolerancing Using the Root-Mean-Square (RMS) Method
  - With bilateral tolerances
  - With unilateral and/or asymmetrical tolerances
  - In 2-D and 3-D applications
  - Participant exercises
- Statistical Tolerancing Using Monte Carlo Simulation
  - Performing Monte Carlo Analysis by hand
  - Demonstrations of computer software for Monte Carlo Simulation and analysis (VSA-2D, VSA-3D and others, if time permits)
- Analyzing Part Tolerances using Main Effect and Sensitivity Analysis Methods -- Methods for Determining the Contribution of Process Variables to Overall Process Variation. A Brief Description of Partial and Full-Factorial Analysis is Also Provided
- Overview of Design of Experiments (DOE) and Tolerance Optimization Techniques -- Their Benefits in Effective Tolerancing of Parts and Assemblies
- Tolerance Management Program Guidelines -- For the Benefit of Participants Interested in Establishing a Comprehensive Quality Assurance Program in Their Organization

Instructor: Kevin Zielinski
Fee $775 .7 CEUs

Tolerance Stack-Up Analysis

2 Days
I.D.# C0022

This course is designed to help product design personnel create tolerance stacks for parts and assemblies that use Geometric Dimensioning & Tolerancing. Those who will benefit most are designers and engineers who are responsible for creating the GD&T callouts for engineering drawings and product models, and who want to be more confident in how the assigned geometric tolerances interact and stack up. The course begins with a quick review of Y14.5 concepts, and then introduces the benefits and uses of a tolerance stack spreadsheet. Participants then learn detailed procedures for performing tolerance stacks on parts and assemblies, beginning with coordinate tolerances and moving on to geometric tolerances.

The course will eliminate confusion over how to include the bonus and shift in a tolerance stack: for example, when using tolerance of position with the MMC modifier. The simple, manual spreadsheet method used throughout the course produces a straightforward documentation trail that is easily interpreted, and readily adaptable to any company's electronic spreadsheet program. Results can be quickly and easily checked, and revisions can be made with ease. Students receive extensive practice at creating stacks, and should bring a calculator or laptop computer equipped with MS Excel for the numerous student exercises.

Each attendee will receive a copy of the *Tolerance Stack Analysis Using GD&T* textbook and an Excel template for generating stacks.

Learning Objectives

By attending this seminar, you will be able to:
- Correctly calculate and apply bonus, shift, virtual condition, and resultant condition
- Perform and develop a tolerance stack-up analysis
- Correctly enter geometric feature control frame data into a tolerance stack

Who Should Attend

This course is intended for designers and engineers who are currently generally familiar with the principles, concepts and practices contained within Y14.5, and who are looking for a comprehensive step-by-step process for getting GD&T into a tolerance stack.

Prerequisites

Previous experience with Geometric Dimensioning & Tolerancing principles, concepts, and practices is required.

Topical Outline

- Introduction to Tolerance Stacks
- Review of GD&T and the Y14.5 Standard
- Review of Virtual Condition and Resultant Condition concepts
- Introduction to Tolerance Stack-up Analysis Procedure for parts (part stacks) using coordinate dimensions and tolerances*
- Introduction to Tolerance Stack-Up Analysis Procedure for assemblies (assembly stacks) using coordinate dimensions and tolerances (100% interchangeability)*
- Tolerance Stack-up Analysis for runout and concentricity*
- Tolerance Stack-up Analysis for surface profile: bilateral and unilateral*
- Tolerance Stack-up Analysis for tolerance of position: RFS*
- Tolerance Stack-up Analysis for tolerance of position: MMC-bonus*
- Tolerance Stack-up Analysis for tolerance of position: MMC-shift*
- Tolerance Stack-up Analysis for form and orientation controls: surface and feature of size*
- Use of Statistical Methods in Stack-up Analysis: Root-Sum-Square and its Derivatives * Indicates hands-on practice exercises immediately follow lecture

Instructor: John-Paul Belanger or John Stolter
Fee $1295 1.3 CEUs

Tolerance Stack-up Fundamentals Webinar

I.D.# C0842

Analysis of tolerance stacks varies widely. This webinar introduces the basic tools to create a common methodology for tolerance stack-ups, and ensure seamless documentation. Participants will create 1-D tolerance stacks for parts and assemblies that use geometric dimensioning and tolerancing using a tolerance stack spreadsheet. This simple, manual spreadsheet method produces an easily interpreted and checked documentation trail, and is easily adaptable to common electronic spreadsheet programs. Multiple examples will be provided to assist engineers in applying tolerance stack-up fundamentals to Y14.5 issues.

Learning Objectives

By connecting with this webinar, you will be able to:
- Perform and develop a tolerance stack-up analysis
- Correctly enter geometric feature control frame data into a tolerance stack
- Apply a common step-by-step methodology to tolerance stack analysis

Who Should Attend

Engineers familiar with concepts and practices contained within Y14.5 and who are looking for a fundamental step-by-step process for getting geometric dimensioning and tolerancing (G D & T) into a tolerance stack will benefit from this course. A basic understanding of G D & T symbols and concepts is required.

Topical Outline

Session 1
- Introduction and review
  - Introduction and tolerancing review
  - Tolerancing strategies
  - Review of G D & T

Session 2
- Stack fundamentals
  - How to identify the stack path
  - The two-column stack spreadsheet
  - Entering dimensions into the spreadsheet
  - Examples with coordinate dimensions

Session 3
- Factoring G D & T into a Stack
  - Location and runout tolerances
  - Profile tolerances
  - Form and orientation tolerances

Session 4
- Bonus and shift tolerance in a stack

- Overview of bonus and shift tolerance
- Part vs. assembly stacks
- Wrap-up

Instructor: John-Paul Belanger

Fee $585 .8 CEUs

Using Computational Fluid Dynamics for Engineering Product Development

2 Days
I.D.# C0909

Over the last three decades Computational Fluid Dynamics (CFD) has developed into a sophisticated tool for analyzing fluid flow and other thermal sciences related phenomena. Most educational courses on this topic focus on the fundamentals of CFD, but sound knowledge of the fundamentals is not enough to make effective use of CFD in practical engineering product development. This seminar provides significant practical considerations in using CFD for product development and is designed to help engineers extract best benefits from CFD while avoiding potential pitfalls.

The seminar begins by discussing the applicability, benefits, and drawbacks of CFD in engineering product development. Ways of leveraging CFD, while avoiding pitfalls at various stages of the product development process, as well as various aspects of managing and implementing practical CFD projects, will be explained. Advanced aspects of CFD management and implementation such as methods development and multiphysics will also be covered. The resource requirements and costs of CFD are then detailed along with a discussion and exercises on performing return of CFD investment calculations. Commercially available codes will also be compared and contrasted. Hands-on exercises and case studies are used throughout the seminar to put practical emphasis on topics taught in the lectures.

Learning Objectives

By attending this seminar you will be able to:

- Explain benefits and limitations of CFD in engineering product development
- Determine where to use CFD in various stages of the product development process
- Use CFD and experimental testing to compliment each other in the product development process
- Determine when to and when not to use CFD
- Plan, manage, and implement CFD simulation projects
- Evaluate CFD results for correctness and accuracy
- Leverage CFD with numerical simulations of other physics
- Calculate and plan the resources needed for implementing CFD
- Perform return on investment calculations for investments in CFD
- Make informed choices of commercial CFD software
- Determine when to and how to effectively use external CFD services

Who Should Attend

All engineering product development personnel involved in applications of fluid flow and thermal sciences will benefit from this course. These include product development and evaluation engineers, design engineers, engineering analysts, supervisors, managers, CAE strategists, and researchers. New entrants to the field of CFD will be able to use this course to identify and adopt the best CFD implementation and management choices and methods for their organizations from the get-go. Existing and experienced personnel in the CFD field will be able to use this course to improve upon their current CFD implementation methods and practices to realize greater benefits from CFD.

Prerequisites

General experience with engineering product development will be sufficient to understand and assimilate the material presented in this course. Prior experience with CFD is preferred but not required.

Topical Outline

DAY ONE

- Review of CFD
  - Overview of basic physics, mathematics, and numerics
  - Applications of CFD in automotive, off-highway and aerospace engineering
  - Typical CFD project work-flow
  - Benefits and limitations of CFD
- Hands-On Exercise - Understanding the Benefits and Limitations of CFD
- Leveraging CFD in the Product Development Process
  - Use of CFD at various product development stages
  - System and component level CFD simulations
  - How CFD and testing compliment each other
  - How to choose between CFD and testing
  - When and when not to use CFD
- Hands-On Exercise 2 - This exercise goes through a complete design optimization cycle, where a specific engineering product design is optimized using CFD
- CFD Project Management and Implementation
  - Need identification and goal determination
  - CAD data handling and extraction
  - Preprocessing, solving, post-processing and reporting
  - Evaluating correctness and accuracy of CFD results
  - Meaningful comparison of CFD results with experimental test data
  - Archiving CFD simulation data

DAY TWO

- Advanced Aspects of CFD Implementation
  - Various stages of CFD acceptance and usage
  - CFD methods development and R&D
  - Leveraging CFD with other numerical simulations
- Multi-physics
  - CFD process compression
- Resources Needed for CFD Implementation
  - Hardware
  - Software
  - Personnel - roles of specialists and non-specialists
- Costs and Returns of CFD
  - CFD costs
  - Typical time needed for CFD implementation
  - CFD return on investment
  - Case studies and exercises
- Overview of Commercial CFD Software
  - Commercial CFD software tools currently available
  - Comparison of commercial CFD software tools
  - How to choose commercial CFD software
- External CFD Services
  - Types of external CFD services
  - When to use external CFD services
  - How to choose an external CFD services vendor
- External Resources for CFD Information

Instructor: Sandeep Sovani

Fee $1265 1.3 CEUs

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Introduction to Hydraulic Hybrid Systems for Road Vehicles 51
Liquid Atomization, Sprays, and Fuel Injection 52
Piston Ring Design/Materials 53
Plug-in Hybrids: Opportunities and Challenges Webinar 53
Powertrain Selection for Fuel Economy and Acceleration Performance 54
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Turbocharging for Fuel Economy and Emissions Webinar 57
Turbocharging Internal Combustion Engines 58
Variable Cam and Valve Timing (VCT) & (VVT) Webinar 59
Variable Compression Ratio (VCR) Webinar 60

Automotive Fuel Cell Systems

3 Days
I.D.# C0112

Fuel cell technology promises to revolutionize the automotive industry, offering tremendous potential to increase efficiency and reduce emissions for many types of vehicles. This course will provide a detailed understanding of the processes, subsystems and vehicle characteristics relating to fuel cell systems for automotive applications.

The course starts with the principles of fuel cells and electrochemical conversion of hydrogen. Each of the supporting subsystems needed for operation of the fuel cell stack is developed to determine the overall fuel cell system efficiency. Vehicle system integration, performance and fuel economy are then related to fuel cell system characteristics. Attendees will receive the text, *Fuel Cell Systems Explained*, written by J. Larminie and A. Dicks.

Learning Objectives

By attending this seminar, you will be able to:
- Understand the advantages and disadvantages of different fuel cell technologies for transportation applications
- Calculate the efficiency and power output of a fuel cell process
- Calculate the net system power and efficiency of a complete fuel cell system over a range of loads
- Select fuel cell system component sizes to meet performance and efficiency goals
- Discuss system integration challenges as well as fuel and operational requirements for fuel cell vehicles

Who Should Attend

Professionals involved in the design, procurement or regulation of fuel cell vehicles and systems. It is recommended that attendees have a background in engineering, physics and chemistry.

Topical Outline

DAY ONE
- Fuel Cell Basics
  - Overview of Fuel Cell Types
  - Principle of Operation
  - Efficiency and Performance
  - Effect of Pressure and Concentration
  - Losses in Fuel Cell Processes
  - Proton Exchange Membrane (PEM) Fuel Cells
  - Water Management in PEM Fuel Cells

DAY TWO
- Fuel Cell Systems
  - Psychrometrics of Humid Gasses
  - Air Supply and Pressurization
  - Humidification and Water Balance
  - Thermal Management
  - Power Processing
  - Fuel Processors and Integration
  - Controls and Sensors
  - System Efficiency and Part-Load Operation

DAY THREE
- Fuel Cell Vehicles
  - Vehicle Load and Performance Requirements
  - Fuel Cell System Sizing
  - Fuel Selection, Infrastructure and Storage Issues
  - Vehicle Systems Integration Issues
  - Hybrid Battery/Fuel Cell Systems
  - Fuel Cell Auxiliary Power Units (APU)
  - Cold Start and Transient Performance
  - Fuel Cell Vehicle Fuel Economy and Greenhouse Gas Impact
  - Current Fuel Cell Vehicles

Instructor: Douglas J. Nelson
Fee $1695 2.0 CEUs

Basic Hybrid and Electric Vehicle Safety Webinar

2 Hours
I.D.# C0904

High-voltage, high-current energy storage systems and electrical circuits in many current and future alternative-propulsion powertrains present unique challenges to the automotive industry. Care must be taken to minimize risk to all who come into contact with the vehicle throughout its development and life cycle, including powertrain developers, assembly line workers, service technicians, vehicle occupants, and first responders. Significant risk to life and limb can arise from technical issues surrounding these vehicles.

This 120-minute webinar reviews safety concerns and precautions related to high-voltage circuits present in hybrid, plug-in hybrid, electric, and fuel cell hybrid vehicles. HV circuits are discussed in general to provide an understanding of "where the risk lies". The effects of electrical current on the human body are summarized and existing protective measures, along with the standards that govern such measures, are described. Specific issues related to vehicle development, service, and operation are explained, along with onboard fault detection systems used to protect individuals from electrical injury. A general understanding of electrical and mechanical engineering is helpful, but is not required.

Learning Objectives

- Describe component functions and locations in a typical high-voltage powertrain as well as the onboard safety systems associated with such components
- Explain the general effects of electric current on the human body
- Know which national and international safety standards apply to high-voltage vehicle circuits
- Summarize HV safety working issues that may be present during a vehicle's development, assembly, service, and operation
- Identify general issues associated with extrication of occupants from vehicles with high-voltage powertrains

Who Should Attend

Light and heavy duty engineers and technicians who work directly with high-voltage vehicle circuits in hybrid, plug-in hybrid electric, and/or fuel cell hybrid vehicles, as well as component suppliers, safety officers and/or personnel who plan to develop high-voltage safety programs or procedures, will benefit from this webinar.

Topical Outline

- General high-voltage electrical safety issues in vehicles
  - Issues with energy storage systems
  - Issues with motor controllers
  - Issues with motor-generators
  - Issues with DC-DC converters
  - Relationship between high-voltage (HV) bus and 12V bus
  - Gasoline-electric hybrids (HEV)
- Electrical injury
  - Effects of electrical energy on the human body
  - Electrical resistance of the human body
  - "Let-go" current
  - Common electrical accidents
- Industry protection against electrical injury
  - Standards and regulations organizations
  - Personal protective equipment
- On-board vehicle protection against electrical injury
  - Insulation and insulation breakdown
  - Fusing and interlocks
  - Ground-fault protection systems
  - Discharge and isolation circuits
- Powertrain development issues
  - Working with prototype battery packs
  - Working in powertrain test cells
- Service and repair issues
  - Hazards associated with routine maintenance
  - Hazards associated with HV component diagnosis and repair
  - General industry safety procedures
- Vehicle occupant and first responder issues
  - Protective measures for vehicle occupants
  - Hazards associated with vehicle occupant

Instructor: Jack Rosebro
Fee $245 .2 CEUs

Combustion and Emissions for Engineers

3 Days
I.D.# 97011

Public awareness regarding pollutants and their adverse health effects has created an urgent need for engineers to better understand the combustion process as well as the pollutants formed as by-products of that process. To effectively contribute to emission control strategies and design and develop emission control systems and components, a good understanding of the physical and mathematical principles of the combustion process is necessary. This seminar will bring issues related to combustion and emissions "down to earth," relying less on mathematical terms and more on physical explanations and analogies.

Learning Objectives

By attending this seminar, you will be able to:

- Identify and describe the important processes in combustion and emission
- Identify the formation mechanisms and reduction strategies of pollutant species in combustion systems
- Recognize the effects of engine design and operating conditions on combustion and emission
- Explain the technology and the logic behind after-treatment of pollutants
- Identify the underlying laws and principles used in combustion and emission black-boxed computer programs
- Explain the role chemical kinetics plays in the design of low-emission combustion systems
- Identify design trade-offs between increasing engine performance and maintaining low emission characteristics

Who Should Attend

Engineers working on the design of combustion engine components, software development and application for modeling of thermal-fluid, combustion and emissions processes, and those working on the reduction of harmful pollutants emissions will find this course valuable.

Topical Outline

DAY ONE

- Air Composition
- Concept of "Complete Combustion"
- A/F & Stoichiometric (A/F) ST, and (Equivalence Ratio)
- Lean, Rich, Stoichiometric Mixture

- First and Second Law and Applications in Combustion Systems
- Adiabatic Flame Temperature, Heat of Reaction (or Heating Value) and Their Usage
- Thermodynamic and Chemical Equilibrium
- Demonstration Applications of Equilibrium Using Computer Simulation (SuperState)

DAY TWO
- Chemical Kinetics
  - General concept and rate of reaction (RR)
  - Classifying reactions
- Reaction Between Gas Molecules and a Solid Surface
  - Physical absorption, chemisorption, and heterogenous catalysts
  - Nature of catalysis reaction
  - Arrhenius equation and activation energy
  - Analysis of data for complex reaction
  - General characteristics of catalysis
- Explosion
  - Simplified generalized kinetic model (slow reaction and explosion)
  - Explosion and flammability limits
- Mechanism of H_2O_2 Reaction
- Oxidation of CO
- Explosion Limits of Hydrocarbons (HC)
  - Experimental combustion characteristics
  - Methane and Paraffin oxidations
  - Demonstration applications of chemical kinetics using SuperState
- Autoignition and Induction Time Using SuperState
- Flame and its Propagation
  - Laminar flame structure
  - Laminar flame speed (S L)
  - Flammability limits
  - Quenching distance d T
  - Flame stabilization

DAY THREE
- Combustion in SI Engines
  - Simple thermodynamic analysis of SI engine combustion
  - Flame and unburned gas motions
  - Mass fraction burned and heat release analysis
  - Combustion process characterization
  - Flame structure, speed, and effects of various parameters on burning rate
  - S L turbulence & turbulent flame
  - Cyclic variability, partial burning & misfire
- Pollutant Formation and Control
  - Nature of problem SI & CI
  - NO and NO2 formation kinetics and reduction
  - CO kinetics and reduction
  - Unburned Hydrocarbon (UHC) emission and reduction
  - Effects of design and operating parameters on HC and NOx
  - Demonstration Applications of Pollution Effects Using SuperState -- Minor species; Lean-burn engine
- Exhaust Gas Treatments
  - Options
  - Catalytic converters
  - Thermal reactors
- Typical Engine Emission Results
- Emission Measurements
- FTP Emission Standards

Instructor: Bruce Chehroudi
Fee $1545 2.0 CEUs

Common Rail Diesel Fuel Injection

1 Day
I.D.# C0920

The improved efficiencies of the modern diesel engine have led to its increased use within the mobility industry. The vast majority of these diesel engines employ a high-pressure common rail fuel injection system to increase the engine's fuel-saving potential, emissions reduction, and overall performance.

This one-day seminar will begin with a review of the basic principles of diesel engines and fuel injection systems. Diesel and alternative fuels will be discussed, followed by current and emerging diesel engine applications. The majority of the day will be dedicated to the common rail system itself, beginning with a comprehensive overview of the complete system. The instructor will then introduce the main subsystems, including hydraulics and controls. Finally, the subsystems will then be broken-down into their respective components.

Learning Objectives

By attending this seminar you will be able to:
- Identify the basic principles of diesel engines and diesel fuel injection
- Distinguish the main properties of diesel and diesel alternative fuels
- Compare and evaluate various diesel engine applications
- Describe the main systems and sub-systems of common rail diesel fuel injection and how these systems interact
- Identify the main design features of the common rail components
- Discuss basic common rail control strategies

Who Should Attend

This course will benefit engineers and other individuals involved in the design, application, and service of common rail diesel engines utilized in passenger cars, light/medium/heavy-duty trucks, and off-highway vehicles, including marine and farm machinery.

Prerequisites

Familiarity with basic engine design and operation theory is recommended.

Topical Outline

- Basic Principles of Diesel Engines
- Basic Principles of Diesel Fuel Injection
- Diesel and Alternative Fuels
- Applications -- Passenger car; Light-duty; Heavy-duty; Off-highway; Pressure history
- Common Rail System Overview
  - Low-pressure system
  - High-pressure system
  - Controls
- Hydraulic Components
  - Pumps -- Radial piston; Inline piston
  - Rails
  - Injectors -- Solenoid; Piezo
  - Nozzles
  - Control valves -- Pressure control valve; Metering unit; Pressure relief valve
  - High-pressure lines
- Controls
  - Overview
  - Requirements
  - Functions
  - Components -- ECU; Sensors; Actuators; Torque control structure
- Seminar Summary and Assessment

Instructor: Vincent Piacenti
Fee $725 .7 CEUs

Diesel Emissions and Control Technologies

2 Days
I.D.# C0206

Stringent emissions legislation, the advent of low-sulfur fuels and fuel additives, and improved engine design and combustion processes have all led to new developments in oxidation catalysts, particulate filters, and reduced particulate emissions. This seminar will explore the progress in combating diesel emissions using oxidation catalysts, catalyzed "trap," continuous regeneration "trap," fuel additives, NOx "trap," and plasma technology. New developments in filter materials, heat capacity and thermal conductivity, low backpressure and safe regeneration will be discussed. Similarly, novel designs that reduce regeneration stresses in SiC filters with high coefficient of thermal expansion and in high cell density cordierite filters with higher mass will be discussed. Several applications for light- and heavy-duty diesel engines will be reviewed to illustrate the design and durability of aftertreatment devices. Finally, the mounting system for large frontal area oxidation catalysts and wall-flow diesel filters, which plays a major role in ensuring their mechanical and thermal durability, will be emphasized.

Dr. Heck's text, *Catalytic Air Pollution Control: Commercial Technology*, is included with the seminar.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the three phases of diesel emissions, namely gaseous, liquid and solid
- Identify and utilize worldwide diesel emissions standards for passenger cars and trucks
- Compare the latest technologies and their limitations for combating diesel emissions, e.g. effect of fuel sulfur
- Formulate design criteria for diesel oxidation catalysts, wall-flow filters, fuel additives, CRTs and NOx traps taking into consideration the trade-offs in performance and durability
- Describe the most current commercial designs for integrated removal for particulate and NOx
- Compare the latest particulate regeneration schemes and describe the passive and active approaches for regeneration
- Compare the latest NOx trap regeneration schemes for denitration and desulfation
- Review progress in sensors and control technology in anticipation of on-board diagnostics
- Discuss new developments in filter materials and designs and select appropriate materials for specific applications
- Implement safe regeneration techniques for diesel filters

Who Should Attend

This course is designed for mechanical, electrical, metallurgical and chemical engineers, material scientists and chemists involved in heterogeneous catalysis. System engineers who are interested in handling, assembling, testing and failure analysis of diesel exhaust systems will also benefit from this course.

Prerequisites

Familiarity with diesel engines and emissions will prove valuable for participants attending this course.

Topical Outline

Catalyst System and Durability
Instructor: Ron Heck
- Fundamentals of Catalysis
  - Definition of catalyst
  - Characteristics of catalysis
  - Catalytic reactions
  - Catalyst preparation & characterization
  - Catalyst durability
- Diesel Background
  - Diesel engine operation
  - Emission characterization
  - Analytical methods
  - Test procedures
  - Emission regulations
  - Emission reduction approaches
- Diesel Oxidation Catalysts (DOC)
  - Reactions
  - Sulfur effect
  - Truck
  - Passenger car
  - Deactivation
- Diesel Particulate Filters (DPF)
  - DPF approaches
  - Catalyzed DPF
  - Continuous regenerative trap (CRT) with NO 2 performance
  - Fuel borne catalyst systems
  - Plasma
  - Deactivation
- NOx Reduction Fundamentals
  - Approaches
  - Direct reduction
  - Plasma
  - Selective catalytic (SCR) reduction with hydrocarbons and ammonia
  - Trapping and regeneration/desulphation
  - Deactivation
- Commercial Applications
  - Particulate removal --Engine map showing passive and active regeneration; CRT; Fuel Borne Catalyst with DPF; CRT and DPX performance comparison; Recent commercial comments
  - NOx removal -- SCR; NOx traps
- Integrated System Approaches for TPM and NOx
  - Diesel particulate NOx reduction (DPNR) -- Passenger cars; Trucks; Regeneration strategies
  - NOx trap-particulate filter-DOC combinations -- Regeneration strategies
  - SCR plus particulate filter -- Regeneration strategies
  - Control strategies -- NOx and NH3 sensors; OBD
  - Retrofit programs

Thermal and Mechanical Durability
Instructor: Suresh Gulati
- Diesel Oxidation Catalyst Supports
  - Automotive vs. diesel
  - Durability requirements
  - Packaging design
- Diesel Particulate Filter
  - Filter concept
  - Performance requirements
  - Filter composition & microstructure
  - Cell configuration & plugging pattern
  - Filter size & contour
  - Pressure drop through filter
- Regeneration Techniques
  - Throttling
  - Burner, electrical and catalytic regeneration

- Physical Properties
  - Thermal and mechanical durability
- Advances in Diesel Filter
  - Duratrap RC 200/19
  - CO & SiC
  - Novel designs
- Applications
  - LFA Filter
  - Light duty diesel engine
  - Filter with optimum microstructure

Instructor: Suresh Gulati & Ronald Heck
Fee $1385 1.3 CEUs

Diesel Engine Technology

2 Days
I.D.# 93014

As diesel engines become more popular, a fundamental knowledge of diesel technology is critical for anyone involved in the diesel engine support industry. This course will explain the fundamental technology of diesel engines starting with a short but thorough introduction of the diesel combustion cycle, and continue with aspects of engine design, emission control design, and more. An overview of developing technologies for the future with a comprehensive section on exhaust aftertreatment is also included.

The text, *Diesel Emissions and Their Control*, authored by Magdi Khair and W. Addy Majewski is included with the seminar.

Learning Objectives

By attending this seminar, you will be able to:
- Summarize the technological advances in modern diesel engines
- Evaluate the sources of emissions from diesel engines and the influence of engine component design on curbing these emissions
- Explain diesel exhaust aftertreatment systems and their effectiveness in reducing emissions
- Recognize the importance of fuel injection parameters to performance and emission control

Who Should Attend

You should attend this seminar if you are involved in diesel engine support industries such as catalytic converters, lube oils, gaskets, and turbocharger suppliers, and if you are not well versed with diesel engines although they play a major role in your career's survival.

Topical Outline

- The Case for the Diesel Engine (Brief)
  - Fuel consumption
  - Emissions
  - The diesel and the future
  - Advantages and disadvantages of diesel engines
  - Thermal efficiency of diesel vs gasoline engines
  - Compression ratio limitations in diesel engines
- The Diesel Combustion Process
  - SI four-stroke
  - CI four-stroke
  - The diesel combustion cycle
- Basic Types of Diesel Engines
  - Open chamber - direct injection (DI)
  - Prechamber - indirect injection (IDI)
- General Characteristics of DI & IDI Engines
  - Peak combustion pressure and temperature
  - Combustion severity
  - Rate of pressure rise
  - Noise
  - Fuel economy
  - Application
  - Emissions
- The Diesel Fuel Injection System
  - Functions of the diesel fuel injection system
  - Types of diesel fuel injection systems
  - Pump-line-nozzle systems (in-line pump)
  - Pump-line-nozzle systems (distributor pump)
  - Pump-line-nozzle systems (unit pump)
  - Unit injector systems
  - Common-rail injection systems
  - Details of an in-line pump
  - Operation of an in-line pump
  - Multi-hole injector holder and nozzle
  - Line dynamics and delivery valves
  - Mechanical governors and boost control devices
  - Engine installation and spray details
  - Operation of a distributor pump
  - Another type of distributor pump
  - Mechanically-controlled unit injector
  - Moving towards electronically-controlled systems
  - Motivation for using electronically-controlled systems
  - Basic electronic injection system
  - Electronically-controlled in-line pump
  - Visual differences between mechanical & electrical pumps
  - Electronically-controlled distributor pumps
  - Single solenoid valve electronically-controlled UI
  - Electronically-controlled UI system
  - Electronically-controlled common-rail system
  - The HEUI system
  - Operation of a HEUI system
  - Development of injection pressure in HEUI
  - Desired injection flexibility
  - Operation differences between HEUI-A & HEUI-B
  - The HEUI-B injection system
  - HEUI-A and HEUI-B injectors
- Air Management - Supercharging & Turbocharging
  - The purpose of air charging
  - Methods of air charging
  - Supercharger drives
  - Types of superchargers
  - Schematic representation of supercharger types
  - Sample performance map of a supercharger
  - Photographs of two centrifugal superchargers
  - Sample performance map of a centrifugal supercharger
  - Types of turbochargers
  - Schematic representation of a turbocharging system
  - Exhaust and charge airflow through a fixed geometry turbocharger
  - Anatomy of a turbocharger
  - Energy conversion in a turbocharger
  - The importance of A/R in a turbocharger design
  - Cutaway in a modern turbocharger
  - Sample performance map of a turbocharger
  - Waste-gated turbocharger
  - Variable geometry turbocharger
  - Combination system - wave charging
  - Turbocompounding
  - Sequential turbocharging
- Emissions Formation in Diesel Engines
  - Hydrocarbon
  - Carbon monoxide
  - Nitrogen oxides
  - Particulate matter

- Smoke
- Emission Standards
  - Europe
  - North America
- Steps Towards the Modern Diesel Engine
  - Injection
  - Combustion
  - Induction
  - Oil consumption
  - Engine electronics
  - Other design parameters
- Current and Future Technologies
  - Exhaust gas recirculation
  - Multiple injections
  - Auxiliary emission control devices (aftertreatment)
  - Fuels and emulsions

Instructor: Magdi Khair
Fee $1425 1.3 CEUs

Diesel Engine Technology e-Seminar

I.D.#PD130812ON (Online Delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this nearly 13 hours e-Seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course is divided into an introduction and eight modules.

View the complete description and demo at http://www.sae.org/e-seminars/det

What You Will Receive:

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf's, subject to DRM)
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Magdi Khair
Fee $645 1.3 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Diesel Engine Technology Engineering Academy

5 Days
I.D.# ACAD03

SAE International is pleased to offer the 2010 Diesel Engine Technology Engineering Academy at SAE Automotive Headquarters, Troy, MI. This Academy covers the diesel engine engineering principles and practices necessary to effectively understand a modern diesel engine. Types of engines addressed include naturally aspirated, turbocharged, pre-chamber, open chamber, light duty, and heavy duty. It is an intensive learning experience comprised of lecture and structured practical sessions, including a team-solved case study problem. Evening sessions are included.

Attendees will receive a copy of the textbook, *Diesel Emissions and Their Control*, by lead instructor Magdi K. Khair and W. Addy Majewski.

This Academy includes several practical activities, including a team-solved case study and a diesel engine facility tour. Prior to the Academy, you will be asked to complete a pre-assessment. Results will be shared with the lead instructor to help customize the learning experience to specific attendee needs.

Learning Objectives

By attending this Academy, you will be able to:
- Articulate basic diesel engine terminology and principles
- Describe the key features of the basic types of diesel engines
- Compare various diesel fuel injection systems and their components
- Analyze the effects of different fuels on engine performance and longevity
- Compare the function and applicability of various air management systems
- List the various emission standards and testing requirements
- Detail the elements of post-combustion emission control devices
- Discuss emerging diesel engine technologies

Who Should Attend

This academy will be especially valuable for engineers who design diesel engines in the following types of vehicles: passenger cars; light trucks; heavy trucks; off-highway vehicles; farm machinery.

Topical Outline

DAY 1
- Terminology and Performance Parameters
- The Case for the Diesel Engine
- Air Management Systems
  - Turbocharging and supercharging -- Purpose of turbocharging; Supercharging vs. turbocharging; Thermodynamic principle of turbocharging; Description of turbocharger; Performance of turbomachinery (swallowing-lines); Types of turbochargers (fixed, variable, waste-gate); Special arrangements (sequential, turbo compounding); An exercise in turbomatching; New role of turbochargers in EGR control
  - Superchargers -- Mechanically driven; Electrically driven; Hydraulically driven; Role of superchargers in modern diesels
- Fuel Injection Systems
  - Requirements and function
  - Injection timing
  - Injection metering
  - The fuel injection system
  - Types of fuel injection systems and main components
  - Diesel control -- Mechanical Governor; Electronic control systems
  - Nozzle and nozzle holders
  - Application
- European Diesel Engines
- Modern Technology Engines & Fuel Systems

DAY 2
- Thermodynamics I
  - First Law -- Energy balance for a closed system; Energy balance for an open system; Property Evaluation
  - Second Law -- Definition of entropy; Irreversibility; Entropy balance for a closed system; Entropy balance for an open system;

Definition of availability; Availability balance
- Air standard cycle analysis -- Otto cycle; Diesel, Dual, Atkinson, Miller cycles; Lessons to be learned from air standard cycles
- Chemical reactions -- Stoichiometry (balancing chemical reactions); Definition of equivalence ratio; Calculating exhaust gas composition from F/A ratio; Calculating F/A ratio from exhaust gas composition; Computation of brake specific emissions
- Energy equation with chemical reactions (combustion reactions) -- Adiabatic flame temperature; Higher/lower heating value
- Detailed example of energy balance on engine -- Fuel energy in=coolant + exhaust + work out

- Thermodynamics II: Combustion in Diesel Engines
  - Basic combustion theory - definitions and concepts
  - Complete combustion vs. equilibrium composition (dissociation) -- Equilibrium assumption vs. kinetics (rate limited reactions); Global vs. elementary reactions; Basic flame theory (Ignition, flame propagation & speed, quenching, flammability limits); Autoignition theory; Hydrocarbon combustion; Laminar and turbulent flame speeds; Premixed and diffusion combustion
  - Diesel combustion -- Phenomenological description of diesel combustion; Ignition delay, premixed combustion, diffusion combustion; Burning rate diagram (heat release diagram)
  - Combustion chamber design considerations -- Relationship between air motion, fuel injection system (injection pressure, number of nozzle holes, orifice size), and combustion chamber geometry (bowl size and shape)
  - Modeling the diesel combustion process -- Fuel-air standard Otto cycle/Diesel cycle (Assumptions, Thermodynamics); Single zone models-heat release type (Assumptions, Thermodynamics); Multi-zone models, phenomenological models; CFD modeling; Lessons to be learned from each approach; Advantages/disadvantages of each approach
  - Heat release analysis -- Collection of cylinder pressure data (transducers, encoders, data acquisition); Analysis of cylinder pressure data (smoothing, frequency characteristics, mean effective pressure); Heat release model (Krieger and Borman assumptions); Interpretation of heat release diagrams
- Diesel Combustion & Emissions in DI Engines
  - Premixed/diffusion combustion -- Effect of low temperature, low cetane number; Effect of turbocharging
  - Factors affecting the combustion process -- Injection pressure; Air swirl; Atomization; Penetration; Drop size distribution; Vaporization; Ignition delay
  - Combustion influence on fuel economy -- Effect of heat release; Effect of heat transfer -Compare to "adiabatic" engine results
  - Combustion influence on emissions -- Origin of hydrocarbon emissions; Origin of carbon monoxide; Origin of NOx emissions; Relation to premixed combustion, aromatic content of fuel, cetane number; Origin of particulates and smoke; Relation to diffusion combustion; Effect of fuel sulfur
  - Tradeoffs -- BSFC vs. NOx; NOx vs. particulates; HC vs. ignition delay
  - Effect of ignition timing on heat release rate and cylinder pressure -- Effect of timing of combustion, ignition delay
  - Effect of injection pressure on heat release rate and cylinder pressure -- Effect of mixing rate on diffusion combustion
- Fuels Technologies

DAY 3
- The Role of Lube Oil in Modern Diesel Engines
  - How are Lubricants Specified
  - Viscosity Grades, Quality
  - Lubricant Performance Categories:
  - North America
  - Europe
  - Japan
  - OEM Specifications
  - Future Developments - Low Emission Fluids
  - Composition of Typical Crankcase Lubricants
  - Drivers for Novel Lubricant Development
  - Aftertreatment Compatible Lubricants: SAPS
  - Beyond Current Lubricant Specification - System Approach
- Engine Controls I
  - Electronic fuel injection system control
  - Control system architectures and hardware
  - Fundamentals of control
  - Design approaches for diesel engine controls
  - Development methods
  - Application requirements -- Fuel injection volume, timing and rate shaping
- Engine Controls II
  - Vehicle aspects
  - Ancillary system control and integration
  - Variable geometry turbocharger control
  - EGR scheduling and control
  - Control of other subsystems - today and tomorrow
  - Adaptive controls and the future
- On-Board Diagnostics
  - Legal Requirements
  - Fault Detection
  - Fault Resolution
  - Diagnostic Tools - OBD and General
  - Future Paths
  - Noise
  - Simulation in Diesel Engines
- In-Cylinder Measures to Control Emissions I and II

DAY 4
- In-Cylinder Measures to Control Emissions III
- Diesel Exhaust Aftertreatment I
  - Exhaust system-based emission reduction technologies (aftertreatment)
  - NOx reduction catalysts
  - Selective Catalytic Reduction -- With Supplemental HC; With Urea and Ammonia
  - Lean NOx Traps
  - Diesel Particulate Filters -- Active Regeneration Systems; Passive Regeneration Systems
- Diesel Exhaust Aftertreatment II
  - Combination Trap/Catalyst Systems -- Catalyst Assist; Catalytically Regenerated Traps
  - Special Aftertreatment Systems
  - Non-Thermal Plasma
  - Non-Thermal Plasma Assisted Catalysts
- Bosch Farmington Hills Diesel Facility Tour

DAY 5
- Diesel Exhaust Aftertreatment III
  - Combination Trap/Catalyst Systems -- Catalyst Assist; Catalytically Regenerated Traps
  - Special Aftertreatment Systems
  - Non-Thermal Plasma
  - Non-Thermal Plasma Assisted Catalysts
- Engine Performance Simulation
- Emerging Technologies
  - Variable Valve Actuation
  - Camless Valvetrain
  - Air Hybrids
  - Other
- Academy Wrap-up and Evaluation

*The order in which the topics are presented is subject to change.

Instructors: Magdi Khair, Ewa Bardasz, André Boehman, Bernard Challen, Philip Dingle, Michael Levin, and Helmut Tschöeke

Fee $3345 4.0 CEUs

Displacement on Demand Systems (DoD) Webinar

4 Hours
I.D.# WB1010

This webinar focuses on the significance, technology and application of Displacement on Demand (DoD) Systems in automotive applications. It will cover the theoretical improvements to engine system performance and efficiency, the historical mechanisms to implement DoD systems, the modern approach to DoD systems, and the practical results. If you have a practical understanding of internal combustion technology and systems, you will gain an appreciation for the DoD System -- its application to the automotive marketplace and its significance as it applies to improvements in all facets of an automotive powertrain. You will learn the fundamental science and implementation technology of the various DoD systems and move to the emerging technologies in DoD system design and operation that can significantly improve operational efficiencies. The course will cover how the Engine Control Module (ECM) uses information related to the operational status to implement real-time running efficiency of the engine and effects changes in the operation of the engine through the control systems that manage its operation. With this understanding, you will be able to derive your own set of improvement criteria that could be made to address the limitations of current engine technology.

Learning Objectives

By connecting with this webinar, you will be able to:
- Describe Displacement on Demand Systems (DoD)
- Discuss theory of operation
- Explore theoretical improvements to engine system performance and efficiency
- Review historical mechanisms to implement DoD systems
- Examine modern approaches to DoD systems
- Outline practical results

Who Should Attend

This intermediate level webinar is appropriate for a number of design and engineering disciplines including, but not limited to: design engineers and engineering managers, automotive engine designers, component suppliers, engine test and development engineers, design services managers, and others who require the technological knowledge to perform their respective job functions.

Prerequisites

You should have a practical understanding of current internal combustion technology and systems. An undergraduate engineering degree, or a strong technical background, is highly recommended. Basic knowledge of algebra and physics is essential.

Topical Outline

Session 1
- Theory and Background
- Theoretical Improvements to Engine System Performance and Efficiency
- General Theory of Operation

Session 2
- Historical Mechanisms to Implement DoD Systems
- Modern Approaches to DoD Systems
- Practical Results

Instructor: W. Mark McVea
Fee $395 .4 CEUs

Fundamentals of Hybrid Electric Vehicles

3 Days
I.D.# C0511

One of the fastest growing automotive fields, hybrid electric vehicles (HEVs), presents both opportunities and challenges. HEVs are more fuel-efficient and environmentally friendly compared to conventional vehicles. Optimizing the power intake in HEVs allows the engine operation to be kept within the range designed for best fuel economy and lowest emission, while the motor/generator system either provides additional power input, or generates electricity using the excessive power from the engine. It also recovers the kinetic energy during braking or coasting. These advantages have attracted worldwide development interests for HEVs in the automotive industry. Global sales of hybrid vehicles continue to grow and experts predict that 38 models will be available by 2011.

The challenges presented in HEVs include power electronics, electric motors and generators, batteries, power management, thermal management, and system integration. Additional challenges related to after-sales issues include reliability, gracefully degradable operation, and servicing.

This three-day seminar will cover the fundamentals of HEV. In an easy-to-understand format, the course will explain the engineering philosophy of HEVs, the component selection and design, modeling, and control of HEVs. Some existing HEV models such as the Toyota Prius, Honda Civic, Mercury Mariner, Saturn VUE and Camry will be used as case studies.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the pros and cons of different types of HEVs
- Implement fundamental HEV design parameters
- Develop specifications for HEV systems and components
- Perform basic design of HEV systems, using parallel, series, or complex topologies
- Develop models and perform simulations of HEVs; simulate the fuel economy and emissions of HEVs
- Size a HEV powertrain
- Size HEV components, including motors, energy sources and motor controllers
- Calculate the regenerative braking performance of a HEV
- Describe the testing procedures for HEVs
- Compare and contrast hydraulic hybrid and electric hybrid systems
- Discuss the emerging technologies, engineering challenges, and development trends in HEVs

Who Should Attend

This fundamental overview course is designed to provide an introduction to HEVs for engineers in electrical, mechanical, automotive and other related fields who are involved or interested in HEV development, design, modeling, manufacturing and marketing.

Prerequisites

Attendees should have a basic understanding of electrical engineering systems, some mechanical system background related to equations of motion, or experience with automotive engineering.

Topical Outline

DAY ONE
- Introduction to Hybrid Electric Vehicles
  - Environmental impacts of HEVs
  - Interdisciplinary nature of HEVs
  - Configuration of HEVs, parallel, series and complex HEVs
  - State-of-the art HEVs
  - HEVs vs. diesel engine vehicles
  - The future of HEVs
  - Opportunities in HEVs
- HEV Fundamentals
  - Vehicle resistances
  - Traction and slip ratio models
  - Vehicle dynamics
  - Transmission: gear transmission, CVT and planetary gear systems
  - Vehicle performance: maximum speed, gradeability and acceleration
  - Fuel economy and improvement
  - Braking performance
  - Sizing of HEV powertrains
  - Vehicle modeling
  - Power management
  - Vehicle control
- HEV Modeling and Simulation
  - Vehicle model
  - Modeling and simulation basics
  - Vehicle performance
  - Modeling examples using ADVISOR
- Power Electronics
  - The need for power electronics in HEVs
  - Overview of power electronics circuits in HEV powertrains
  - Fundamentals of power electronics
  - Bidirectional DC/DC converter
  - Inverter and motor control
  - Regenerative braking and rectification

DAY TWO
- Series HEV Powertrain Design
  - Concepts of hybridization
  - Hybrid architecture
  - Series hybrid configuration and functionality
  - Operation patterns, advantages
  - Control strategies
  - Power management
  - Sizing of major components
  - Design examples
  - Modeling of series HEVs
- Parallel HEV Powertrain Design
  - Parallel architecture and operation modes
  - Torque coupling
  - Speed coupling
  - Torque and speed coupled architecture
  - Control strategies and power management
  - Design example and modeling using ADVISOR
  - Mild hybrid and micro hybrid
  - Complex hybrid
  - Plug-in hybrid
- Electric Propulsion Systems
  - Fundamentals of electric motor drives
  - DC motor drives
  - Induction motor drives
  - Permanent magnet synchronous motor drives
  - Brushless DC PM motor drives
  - Switch reluctant motor drives
  - Sizing of electric motors and power electronics in HEVs
  - Speed control of electric drives
  - Starter/alternator
- Regenerative Braking in HEVs
  - Energy consumption during braking
  - Limitation of energy recovery
  - Control strategies

DAY THREE
- HEV Energy Storage
  - Battery basics
  - Lead acid battery, nickel-metal-hydride battery, and Li-ion battery
  - Fuel cell
  - Ultra capacitor
  - Flywheel
  - Hybridization of energy source
- Fuel Cell Vehicles
  - Configurations
  - Design examples
- Current HEVs
  - Toyota Prius
  - Honda Civic
  - Mercury Mariner
  - Toyota 2007 Camry
  - Saturn VUE
  - ISE truck
  - Military HEV
- Special Topics
  - Military applications
  - Novel topologies
  - Antilock braking (ABS) of HEVs
  - HEV testing
  - System integration issues
  - Hydraulic hybrid vehicle architecture vs. electric hybrid systems
  - User level issues - reliability, servicing
- Emerging Technologies of HEV
  - Electric motors
  - Power electronics, silicon-carbide devices
  - Thermal management
  - EMC issues

Instructors: Abul Masrur and Chris Mi
Fee $1645 2.0 CEUs

Gasoline Direct Injection (GDI) Engines

3 Days
I.D.# C1009

The quest for more efficient, smarter, and environmentally cleaner liquid-fueled spark ignition (SI) reciprocating engines is more alive and intense now than ever before. GDI SI engines have overcome many of the original limitations and are now becoming commonplace. This seminar will provide a comprehensive overview of GDI engines. Mixture preparation and the combustion process, with an emphasis on strategies for both homogenous and stratified charge operation and control, including issues related to the direct injection of gasoline into the combustion chamber, and fuel injection system requirements for optimal spray characteristics will be explored. Emission of pollutants, fuel economy and effects of some key design and operating parameters will also be covered. The seminar concludes with an overview of a select list of production and prototype GDI engines.

Learning Objectives

Upon completion of this seminar, you will be able to:
- Describe the rationale behind the GDI engine operation
- Analyze the important processes in GDI engines
- Explain liquid atomization, sprays, and injector requirements for successful GDI operation
- Utilize the technology and the logic behind gasoline direct injection
- Estimate and predict effects of key engine design and operating conditions on performance, combustion, and emission in GDI engines
- Communicate effectively with engineers working on fuel injection, combustion and emission aspects of the GDI engine in your firm or with customers
- Effectively contribute to the design of critical components such as combustion chambers, injectors, and emission reduction strategies
- Explain and utilize trade-offs between increasing engine performance and maintaining low emission characteristics

Who Should Attend

This seminar will be especially valuable for engineers, technical and project managers, researchers, and academicians. Engineers working on the design of components for high efficiency and performance of GDI engines as well as those directly and indirectly involved in mixture preparation and emission reduction of harmful pollutants from these engines will highly benefit from this course. Environmental engineers desiring to expand their understanding of fuel spray formation, combustion and emissions from GDI engines will benefit, as well as, engineers active in the development and application of software for the modeling and design of combustion chambers, fuel spray dynamics, combustion and emission issues.

Prerequisites

Attendees should have general knowledge of engine operation especially in-cylinder combustion processes. However, a very concise review of the subject is presented.

Topical Outline

DAY ONE
- Combustion Systems
  - Relative position of spark plug and fuel injector
  - How to achieve homogeneous and stratified charge -- spray-, wall-, and air-guided combustion systems
- Fuel Injection System
  - Fuel injection system requirements
  - Fuel injector requirements and classification
- Fuel Spray Characteristics
  - Spray atomization requirements
  - Sac spray consideration
  - After-injection
  - Fuel spray penetration and cone angle
  - Split injection
  - Sprays characteristics of injectors
  - Effects of ambient pressure (density) on spray
  - Spray characterization (GDI)

DAY TWO
- Mixture Formation
  - In-cylinder flow characteristics and GDI combustion
  - Fuel-air mixing process
  - Spray-wall interactions
  - Cold start and wall wetting issues
- Combustion Process and Control Strategies
- Engine Operating Modes and Fuel Injection Strategies
  - Early-injection, late-injection, stoichiometric operation
  - Operating mode transition
- Split Injection Strategy
  - Two-stage, split, and post injection
- Combustion characteristics
  - Homogeneous-charge and stratified-charge combustion
- Effects of Engine Operating and Design Parameters on GDI Combustion
  - Injection and ignition timings
  - Spray cone angle
  - EGR
  - Knock resistance characteristics
  - Air-assisted versus single-fluid GDI fuel system
- Injector, Combustion Chamber, and Intake Valve Deposits

DAY THREE
- Emissions of Pollutants - Reduction Approaches
  - Hydrocarbon, NOx, particulate and noise emissions
- Fuel Economy
  - Factors affecting improved fuel economy
  - Fuel economy versus emissions compromise
- Select Gasoline Direct-Injection Engines
  - Early DISC engine
  - Mitsubishi reverse-tumble-based wall-guided
  - Concise review of Toyota, Nissan swirl-based (wall-guided), Audi wall-guided, AVL, FEV air-guided, Ford, Honda spray-guided, Isuzu, Mazda swirl-based, wall-guided, Mercedes-Benz spray-guided, Ricardo tumble-based, wall-guided, Volkswagen tumble-based, wall-guided FSI
- GDI Fuel Rail Technology
- Benefits of Turbocharging a GDI engine

Instructor: Bruce Chehroudi
Fee $1545 2.0 CEUs

High Performance Engine Design and Development

1 Day
I.D.# C0725

Ever since Beau de Rochas patented the four stroke cycle in 1862, engineers have pursued the development of high performance engines for road and racing applications. While this course will not cover such ancient history, it will focus on engine design and development advances over the last 40 years from "BC to AD" ("Before Cosworth to After Duckworth"), covering the concepts and designs behind the modern racing engines for series including Formula One, Indy Cars, the IRL, and NASCAR.

This course will help you determine how to design a championship-winning racing engine including many of the key calculations that support the pursuit of power. Attention to detail on every aspect of engine design is emphasized with focus on applying simple math, physics, and even plain old common sense, rather than relying heavily on sophisticated software.

The course begins with a review of the major advances in engine design , then explores the design of the engine's primary systems and structures including oil systems, cam drive systems, water systems, inlet systems, exhaust systems, cylinder heads, cylinder blocks, and sumps. It will then explore how combustion works and how to analyze the major parameters involved in burning different fuels. This will be followed by the design and optimization of inlet and exhaust systems and applying mathematics via simple excel spread sheets to determine the key factors for cam design, port design, inlet and exhaust tuning, and turbocharger / supercharger matching for those

formulae that permit the use of boost to increase the inlet pressure.

The day concludes with a discussion and opportunities to continue design exercises that will allow attendees to put into practice several of the key concepts learned throughout the seminar.

Detailed course notes and illustrations are provided along with example calculations to enable the attendee to calculate the key parameters required in the design and development of racing engines.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the key parameters and choices facing the high performance engine designer
- Consider a variety of tips and solutions which can be applied by both design and development engineers to enhance the performance of competition engines
- Select "the least worse design solution" for any particular problem
- Summarize the major advances in engine design over the past 40 years

Who Should Attend

This course is for individuals with a thirst to improve their understanding of what makes a racing engine a championship winner. It can be valuable to those responsible for engine design, component design, and overall engine performance calculations or those who are merely interested in the subject.

Prerequisites

An undergraduate engineering degree or a strong automotive technical background is highly recommended. A basic knowledge of college algebra, college physics, and a familiarity with how we currently think engines work is helpful.

Topical Outline

- Engines from BC to AD A brief outline of racing engine history covering the design and development of several famous racing engines to highlight how fundamentally different approaches to design and manufacturing can generate championship winning engines for various classes of racing
- Detailed Design of Engine Systems
  - How does a modern racing engine work and why?
  - Review of fundamental systems of the modern racing engine
- Engine Structures
  - Designing from the inside out, focusing on performance design
  - Adding the structures to integrate the load paths throughout the engine core
- Combustion
  - How any given fuel burns and what the combustion processes are that underpin performance
  - Combustion kinetics and fuel chemistry to enable calculation of energy release, peak combustion temperatures, and tail pipe emissions for any fuels or fuel mixtures.
  - Major fuel types and how to deal with any fuel starting from its basic chemical equations
- Engine Tuning
  - Inlet systems
  - Exhaust systems
  - Simple math for optimizing tuning orders and lengths
  - Camshafts
- Turbocharging and Supercharging How to calculate the requirements and the major performance parameters before starting the design process
- Discussion and Design Exercise How to design the next engine to move the boundaries of engine performance forward again...

Instructor: Geoff Goddard
Fee $725 .7 CEUs

Homogeneous Charge Compression Ignition (HCCI) Webinar

6 Hours
I.D.# WB1013

The objective of this Webinar is to describe the significance, technology and application of Homogeneous Charge Compression Ignition (HCCI), as it applies to improvements in all facets of an automotive powertrain. This Webinar will provide an overview and historical perspective of HCCI technologies, a hardware review, and an explanation of the differences between gasoline and diesel based HCCI, as well as the chemistry. HCCI control and Kinetics of HCCI combustion will be covered. Participants with a practical understanding of internal combustion technology and systems will gain an appreciation for HCCI and its application to the automotive marketplace. This webinar will expose you to the emerging technologies in HCCI design and operation that can significantly improve operational efficiencies. The fundamental science and implementation technology of the various HCCI systems will be presented. You will learn how the Engine Control Module (ECM) uses information related to the operational status to implement real-time running efficiency of the engine and how the ECM affects changes in the operation of the engine through the control systems that manage its operation. With this understanding, you will be able to derive your own set of improvement criteria that could be made to address the limitations of current engine technology.

Learning Objectives

By connecting with this webinar, you will be able to:
- Identify, describe and explain the various types of Homogeneous Charge Compression Ignition (HCCI) Systems including gasoline-based and diesel-based
- Recognize the hardware used in an HCCI system
- Review the chemistry of an HCCI
- Examine HCCI control
- Describe the kinetics of HCCI combustion
- Discuss new engine technology

Who Should Attend

This intermediate level webinar is appropriate for a number of design and engineering disciplines including, but not limited to: design engineers and engineering managers, automotive engine designers, component suppliers, engine test and development engineers, design services managers, and others who require the technological knowledge to perform their respective job functions.

Prerequisites

You should have a practical understanding of current internal combustion technology and systems. An undergraduate engineering degree, or a strong technical background, is highly recommended. Basic knowledge of algebra and physics is essential.

Topical Outline

Session 1
- Overview and Historical Perspective of HCCI Technologies
- Hardware Review
- Introduction to the Gasoline-Based HCCI
- Introduction to the Diesel-Based HCCI

Session 2
- The Chemistry of HCCI
- HCCI Control
- Kinetics of HCCI Combustions

Session 3
- New Engine Technology

Instructor: W. Mark McVea
Fee $515 .6 CEUs

Homogeneous Charge Compression Ignition Engines

2 Days
I.D.# C1010

The potential benefits of the Homogeneous Charge Compression Ignition (HCCI) engine are numerous and have the potential to combine some of the best features of the Compression Ignition engine with that of the Spark Ignition engine. These benefits include overall engine efficiencies available with compression ignition and the substantially lower emissions of PM and NOx available with spark ignition systems. However, the commercial viability and wide-spread use of the HCCI engine has been slow to materialize due to significant technical challenges.

This two day seminar will provide attendees a comprehensive overview of the benefits of HCCI combustion and the main challenges to its acceptance and use in vehicles. Current technologies will be examined along with recent developments in HCCI engines. The characteristics of several commercial engines that use HCCI combustion during a portion of their operating range and the future directions for HCCI research will also be examined.

Learning Objectives

By attending this seminar, you will be able to:
- Evaluate the benefits of HCCI combustion
- Identify the primary challenges in the development of commercially viable HCCI engines
- Identify recent developments in HCCI technology
- Describe the characteristics of several commercial engines that use HCCI combustion during a portion of their operating range
- Evaluate current research being performed and with support from governmental agencies
- Assess the potential and future direction of HCCI technology

Who Should Attend

This course is designed for engineers, technicians, managers, and students that are associated with engine design. In addition, personnel in the transportation industry that are involved in the research of advanced low pollutant emission technologies and high thermal efficiency engine concepts will benefit from this seminar.

Prerequisites

Attendees should have at least a basic understanding of fluid dynamics, thermodynamics, internal combustion engine operation, and combustion.

Topical Outline

DAY ONE
- Introduction and HCCI Overview
  - What is Homogeneous Charge Compression Ignition?
  - HCCI and other low temperature combustion strategies
  - HCCI for diesel engines -- Advantages; Limitations
  - HCCI for gasoline engines -- Advantages; Limitations
  - The importance of R&D in HCCI
- Benefits and Challenges
  - Benefits -- Efficient; Fuel flexibility; Lower emissions
  - Challenges -- Controlling ignition timing over a range of speeds and loads; Extending the Operating Range to High Loads; Cold-Start Capability; Hydrocarbon and Carbon Monoxide Emissions
- Developments in HCCI for Diesel Engines
  - Fundamental understanding
  - Advancements in speed and load control
  - Results using different fuels
  - Early applications of HCCI technology
- Developments in HCCI for Gasoline Engines
  - Fundamental understanding
  - Advancements in speed and load control
  - Results using different fuels
  - Early applications of HCCI technology

DAY TWO
- Future Directions
  - Ignition Timing Control
  - Low Temperature Combustion Strategies
  - Combustion Rate Control for High-Load Operation
  - Cold-Start
  - Emission Control
  - Exhaust Aftertreatment
  - Transient Operation
  - Dynamic Predictive Control and Mode Transitioning
  - Advanced Control Systems
  - High Pressure and Low Pressure EGR Applications
  - Valve Train Development
  - Fuel Injection System Development
  - Multi-Cylinder Effects
  - Combustion Modeling

Instructor: Gerald J. Micklow
Fee $1225 1.3 CEUs

Hybrid and Electric Vehicle Engineering Academy

5 Days
I.D.# ACAD05

SAE International is pleased to offer the first Hybrid and Electric Vehicle Engineering Academy at SAE Automotive Headquarters in Troy, Michigan. This Academy covers hybrid and electric vehicle engineering concepts, theory, principles, and practices necessary to understand electrified vehicle powertrains, and will focus on gasoline-electric and diesel-electric hybrids. The course will provide a collaborative, immersive learning experience comprised of lectures as well as structured practical sessions, including case studies. Some key hardware examples will also be on-hand. Attendees will gain useful insights into the design and development of hybrid and electrical vehicles taught by a team of instructors with extensive practical industry experience.

Pre-Academy Activity

Prior to attending the Academy, you will be asked to complete a pre-assessment. Results will be shared with the instructors to help establish the baseline of participants' knowledge. Based on the results, participants may be asked to review additional material prior to attending the academy.

Learning Objectives

By attending this Academy, you will be able to:

- Describe the different hybrid architectures, their attributes, and appropriate implementation
- Explain the operation, attributes, and behavior of battery packs, inverters, motor-generators, on-board and off-board charging systems, and DC-DC converters across all ranges of performance
- Identify the different design configurations and requirements of electric drives in conventional hybrids as well as plug-in hybrids and all-electric vehicles
- Classify different types of battery packs, inverters, motors, and DC-DC converters
- Describe the functions and capabilities of an Energy Storage System (ESS)
- Describe the functions and capabilities of a Battery Management System (BMS)
- Specify the ESS influences in acceleration and range
- Apply the concepts of balancing an ESS (automatically and manually)
- Analyze the design and construction of a given electric powertrain, and evaluate its particular attributes and drawbacks
- Assess fault detection and protection strategies and circuits as well as on-board diagnostic requirements
- Appraise technical limitations of electric drive components, as well as design and technological trends that may address such limitations
- Evaluate internal-combustion engine technologies appropriate to specific hybrid vehicle powertrains
- List various advanced ancillary devices that can be integrated into hybrid powertrains to help improve overall powertrain efficiency
- Create a diagram of the power flow within a hybrid vehicle system
- Demonstrate a working knowledge of hybrid component sizing tools
- Utilize a greenhouse gas assessment tool (Greenhouse gases, regulated emissions, and energy use in transportation (GREET model)

Who Should Attend

The Academy is designed for individuals who already have a basic understanding of hybrid and/or electric vehicles, and who are seeking to increase their knowledge and understanding of hybrid vehicle system applications. Mechanical and electrical application engineers, design engineers, project managers, and other individuals who are working with or transitioning to hybrid-electric powertrain development for the following vehicle sectors will find it particularly helpful:

- Light-duty passenger cars and trucks
- Medium and heavy-duty trucks and commercial vehicles (non-hydraulic hybrids)
- Some off-highway applications

Prerequisites

An engineering degree is highly recommended but not required. This Academy does not cover basic electrical concepts and assumes the attendee already understands such concepts (voltage, current, resistance, capacitance, inductance, etc). In order to understand concepts discussed, all participants are required to have driven an HEV prior to attending the academy. It may be helpful for participants to review the book, *Propulsion Systems for Hybrid Vehicles*, by John Miller prior to taking this academy.

Topical Outline

DAY ONE

- Basics of Hybrid Powertrains
  - Series, parallel, and series-parallel powertrains
  - HEV, PHEV, and E-REV operational differences
  - Generic electric drive components and operation
  - Operation of series parallel and two-mode transmissions
- Plug-In Hybrids (PHEVs), Vehicle-To-Home (V2H), Vehicle-To-Grid (V2G)
  - Advantages and disadvantages of PHEVs
  - AER, charge-depleting, and blended modes
  - V2H and V2G integration
- Overview of Energy Storage Systems (ESS)
  - Electrochemical cell operation
  - Physical cell construction
  - Performance terms (energy density, power density, etc.)
  - Different chemistries (PbA, NiMH, Li-Ion, others)
  - ELDCs, hybrid battery/capacitor systems
  - Generic BMS, sensors, ventilation
  - Relays, service plugs, ground fault detection
  - Series and series-parallel arrangements
  - Packaging issues
  - On-board diagnostics
  - Recycling, recovery, and resource issues
- Inverter and DC-DC Converter Operation
  - Switching devices
  - Basic DC to AC switching cell
  - Pulse-width modulation (PWM)
  - Space-vector modulation and field weakening
  - Thermal management
  - Packaging issues
  - Boost converters
  - DC-DC converters for 12V/24V bus
  - Bi-directional DC-DC converters for battery charging
- PMSM and AC Induction Motors
  - Vehicle propulsion needs
  - Motor terms
  - Single-phase motor operation
  - Multiphase motor operation
  - Winding construction
  - PM and IM advantages and disadvantages
  - Reluctance motor-generators
  - Thermal management
  - Fail-safe strategies

DAY TWO & DAY THREE

- Vehicle Development
- Energy Storage System (ESS) Design
  - Cell types
  - Cell chemistries
  - Cell configurations (cylindrical, pouch, prismatic etc.)
  - Parallel and series cells
  - Modules
  - Bus bars and power distribution
  - Connectors
  - High voltage power distribution
  - Locations for crashworthiness
  - Structural batteries
  - Liability
- Battery Management Systems (BMS): Design Considerations
  - State of Charge (SOC)
  - State of Health (SOH)
  - Charge/discharge limits
  - Temperature monitoring
  - Balancing â€“ passive and active
  - Safety systems: service disconnects, HV insulation, smoke, fusing, PTCs
  - CAN bus topology and noise immunity

- Energy Storage System Servicing
  - Better place swap model
  - Installation and removal
  - Manual cell/module balancing
  - Racing applications
  - Upgrades and enhancements
- Charging Systems
  - Regenerative charging modes: pedal off, blended
  - REGEN with electronic braking controllers
  - On-board and off-board chargers
  - Grid tied charging rates with respect to on-board/off-board
  - Solar charging
- Auxiliary Power Units
  - The series PHEV, aka E-REV, aka ReEV
  - Operational strategies
  - Charge depletion and charge sustaining modes
  - Internal combustion engine types (Piston, Wankel rotary, microturbine, etc.)
  - APU trailers
- Motors and Transmissions
  - Centralized motors
  - Per-wheel motors
  - In-wheel motors
  - Powered axles
  - Single-speed transmissions
  - Multi-speed transmissions
  - CVT and eCVT

DAY FOUR & DAY FIVE

- Review of previous lessons, requirements and validation of hybrid powertrain design/development to meet those requirements
  - Energy storage systems
  - Motor-generators
  - ICE integration
  - Power electronics
  - Attributes of each hybrid powertrain topology
- Hybrid Vehicle Testing
  - Vehicle modeling for test plan development
  - Instrumentation associated with vehicle benchmarking
  - Dynamometer and on-track testing for performance, emissions, energy consumption
  - Review of SAE J1711™ (hybrid vehicle test procedures)
  - Review of SAE J1634™ (EV test procedures)
  - SAE J2841™ (utility factor definitions for plug-in hybrid vehicles)
- Ratings and Limitations of Electric Drive Systems
  - SAE J2907/J2908™ (draft - motor ratings standards: component and vehicle system level)
  - Definitions of load profiles; impulse, transient, peak, steady state
  - Motor and electronics cooling systems
  - Circuit protection and fault detection diagnostics
  - Ancillary drive systems loading impacts
- AC and DC Off-board Charging Systems/Standards
  - Public charging stations
  - Charge Coupler requirements
  - National Electrical Code (NEC) requirements
  - SAE J1772™ (charge coupler standards AC Level 1, 2, and 3)
  - CHAdeMO (Japanese DC Standard)
  - SAE J2847™ (charger communication standard-smart grid)
- Tools to Assess Vehicle Performance and Fuel Consumption
  - Vehicle Miles Traveled (VMT)
  - Sankey power flow diagrams
  - Overview of ADVISOR backward looking vehicle modeling tool
  - Case study: evaluating hypothetical vehicle with constrained mass (e.g. <500kg vehicle)
  - Case study: utilizing a greenhouse gas assessment tool-GREET, for fuels/powertrains
- Advanced Energy Storage System Solutions
  - Battery/capacitor hybrids
  - On-road battery exchange
  - Non-contact power transfer systems
  - Flow batteries
- Future Trends in Advanced Power Electronics/Drive Systems
  - Multilevel inverters
  - Silicon carbide power devices
  - Advanced component cooling methods
  - Integrated drive systems
- Wrap-up/Questions and Answers

Instructors: Jack Rosebro, Thomas Prucha and Theodore Bohn
Fee $3345 3.8 CEUs

Hybrid and Electric Vehicles: Current Production, Future Strategies Webinar

2 Hours
I.D.# C0906

Hybrids, and to a lesser extent, electric vehicles, have been on the road since 1997. Although just two hybrids were on the market in 2001, there are more than a dozen today, and the market is ramping up quickly, driven by fuel prices and constraints, environmental regulations, and customer demand. The commercial vehicle market is also rapidly embracing hybrid technology. This two-hour webinar will highlight the passenger, light-duty, and heavy-duty hybrid and electric vehicles that are currently in production, offered for sale, or planned for near-term production. Asian, European, and North American manufacturers of hybrid and electric vehicles will be reviewed. Tier 1 suppliers of major hybrid and electric vehicle components will be covered as well.

Learning Objectives

By connecting with this webinar, you will be able to:

- List the hybrid and electric vehicles that have been commercialized from 1997 to present
- Identify passenger, light-duty, and heavy-duty hybrid-electric vehicles that are on the market
- Explain the major resource and regulatory drivers of hybrid and electric vehicle development
- Recognize basic layouts of light, medium, and heavy-duty hybrid vehicle powertrains
- Compare advantages and disadvantages of different hybrid architectures
- Summarize upcoming HEV and EV production plans

Who Should Attend

This webinar will benefit executive, manager, marketing, or other passenger car and light duty industry professionals who need a comprehensive overview of past, current, and future hybrid and electric vehicle production. Those unfamiliar with the evolution of hybrid and electric vehicle development, yet whose job will be impacted by hybrid and electric vehicles in the future, will benefit also.

Topical Outline

- Hybrid and electric vehicle production, 1997-present
- Current Asian hybrid vehicle production
- Current US hybrid vehicle production
  - Advantages and disadvantages of series hybrids

- Upcoming commercialization of series hybrids
- Market and regulatory drivers of HEV/EV production
  - Fuel constraints
  - US regulatory drivers
  - "Green state" regulatory drivers
  - EU regulatory drivers
  - Asia's regulatory drivers
- Planned Asian hybrid and electric vehicle production
- Planned European hybrid and electric vehicle production
- Planned US hybrid and electric vehicle production
- Commercial hybrid and electric vehicle production
  - Asian commercial hybrids
  - European commercial hybrids
  - North American commercial hybrids
- Tier 1 suppliers and partnerships
  - Internal-combustion engines (ICE)
  - Energy storage systems
  - Motors and power electronics

Instructor: Jack Rosebro
Fee $245 .2 CEUs

Ignition Issues and Their Impact on Engine Performance, Efficiency and Emission

2 Days
I.D.# C0131

Improved understanding and control of ignition and thereby combustion are critical in dealing with the problems of pollutants formation, engine performance, and fuel economy. This seminar will provide you with basic knowledge and recent advances in combustion-initiation (ignition) issues to more intelligently evaluate and harness their potentials. Thermodynamic and fluid mechanical properties of the unburned charge near the spark plug and at the time of ignition strongly affect the quality of the combustion and therefore the emission of the pollutants from the engine. Furthermore, a weak ignition limits engine performance and drivability. The so-called cyclic variability, which affects and bounds the lean and knock limits of an engine design is to a great degree influenced by the ignition system. Equally important, the ignition system can and is being used to provide local in-cylinder information on air-fuel ratio, misfire, knock, and mass fraction burned in each individual cylinder. Hence, great potential exists for applications of this information for individual cylinder control strategy to attain a more fuel efficient and environmentally compatible engine.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the important processes in ignition and its relation to engine performance, efficiency, and emission
- Explain the combustion process in internal combustion engines
- Apply ignition strategies for reduction of engine pollutants
- Recognize the effects of ignition system design and engine operating conditions on combustion and emission
- Describe the technology and the logic behind the current and future ignition-based engine diagnostics
- Assist in the design of critical components such as combustion chambers and exhaust systems
- Identify key design components of an ignition system for optimum combustion chamber design and low engine emission of pollutants

Who Should Attend

This seminar will be especially valuable for engineers, technical and project managers, researchers, and academicians involved in ignition and combustion/emission aspects of the combustion engines. Currently, the design strategy of many components in these engines is affected by combustion and emission control measures to meet customer's, federal and local government's demands and regulations. Therefore, engineers working on the design of components for high efficiency and performance of combustion engines as well as those directly and indirectly involved in ignition and emission reduction strategies will highly benefit from this seminar.

Topical Outline

DAY ONE
- A Concise Background on Combustion in Spark Ignited (SI) Engines
  - Cylinder pressure traces
  - MBT and ignition timing
  - Flame propagation issues
  - Combustion characterization
  - Cyclic variability
- Ignition Fundamentals
- Spark Ignition
  - Function of ignition system
  - Commonly used ignition systems
  - What determines the amount of ignition energy
- Four Phases of Spark Ignition
  - Pre-breakdown, breakdown, arc, and glow discharge

DAY TWO
- Effects of Some Key Parameters on Combustion, Emission and Performance
  - Higher power and/or energy
  - Longer duration discharge
  - Multiple spark plugs
  - Different spark plug designs
- Alternative Ignition Methods
  - Corona ignition system
  - Plasma-jet ignition system
  - Flame-jet ignition system
  - Activated radical (AR) ignition
  - Others
- Diagnostic and Control Opportunities
  - Use of spark voltage for monitoring combustion
  - Spark spectroscopy
  - Ionization measurement for engine health monitoring & diagnostics
- Ignition Systems for Highly Diluted Mixtures
- Conclusions

Instructor: Bruce Chehroudi
Fee $1225 1.3 CEUs

Internal Combustion Systems: HCCI, DoD, VCT/VVT, DI and VCR

3 Days
I.D.# C0613

Societal and regulatory demands to lower emissions and increase engine-operating efficiencies have forced engine designers to adopt new technologies and control strategies. This has resulted in dramatic evolutions of the technology of internal combustion engines and their support systems in recent years. These operational management strategies have evolved into more robust control systems and sensory packages, which in turn has driven the need for more accurate and specific information being communicated between the various systems found within a modern automobile.

This seminar will expose you to the emerging technologies in engine design and operation that can significantly improve operational efficiencies. The fundamental science and implementation technology of the various internal combustion engine systems will be presented. Attendees will learn how the Engine Control Module (ECM) uses information related to the operational status to implement real-time running efficiency of the engine. You will also learn how the ECM effects changes in the operation of the engine through the control systems that manage its operation. With this understanding, you will be able to derive your own set of improvement criteria that could be made to address the limitations of current engine technology.

Learning Objectives

By attending this seminar, you will be able to:
- List the typical sensors, the sensory information they collect and describe the use of that information as it addresses improved fuel economy and reduced combustion emissions
- Describe the significance, technology, and application of:
  - Direct Injection (DI) of both gasoline and diesel fuels
  - Homogeneous Charge Compression Ignition (HCCI)
  - Displacement on Demand (DoD) Systems
  - Variable Cam Timing (VCT) and Variable Valve Timing (VVT)
  - Variable Compression Ratio (VCR) engine designs
- Explain the fundamental physics of the various technologies
- Specify the operational parameters and inter-relationships of each of the sub-systems of the enabling hardware
- Describe the basic design synthesis and analysis techniques for each of the major operational improvement technologies

Who Should Attend

This intermediate level seminar is appropriate for a number of design and engineering disciplines including, but not limited to: design engineers and engineering managers, automotive engine designers, component suppliers, engine test and development engineers, design services managers, and others who require the technological knowledge to perform their respective job functions.

Prerequisites

Individuals should have a practical understanding of current internal combustion technology and systems such as that covered in the SAE seminar ID# C0103, "The Basics of Internal Combustion Engines," or its equivalent. An undergraduate engineering degree, or a strong technical background, is highly recommended. Basic knowledge of algebra and physics is essential.

Topical Outline

DAY ONE
- Operation of ECM and Sensor Systems
  - Information requirements
  - Use and distribution of collected information
  - Control theories and implementation of fuel management strategies
- Direct Injection (DI) of Both Gasoline and Diesel Fuels
  - Overview and historical perspective of DI technologies -- Gasoline; Diesel
  - DI hardware review
  - Potential and proven benefits of DI -- Theory; Aspects of gasoline combustion; Aspects of diesel combustion; Engine hardware development
- Homogeneous Charge Compression Ignition (HCCI) Technologies
  - Overview and historical perspective of HCCI technologies
  - Hardware review
  - Gasoline based HCCI -- Theory; Aspects of gasoline combustion; Engine development
  - Diesel based HCCI -- Theory; Premixed HCCI; Historical direct inject systems; Current technology direct inject systems; Water injection systems for HCCI control
  - The chemistry of HCCI -- Alternative fuels; Fuel blends; Fuel additives
  - HCCI control -- Operating range extension; Key parameters for control; Control strategies
  - Kinetics of HCCI combustion

DAY TWO
- Displacement on Demand (DoD) Systems
  - Theoretical improvements to engine system performance and efficiency
  - Historical mechanisms to implement DoD systems
  - Modern approaches to DoD systems
  - Practical results
- Variable Cam and Valve Timing (VCT, VVT)
  - General theory and potential system benefits of varying valve timing
  - Variable cam timing or phasing -- Benefits associated with VCT; Mechanisms to implement VCT; Modern approaches to VCT systems
  - Variable valve timing -- Benefits associated with VVT; Mechanisms to implement VVT systems; Modern approaches to VVT systems
  - Practical results

DAY THREE
- Variable Compression Ratio (VCR) Engine Designs
  - Theoretical improvements to engine system performance and efficiency
  - Mechanisms to implement VCR technology
  - Modern approaches to VCR systems
  - Practical results
- General Discussion
  - Use of alternate fuels
  - Implementing dual-fuel engines
  - Engines designed to run multiple fuels (not dual-fuels)
  - Control strategies for implementing and combining above technologies
  - Emerging technologies
  - New technologies

Instructor: W. Mark McVea
Fee $1545 2.0 CEUs

Introduction to Hybrid and Electric Vehicle Battery Systems

2 Days
I.D.# C0626

Driven by the need for lower emissions, better fuel economy and higher efficiency, hybrid vehicles are appearing in many different configurations on today's roadways. While the powertrain components such as the drive motor, motor controller and cooling system are somewhat familiar to the automotive industry, the battery systems are a relatively unfamiliar aspect. This seminar will introduce participants to the concepts of hybrid vehicles, their missions and the role of batteries in fulfilling those requirements. Battery topics including limitations, trends in hybrid development, customer wants and needs, battery system development timelines, comparison of electrochemistries and safety will be examined. Current offerings, cost factors, pack design considerations and testing will also be reviewed. Students will have an opportunity to perform a battery pack analysis exercise using a real world application and are requested to bring a calculator to class.

Learning Objectives

By attending this seminar, you will be able to:
- Capture customer wants and expectations of the battery system
- Identify factors that drive power and energy requirements
- Determine test program structure
- Compare and contrast the newest relevant battery technologies
- Calculate estimates of electric range and quantify the assumptions
- Critically assess media claims of new battery discoveries

Who Should Attend

This seminar is primarily intended for vehicle systems engineers, battery system integration engineers, testing engineers, electrical engineers and thermal management engineers recently assigned to their roles or returning to hybrid or electric vehicle programs. It will also be beneficial to those involved in the specification, design, development, testing and planning of hybrid vehicle programs. Product planners and program managers will find the overview aspects helpful.

Prerequisites

Material presented will be practical in nature with basic mathematics used to describe quantitative measures. An undergraduate degree in electrical or electromechanical engineering will assist in gaining maximum benefit from the material presented. Experience or training in battery electrochemistry is helpful, but not essential.

Topical Outline

DAY ONE
- Terminology, Definitions and Conventions
- Brief Review of the Hybrid Market
  - Market drivers and expectations
  - Market influences
  - Competing technologies
  - Customer expectations
- Review of Common Vehicle Product Offerings (battery descriptions, power, technology, size, architecture)
- Fundamentals
  - Fossil fuel vs. hybrid vs. electric
  - Source ragone plot
  - Efficiencies, weights
  - Cost of fuel (fossil vs. electrons)
- Role of Battery
  - ICE vs. electric systems
  - Energy vs. power
  - Expectations over vehicle lifetime
- Product Liability / FMEA
- Battery Development Cycle
  - You don't know what you don't know!
  - Why does it take so long and cost so much?
- Cost Factors
  - Scope of product: system vs. cells vs. sticks
  - $/kW vs. $kWh
- System Considerations
- Electrochemistry Selection
- Safety
  - Advance planning for safety tests
  - Thermal runaway
  - String configuration (series, parallel)
- Range Estimation (hybrid vs. electric)

DAY TWO
- Real-life Battery Analysis Exercise (using a contemporary vehicle as an example)
- Battery Pack Design Considerations
- Failure Modes
  - Wear-out
  - Power and energy degradation
  - High resistance / open circuit
  - Controller / signal malfunction
- Vehicle Trends
  - Plug-in hybrid
  - Battery electric
  - Demanding applications
  - Fuel cell hybrids
- Battery Trends
- Battery Warranty
- Battery Recycling

Instructor: Erik Spek
Fee $1265 1.3 CEUs

Introduction to Hybrid Powertrains Webinar

2 Hours
I.D.# C0903

Although hybrid powertrains have been on the market for little more than a decade, hybridization has quickly become one of the most successful alternative powertrains available today. Some OEMs estimate that up to 80% of their light-duty vehicles will require some level of hybridization to meet upcoming CAFE regulations in the United States. Additional market drivers, such as California's greenhouse gas legislation (now adopted or in process in 20 US states and two Canadian provinces) and a possible global agreement on greenhouse gas production at the end of 2009 may help to accelerate the process. Basic information on hybrids is scattered among information sources, and is often difficult to synthesize. In this two-hour webinar, energy storage systems, inverters, motor-generators, and DC-DC converters are explained, as well as design considerations for both light-duty and heavy-duty vehicle powertrains and developing trends such as plug-in, flywheel and hydraulic hybrids.

Learning Objectives

By connecting with this webinar, you will be able to:
- Describe the efficiency improvements that hybrid vehicles achieve with respect to conventional vehicles
- Identify common components of hybrid powertrains
- Recognize basic layouts utilized in light, medium, and heavy-duty hybrid vehicle powertrains
- Compare the advantages and disadvantages of different hybrid architectures
- Summarize hybrid powertrain applications that are on the market today
- Explain upcoming HEV developments

Who Should Attend

This course is designed for the engineer, manager, or marketing professional who needs a quick overview of the design and manufacture of hybrid vehicle powertrains. Industry professionals who want a broad yet concise overview of the technological aspects of current and upcoming hybrid powertrains will benefit. Anyone who is unfamiliar with basic hybrid technology, yet whose job will be impacted by hybrid vehicles in the future, will benefit from this webinar. A basic understanding of road vehicle construction and operation will be helpful.

Topical Outline

- Types of hybrids
  - Gasoline-electric hybrids (HEV)
  - Diesel-electric hybrids (HEV)
  - Hydraulic hybrids (HH)
- Hybrid-electric powertrain components
  - Energy storage systems
  - Motor controllers
  - Motor-generators
  - DC-DC converters
  - Safety interlocks and circuits
  - Ancillary systems
- Series hybrid architectures
  - Advantages and disadvantages of series hybrids
  - Upcoming commercialization of series hybrids
- Parallel hybrid architectures
  - Engine-assist systems
  - Through-the-road systems
- Series-parallel hybrid architectures
  - Power-split hybrids
  - GM "two-mode" hybrids
- Plug-in Hybrids
  - Advantages and disadvantages of PHEVs
  - Early PHEV conversions
  - Commercialization of PHEVs
  - Design considerations for PHEVs
- Hybrid vehicle trends and developments
  - Effects on IC engine development
  - Research and development trends

Instructor: Jack Rosebro
Fee $245 .2 CEUs

Introduction to Hydraulic Hybrid Systems for Road Vehicles

2 Days
I.D.# C0833

Considerable attention has been given to the design and efficiencies of electric hybrid propulsion systems and energy storage technologies. Although they draw much less attention, hydraulic hybrid propulsion and regenerative braking systems for road vehicles are a cost effective alternative to electric systems and have relevance to important sectors of the passenger and commercial vehicle markets. In this two-day seminar, hydraulic hybrid vehicle systems and their potential will be examined using model based evaluations.

This will include an evaluation and comparison of hybrid configurations as well as the introduction of components used in these hydraulic hybrid systems. Also provided will be details on how hydraulic systems are designed and integrated into vehicles, including interactions with braking systems and various other vehicle systems. Recent developments in hydraulic machines and an update on the component technology needed to implement these solutions will also be presented.

Learning Objectives

By attending this seminar, you will be able to:
- Identify the fundamentals of parallel and series hydraulic hybrid vehicle transmission systems and components
- Evaluate the applicability of such systems to particular vehicle applications
- Identify how hydraulic hybrid system components can be integrated into the vehicle
- Recognize the interactions with other vehicle systems (e.g. engine, transmission, ABS, foundation brakes) and integration of controls

Who Should Attend

This course will benefit individuals new to hydraulic hybrid systems as well as engineers and designers involved in all areas related to the design and development of vehicle powertrain systems. Also benefiting will be individuals interested in the interaction of this hybrid system with braking systems and engine controls.

Prerequisites

An undergraduate degree or strong technical background is highly recommended. A basic familiarity with vehicle powertrain and braking systems is required.

Topical Outline

DAY ONE
- Introduction and Overview
  - Objectives
  - Course outline and scope
- Hybrid Vehicle Systems - Outline and Comparisons
  - Definitions
  - Energy storage
  - Basic electric and hydraulic configurations: Parallel and Series -- Efficiency evaluations; Weight comparison; Cost outline
- Hydraulic Components for Vehicle Hybrid Systems
  - Accumulators -- Types; Size and weight; Efficiency and response; Installation
  - Pumps and Motors: Requirements -- Efficiency and response
  - Types: Descriptions and Potential Applications (Axial Piston; Swash Plate; Bent-Axis; Radial Piston; Other
  - Other components - valves pipes, filters, coolers, etc.
  - Controls -- System; Vehicle

DAY TWO
- System Design
  - Simulation strategy -- Drive cycles; Launch criteria; Maximum speed; Towing/grades
  - Stop/Start functionality -- Accessory drives
- Control Strategies
  - Regenerative braking
  - Parallel hybrid hydraulic systems
  - Series hybrid hydraulic systems
  - Engine operation management -- Simplified engine calibration for emissions and fuel economy; Advanced engines enabled by series hybrids
  - Safe Operation
- Application Examples
  - Car and taxi
  - Light truck (SUV, pickup, work truck)
  - Light delivery truck and shuttle bus
  - Refuse and transit bus
  - Off-highway
- Hydraulic Hybrid Potential and Developments
- Course Assessment and Summary

Instructor: Simon J. Baseley
Fee $1225 1.3 CEUs

Liquid Atomization, Sprays, and Fuel Injection

3 Days
I.D.# 98019

Liquid fuel atomization and spray formation is the heart of the majority of stationary and mobile power generation machines that we rely on. This seminar focuses on the process of liquid atomization and spray formation and how it relates to fuel injection systems and emission of pollutants in modern engines. The seminar begins with background coverage of terminology, the purposes of liquid atomization and spray formation, and different designs of atomizers and nozzles employed in various industries. The focus is then directed to gasoline and diesel fuel injections, injector designs, and performance requirements for optimum engine operation with lowest possible emission of harmful pollutants. Based on the idea that knowledge of technical practices and advances in one area (i.e. diesel fuel injection) is beneficial to engineers in other areas (gasoline direct injection, rocket engines), this seminar takes an interdisciplinary approach. Attendees will understand the technology and logic behind different injector designs, and gain the knowledge to judge, adapt and transfer technology advances from one discipline to another.

Learning Objectives

By attending this seminar, you will be able to:
- Explain important terminology commonly used in atomization and sprays
- Describe important processes in atomization and spray formation
- Articulate the effects of injection system design and operating conditions on engine performance, combustion, and emission of pollutants
- Describe different injector designs and the rationale for the use of each
- Define the role the injection system plays in combustion and emission and how it is used to provide guidance in design of low-emission combustion systems
- Implement appropriate design concepts and logic in the design of critical components such as intake valves and induction systems
- Evaluate future trends and technology developments in fuel injection

Who Should Attend

Automotive and aerospace engineers, technical and project managers, researchers and academicians will benefit by attending this seminar. Automotive engineers working on the design of combustion engine components, reduction of harmful pollutants emissions, software development and application for modeling of thermal-fluid, combustions and emissions and engineers and managers directly involved in fuel injection systems will also benefit. Aerospace engineers involved in the design of gas turbine or rocket engines' combustion chambers will benefit as well.

Topical Outline

DAY ONE
- Description of the Atomization Process
- Disintegration of the Liquid Jets
  - Rayleigh criterion (no viscosity)
  - Weber's criterion (effects of viscosity)
  - Ohnesorge criterion for atomization (Ohnesorge Number)
  - Rayleigh, first and second wind-induced breakup and atomization regimes
  - Influence of some parameters -- jet velocity profile; nozzle length-to-diameter ratio; ambient pressure
  - Disintegration of liquid sheets
  - Drop breakup in air flow, turbulent flow, and viscous flow
- Types of Atomizers: Pressure, Air-Assist, Air-Blast, Effervescent, Electrostatic, Ultrasonic, Diesel Injector and Gasoline-Fueled Injectors
- Drop Size Distribution and Measurements
  - Graphical and mathematical representation of drop size distribution
  - Averaged diameter and representative diameters
  - Measurement techniques -- patternation; drop size measurements and spray characterization
  - Mechanical methods -- drop collection on slides; molten-wax and frozen-drop approach; cascade impactors; electrical; charged-wire and hot-wire methods; optical methods; imaging - photography and holography; single-particle light scattering (Phase Doppler Particle Analyzer, etc.); diffraction size analyzer
  - Drop evaporation

DAY TWO
- Diesel Fuel Spray, Injector and Injection System
  - Fuel injection system -- pumps: in-line injection, distributor-type injection, single-barrel injection, and unit injector & unit pumps; injector designs: nozzle holder, nozzles, others
  - Overall spray structure
  - Liquid fuel atomization
  - Spray angle
  - Intact core length
  - Spray evaporation
  - Ignition delay
  - Mixing-controlled combustion
  - HC emission mechanisms in diesel engines and its relation to fuel injection
  - Soot formation and fuel sprays
  - Advanced topics (details of split injection, common-rail injection, interacting-sprays injection, ultra-high pressure fuel injection, effects on performance and emissions, and others)

DAY THREE
- Gasoline Port Fuel Injectors and Injection System
  - Multipoint port injection system -- classes of gasoline port injectors: low pressure, medium pressure, high pressure, air-assisted, swirl, heated vaporizing, ultrasonic, and electrostatic; key

requirements of gasoline port injectors; deposit considerations
  - Single-point throttle body injection system
  - Feedback system
  - Effects of injection parameters on engine performance and emission: injection timing, spray targeting, spray momentum, mean drop size, pulse-to-pulse variability, and others
- Flow of Fuel and Air in Intake Manifolds
- Details of Gasoline Direct Injection (GDI) and its Effects on Engine Performance and Emission of Pollutants
- Fuel-air mixing processes
- Spray Modeling and Demonstration of Computer Software for Spray Calculation in Engines
- Summary and Conclusion

Instructor: Bruce Chehroudi
Fee $1545 2.0 CEUs

Piston Ring Design/Materials

2 Days
I.D.# 86009

The purpose of this course is to provide an overview of the factors in the cylinder kit assembly of natural gas, gasoline, and diesel engines that affect oil consumption, ring and cylinder bore wear, and blow-by. This course includes background and the evolution of designs and materials currently employed in modern engines as well as providing an overview of computer models, designs, and material systems that can be utilized to optimize the performance of new engines. An overview of the trends in materials and designs employed in U.S., European and Japanese engines will be presented.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the function of each ring and its interaction with other components within the cylinder kit to provide oil consumption and blow-by control
- Identify available computer models and instrumentation that is available to predict and measure the function of each of the components in the cylinder kit on oil consumption and blow-by control
- Compare the base systems and facing material systems and the trade-offs associated with each of the material systems, i.e., wear rate, scuff resistance, etc.

Who Should Attend

If you are an engineer associated with engine design and development and interested in understanding the function and design considerations within the cylinder kit system, you would benefit from attending.

Prerequisites

Participants should have an undergraduate engineering degree and some exposure to piston ring design and materials.

Topical Outline

- Background
  - Evolution of piston ring designs/materials -- diesel engines
  - Evolution of piston ring designs/materials -- gasoline engines
- Outline of Nomenclature & Ring Design Methodology, including Referencing to Various Published Standards i.e. -- SAE, DIN, ISO
- Systems Parameters & Their Interaction with Piston Rings to Cause Variations in Performance
  - Cylinder bore geometry
  - Cylinder bore finish
  - Piston design
  - Power density
  - Operating speed
  - Engine lubricants
- Typical Procedures/Equipment Employed to Measure Dimension Properties of Piston Rings
- Developed Models Aiding in Cylinder Kit Design
- Determining the Effect of Design Parameters on Oil Consumption, Ring Function, Cylinder Bore Distortion, Friction & Wear Rates -- Unique test set-up procedures and their utilization

Instructor: Harold E. McCormick
Fee $1225 1.3 CEUs

Plug-in Hybrids: Opportunities and Challenges Webinar

2 Hours
I.D.# C0905

The path to commercialization of plug-in hybrids is likely to require complex interactions between OEMs, battery manufacturers, electric utilities, and government, yet the plug-in hybrid is a still-developing technology. How do plug-in hybrids (PHEVs) differ from conventional hybrids? What are the advantages and challenges for vehicle manufacturers, public utilities, energy and environmental concerns, and end-users? What is the current state of plug-in hybrid development?

Those unfamiliar with PHEV or vehicle-to-grid (V2G) technology, yet whose job will be impacted by plug-in hybrid vehicles in the future, will benefit from this two-hour webinar.

Learning Objectives

By connecting with this webinar, you will be able to:
- Describe the relevant differences between plug-in hybrid (PHEV) and conventional hybrid vehicles
- Identify fundamental charge-discharge strategies
- Explain the performance demands placed on PHEV energy storage systems and development trends in energy storage
- Recognize the enablers and barriers to mass commercialization of PHEVs
- Summarize infrastructure requirements as well as supply-side and demand-side incentives
- Explain the potential energy and emission benefits of PHEV and V2G synergies

Who Should Attend

This webinar will benefit automotive and commercial vehicle industry professionals who want to understand the rapidly-changing development of plug-in hybrids, as well as proposed legislation that may affect that development, and surrounding infrastructure that will play a supporting role in PHEV commercialization.

Topical Outline

- Plug-in hybrid (PHEV) architectures
  - Gasoline-electric plug-in hybrids
  - Diesel-electric plug-in hybrids
  - Fuel cell plug-in hybrids

- Plug-in hybrid (PHEV) charge-discharge strategies
  - Series plug-in hybrids
  - Parallel plug-in hybrids
  - Series-parallel plug-in hybrids
  - Charge-sustaining (CD) strategies
  - Charge-depleting (CD) strategies
  - Blended charge-discharge strategies
- Plug-in hybrid (PHEV) energy storage systems
  - State of energy storage chemistries today
  - Influence of all-electric range
  - Influence of charge-discharge strategies
- State of plug-in hybrid development today
  - Conversion of existing hybrid vehicles
  - Passenger and light-duty vehicles
  - Heavy-duty vehicles
- Interaction between plug-in hybrids and the electrical grid
  - Charging considerations
  - Infrastructure considerations
  - PHEVs and grid demand
- Vehicle-to-grid (V2G)
  - How V2G works
  - State of V2G development today
  - What's needed to enable large-scale commercialization V2G
- Government incentives toward development of PHEVs
  - Supply-side incentives
  - Demand-side incentives

Instructor: Jack Rosebro
Fee $245 .2 CEUs

Powertrain Selection for Fuel Economy and Acceleration Performance

2 Days
I.D.# C0243

Developing vehicles that achieve optimum fuel economy and acceleration performance is critical to the success of any automotive company, yet many practicing engineers have not received formal training on the broad range of factors which influence vehicle performance. This seminar provides this fundamental understanding through the development of mathematical models that describe the relevant physics and through the hands-on application of automotive test equipment. Attendees will also be introduced to software used to predict vehicle performance.

The course begins with a discussion of the road load forces that act on the automobile (aerodynamic, rolling resistance, and gravitational) followed by a review of pertinent engine characteristics. This background information is then used to show how appropriate gear ratios for a vehicle transmission are selected and to develop models for predicting acceleration performance and fuel economy. The models form the basis for the computer software used to predict vehicle performance. Participants will also use an in-vehicle accelerometer, GPS fifth-wheel, and an OBDII scanner to measure vehicle performance.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the basic operation of the components in an automotive powertrain
- Calculate road loads on a motor vehicle
- Select appropriate gear ratios for a given engine/chassis combination
- Predict the effect of gear selection, body design, and weight on the fuel economy of a vehicle
- Explain and utilize the mathematical models for predicting the acceleration of an automobile
- Explain and utilize the mathematical models for predicting the fuel economy of an automobile
- Use computer software for predicting vehicle fuel economy and performance

Who Should Attend

As this seminar is designed for automotive engineers involved in the design and development of automotive powertrains (with special value for entry-level engineers and others seeking to develop a fundamental understanding), attendees should have a degree in mechanical engineering or a related field, be able to apply Newton's second law of motion, and be familiar with spreadsheets and simple computer programming concepts.

Topical Outline

DAY ONE
- Course Introduction/Powertrain Configuration
  - Powertrain layout: front-wheel drive, rear-wheel drive, four-wheel drive
  - Powertrain components: engine, clutch/torque converter, transmission, drive shaft, differential, tires
- Road Load Forces and Power
  - Vehicle freebody diagram
  - Aerodynamic forces
  - Rolling resistance forces
  - Gravity forces
- Vehicle Coastdown Test
  - Theory behind coastdown test
  - GPS fifth-wheel
  - SAE Recommended Practice J1263
- Vehicle Tractive Effort
  - Characterization of internal combustion engines
  - Characterization of pneumatic tires
- Drivetrain Selection
  - Vehicle design criteria
  - Selection of top gear ratio
  - Selection of low gear ratio
  - Selection of intermediate gear ratios

DAY TWO
- Analysis of Power and Torque Flow in Drivetrain Components
  - Clutches
  - Standard & planetary gear sets
  - Axles and differentials
  - Manual transmissions
  - Automatic transmissions
  - Torque Converters
- Acceleration Performance Prediction
  - Vehicle acceleration modeling
  - Effects of drivetrain component selection
- Road Load and Acceleration Power Testing Laboratory
  - In-vehicle accelerometer
  - GPS fifth-wheel
  - SAE Recommended Practice J1491
- Fuel Economy Prediction
  - Vehicle fuel economy modeling
  - EPA driving cycles
  - CAFE standards
  - Effects of drivetrain component selection
  - SAE recommended practice J1256

- Emissions prediction
- Demonstration of Vehicle Performance Software
  - DOE Advisor
  - Commercial packages
  - Effects of drivetrain component selection

Instructor: Craig J. Hoff
Fee $1265 1.3 CEUs

Principles of Electric Drives Webinar

I.D.# WB0941

Electric drives are found in hybrid, plug-in hybrid, and hydrogen fuel cell vehicles, as well as battery electric vehicles. More than two million hybrid vehicles worldwide utilize electric drive components, and battery technology has matured enough to enable major manufacturers to develop light-duty and commercial electric vehicles for mass production and sale beginning in 2010-2012. It is also likely that many conventional vehicles will incorporate some form of idle-stop or stop-start system comprised of a low-output electric drive, as an integral part of efforts to meet U.S. CAFE fuel economy standards and EU CO2 emission requirements.

Industry professionals who are looking for a general understanding of the structure and components of vehicular electric drives will benefit from this course, which will cover theory, design, operation, and diagnostics of all major components used in electric drives (battery packs, inverters, motor-generators, DC-DC converters, and charging apparatus) as applied to all forms of vehicles, including charge-sustaining hybrids, plug-in hybrids, fuel cell hybrids, and battery electric vehicles. Battery chemistry, charging systems, power conversion, switching techniques, and traction motor construction will be discussed in detail.

Learning Objectives

By connecting with this webinar, you will be able to:
- Explain the design, function, and interactions of all major components of a typical electric vehicle powertrain
- Describe the operation, attributes, and behavior of battery packs, inverters, motor-generators, on-board and off-board charging systems, and DC-DC converters across all ranges of performance
- Identify the different design configurations and requirements of electric drives in hybrids, plug-in hybrids, fuel cell hybrids, and battery electric vehicles
- Classify different types of battery packs, inverters, motors, and DC-DC converters
- Analyze the design and construction of a given electric powertrain, and evaluate its particular attributes and drawbacks
- Assess fault detection and protection strategies and circuits as well as on-board diagnostic requirements
- Appraise technical limitations of electric drive components, as well as design and technological trends that may address such limitations

Who Should Attend

Powertrain engineers, electrical engineers, project planners, project managers, technical writers, safety officers, component specialists, component suppliers, and anyone else who is professionally impacted by the development of electric vehicle technology will be able to use this information to help them transition to working with electric drives. Participants should have a basic knowledge of electric circuits. This is an introductory webinar; a mechanical or electrical engineering degree is helpful but not necessary.

Topical Outline

Session 1 -- Battery Packs, Capacitors, and Energy Management
- Calculating Onboard Energy Storage Needs
- Battery Chemistries and Lithium-Ion Sub-Chemistries
- Electrolytic Double Layer Capacitors
- Combination Systems (Hybrid Battery-Capacitor Systems)
- Battery Pack Performance
- Integrating an Energy Storage System into the Chassis
- System Relays and Power-on Sequences
- Battery Management Systems and Communication with the CAN Bus
- Thermal Management Systems and Considerations
- System Degradation
- Onboard Charging Strategies
- Failure and Diagnostic Modes
- Recycling and Recovery of Battery Cell Material

Session 2 --External Charge-Discharge Systems and DC-DC Converters
- Charging Systems for Electric Vehicles
- Inductive and Conductive Charging
- Charger-to-Vehicle Communication
- Power Supply Considerations
- Vehicle-to-Grid Systems
- Switching Power Supplies and DC-DC Converters
- Packing and Thermal Management of DC-DC Converters
- Failure and Diagnostic Modes
- Power Requirements of Drive-By-Wire Systems

Session 3 -- Inverters and Fundamentals of Power Electronics
- Power Transistors And Switching Operation
- Basic Motor Control
- Producing AC Waves from a DC Supply
- Capacitors in Inverters
- Pulse-Width Modulation
- PWM Inefficiencies
- Overmodulation and Six-Step Control
- Space-Vector Modulation
- Boost Converters
- Thermal Management of Inverters
- Circuit Protection
- Failure and Diagnostic Modes
- Upcoming Power Electronics Developments and Enhancements

Session 4 -- Synchronous and Asynchronous Motor-Generators
- Flux Linkages and Rotating Magnetic Fields
- Rotor and Stator Construction
- Torque Production, Motor-Generator Types
  - Permanent-Magnet
  - Induction
  - Reluctance
  - Enhanced Lundell Motor-Generators
- Operation in Motor, Generator, and High-Speed Modes
- Field-Weakening
- Choosing a Motor-Generator, Thermal Management of Motor-Generators
- EMF Considerations
- Failure Modes and Diagnostic Strategies

Instructor: Jack Rosebro
Fee $585 .8 CEUs

The Basics of Internal Combustion Engines

2 Days
I.D.# C0103

In your profession, an educated understanding of internal combustion engines is required, not optional. This two-day technology survey seminar covers the most relevant topics - ranging from the chemistry of combustion to the kinematics of internal components of the modern internal combustion engine - for maximum comprehension. Attendees will gain a practical, hands-on approach to the basics of the most common designs of internal combustion engines, as they apply to the gaseous cycles, thermodynamics and heat transfer to the major components, and the design theories that embody these concepts.

Learning Objectives

By attending this seminar, you will be able to:

- Discuss in detail the basic functioning and component interaction in a modern internal combustion engine, specifically; two and four-stroke cycles as they relate to reciprocating and rotary engine designs
- Describe the general thermodynamic concepts governing the operation of an internal combustion engine and its various cycles
- Compare the principle operational differences of the various fuels used in internal combustion engines, their availability, and understand the applicability of each
- Discuss the function and operation of all major components and systems within a modern internal combustion engine
- Identify the operational principles behind the timing and working relationships among all internal components, and articulate the importance of this inter-relationship
- Recognize the limitations of the current designs and implementations of the modern internal combustion engine
- Perform a basic assessment and evaluation of new, cutting-edge designs and new powertrain initiatives as they apply to the mobility industry

Who Should Attend

Designed for powertrain engineers, component suppliers, vehicle platform powertrain development specialists, and those involved in the application, design and discussion of engines. It is recommended that seminar attendees have an undergraduate engineering degree.

Topical Outline

DAY ONE

- Fundamental Operating Procedures
  - Open circuit
  - Closed circuit
  - Internal combustion
  - External combustion
  - Spark ignition
  - Compression ignition
- Engine Technology
  - 2-stroke
  - 4-stroke
  - Pistons, connecting rods and crankshaft
  - Valvetrain, camshaft and timing gear
  - Engine block, cylinder and head geometry
  - Manifold, surface finish, track length
  - Fuel systems, carburetors, fuel injection
  - Turbo- and super-charger
  - Ignition, timing and spark advance
- Fuel Delivery Systems
  - Air intake systems
  - Fuel delivery
  - The problem of part throttle operation
  - Intake manifold design and tuning
  - Turbo-charging
  - Super-charging
  - Introduction to emissions
  - Fuel management and control theory
  - Fuel injection
  - ECU operation
  - Sensors and instrumentation
- Valve Train
  - Operation
  - Arrangement -- Push-rod; Single overhead cam shaft (SOHC) design; Dual-overhead cam shaft (DOHC) design
  - Camshaft function and design considerations
  - Valve timing
  - Valve-train design considerations

DAY TWO

- Component and Event Timing
  - Valve actuation timing
  - Valve timing diagram
  - Spark ignition event and timing
  - Compression ignition injection event and timing
- Fuels & Combustion
  - Definition of hydrocarbon based fuels
  - Stoichiometric Burn Efficiency
  - Air / Fuel Ratio
  - Gasoline
  - Diesel
  - Octane rating
  - Cetane rating
  - Hydrocarbon emission
  - Flame types
  - Thermodynamic efficiencies
  - Ignition requirements
  - Combustion chamber and head design
- Ignition
  - Common ignition sources
  - Combustion abnormalities
  - Spark plug design considerations
  - Ignition timing
- Emissions & Controls
  - Chemistry of emissions
  - Emission controls
  - Catalytic converter operation
  - Exhaust gas recirculation (EGR)
  - Valve overlap control
  - Introduction to variable camshaft timing (VCT)
- Thermodynamics
  - Definition and comparison of common internal combustion cycles
  - Otto cycle
  - Diesel cycle
  - Dual cycle
  - Atkinson cycle
- Energy Conversion Kinematics and Mechanisms
  - Cylinder arrangement
  - Piston design considerations
  - Piston ring application
  - Connecting rod design considerations
  - Crankshaft design
  - Balancing

Instructor: William Mark McVea
Fee $1245 1.3 CEUs

Thermodynamics of Gas Turbine Engines

2 Days
I.D.# C0118

This seminar explores the principles of conversion of thermal energy to mechanical work output, the basics of thermodynamics and fluid flow, and the application of the First Law of Thermodynamics to systems with mass flow processes. This foundation is necessary to analyze the energy transfer processes in the major components of a gas turbine plant; namely, compressor, combustion chamber, turbine, and heat recovery system. Hands-on problem solving will reinforce the learning experience. In addition, this seminar investigates the various causes of less than ideal performance of a gas turbine plant. Calculations will be done to permit evaluation and analysis of plant performance when parameters are specified. The techniques of staging and intercooling, designed to improve performance, will also be explored. Hardware components of a typical gas turbine plant and commercial applications of gas turbines will be reviewed.

Learning Objectives

Upon completion of this seminar, the attendee will be able to:
- Define Thermodynamic Properties Of Ideal And Real Gases, Heat, and Work
- Apply the First Law of Thermodynamics to Closed and Open Systems
- Perform Calculations to Determine Entropy Changes
- List the Components of a Gas Turbine Power Plant
- Define Thermal Efficiency of the Gas Turbine Power Plant and Isentropic Efficiencies of the Compressor and the Turbine
- Recognize the Need for Staging, Intercooling, Reheating and Regeneration
- List the Causes for the Departure from the Ideal Performance of a Gas Turbine Power Plant
- Calculate the Performance of a Gas Turbine Power Plant with Staging and Intercooling Under Ideal and Real Life Conditions
- Describe the Recent Advances in Gas Turbine Technology

Who Should Attend

Design, mechanical, or facilities engineers with an interest in gas turbine engines and plants; engineers interested in cogeneration; stationary generator-set manufacturers and users; public and private sector service providers, including hospital and municipal authorities.

Prerequisites

Participants should have an undergraduate engineering degree or equivalent.

Topical Outline

DAY ONE
- Thermodynamic Properties of Substances
- Ideal and Real Gases
- Closed and Open Systems
- Forms of Energy: Work and Heat
- The First Law of Thermodynamics and Internal Energy
- The Second Law of Thermodynamics and Entropy
- Hands-On In-Class Problem Solving
- The Carnot Cycle

DAY TWO
- Energy Conversion Devices
- The Gas Turbine Plant
- The Air Standard Brayton Cycle and Its Thermal Efficiency
- Hands-On In-Class Problem Solving
- Isentropic Efficiencies of the Compressor and the Turbine
- Ideal and Actual Performances
- Staging Brayton Cycle with Intercooling and Reheat
- Regeneration
- Hands-On In-Class Problem Solving
- Advances in the Gas Turbine Technology and Applications

Instructor: B. V. Karlekar
Fee $1225 1.3 CEUs

The Basics of Internal Combustion Engines e-Seminar

I.D.#PD130944ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this more than ten hour e-seminar option offers an alternative way to receive the same instruction as the live classroom learning without the expense of travel and time away from the workplace. The course offers ten video modules accompanied by a handbook.

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- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: William Mark McVea
Fee $565 1.0 CEUs

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Turbocharging for Fuel Economy and Emissions Webinar

4 Hours
I.D.# WB1018

Turbocharging is already a key part of heavy duty diesel engine technology. However, the need to meet emissions regulations is rapidly driving the use of turbo diesel and turbo gasoline engines for passenger vehicles. Turbocharged diesel engines improve the fuel economy of baseline gasoline engine powered passenger vehicles by 30-50%. Turbocharging is critical for diesel engine performance and for emissions control through a well designed exhaust gas recirculation (EGR) system. In gasoline engines, turbocharging enables downsizing which improves fuel economy by 5-20%.

This webinar will explore turbocharging for gasoline and diesel (heavy

and light duty) engines, including the fundamentals of turbocharging, design features, performance measures, and matching and selection criteria. It will discuss the interaction between turbocharging and engine systems and the impact on performance, fuel economy and emissions. Developments in turbocharging technology such as variable geometry mechanisms, two-stage and sequential (series & parallel) turbocharging, EGR including low pressure loop, high pressure loop and mixed mode systems and novel turbocharging systems will be described using figures and data.

Learning Objectives

By connecting with this webinar, you will be able to:
- Identify the basics of how a turbocharger works, how to measure the appropriateness of a turbocharger, and how to select and match a turbocharger to the needs of your powertrain
- Estimate the impact of turbocharging on performance and emissions
- Anticipate potential issues such as packaging, noise, driveability, reliability, and durability
- List the latest developments in turbocharging technology, their impact on engine performance and emissions, and the use of turbocharging world-wide

Who Should Attend

This course will be beneficial to powertrain development engineers, component development engineers, engineering managers, product planners, service engineers, and those developing product strategy. Heavy duty diesel engine development engineers may find the course helpful by increasing their knowledge of turbocharging and EGR systems.

Prerequisites

To get the most out of this webinar, you should have a familiarity with automotive engines. A Bachelor's degree in Engineering is desirable.

Topical Outline

Session 1 - Introduction to Turbocharging
- Fundamentals, Functionality, and Basic Design Features of Turbochargers
- Impact of Turbochargers on Engine Performance, Emissions, and Fuel Economy
- Performance Maps, Selection Criteria, Comparison and Matching of Turbochargers to Engine and Powertrain Needs

Session 2 - Advanced Issues and Technology
- Turbocharger Noise, Reliability, and Durability Considerations
- Advanced Technology Developments Including Variable Geometry, EGR Systems, and Multi-Stage Turbocharging
- Worldwide Growth in Application of Turbocharging

Instructors: S. M. Shahed and Arjun D. Tuteja
Fee $395 .4 CEUs

Turbocharging Internal Combustion Engines

3 Days
I.D.# C0314

The need to control emissions and maintain fuel economy is driving the use of advanced turbocharging technology in both diesel and gasoline engines. As the use of diesel engines in passenger car gasoline and diesel engines increases, a greater focus on advanced turbocharging technology is emerging in an effort to reap the benefits obtained from turbocharging and engine downsizing.

This seminar covers the basic concepts of turbocharging of gasoline and diesel engines (light and heavy duty), including turbocharger matching and charge air and EGR cooling, as well as associated controls. The limitations and future possibilities of today's systems will be covered, as well as details on how emerging technologies will impact engine/vehicle performance. The seminar's primary focus is on the turbocharger-engine interface (subjects such as matching, benefits, limitations, and new technologies) rather than detailed turbocharger aerodynamics and design. Advanced technologies such as variable geometry and multi-stage turbocharging, high and low pressure loop EGR systems, assisted turbocharging and turbocompounding are discussed. Students will have the opportunity to perform hands-on exercises to gain an appreciation of parametric effects in a wide range of engines.

**Participants are expected to bring a laptop computer, with Excel, to the seminar for class exercises.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the thermodynamic principles governing the turbocharging of internal combustion engines
- Articulate the critical contribution of turbocharging to modern day diesel engine performance and emission control
- Determine the possible benefits of turbocharging for specific gasoline and heavy and light duty diesel engine applications
- Estimate the appropriate turbocharger characteristics for specific applications based on engine system requirements
- Describe the limitations of current technologies and evaluate new technologies and their possible role in meeting future engine/vehicle system challenges
- Apply the basic principles of matching turbocharger with engine and optimizing overall system for desired performance and emissions

Who Should Attend

This seminar is designed for engineers, managers, and other technical personnel from OEM and support industries concerned with the design and development of optimized diesel and spark ignition engine systems, including performance, fuel economy and emissions for passenger car, light truck and heavy duty engines. Some background in thermodynamics, IC engine performance and emissions will be helpful. Individuals who need more background should consider attending SAE seminar "Diesel Engine Technology" (ID# 93014) or "The Basics of Internal Combustion Engines" (ID# C0103).

Topical Outline

DAY ONE
- Engine-Turbocharger Basics
  - Overview
  - Impact of charge density

- Pumping loop and thermodynamics effects
- Gas exchange/air flow and performance characteristics -- Engine; Turbocharger; Engine/turbocharger interaction

- Turbocharger Design Features
  - Overview
  - Compressor side components and features
  - Turbine side components and features
  - Other significant turbocharger design requirements
  - Charge and EGR cooler features
  - Durability - thermal stress, materials, high and low cycle fatigue
  - Cooling, bearings, lubrication and sealing
  - Noise considerations
- Free-floating, Wastegate, Variable Area or Variable Geometry Turbochargers and Controls
- Compressor and Turbine Aerodynamics
  - Aerodynamic design features
  - Figures of merit for aero performance
  - Performance maps and their impact on engine characteristics
  - Methodology to evaluate the performance of compressors and turbines

DAY TWO

- Engine Air and EGR Flow Requirements
  - Power density and efficiency considerations
  - Emissions control considerations
- Turbocharger Matching
  - Matching principles with and without EGR
  - Single and multi-stage turbo matching
- Turbocharger Selection Based on Engine System Requirement
- Transient Response Considerations
- Basic Spreadsheet Tools for Engine and Turbocharger Parametric Explorations
  - Hands-on exercises for turbocharger and engine performance calculations
  - Hands-on parametric studies using simple calculation tools

DAY THREE

- Impact of Turbocharging on Gasoline and Diesel Engine Performance and Emissions
- Charge (Air and EGR) Cooling Systems
- Advanced Concepts in Turbocharging including Design Features of Advanced Concepts
  - Advanced versions of variable geometry turbocharging
  - High temperature and high strength materials
  - Two-stage turbocharging, series, parallel and sequential
  - Exhaust gas recirculation systems to minimize impact on efficiency
  - Turbocompounding
  - Electrically (and hydraulically) assisted turbocharging
  - Impact on emissions control in diesel and gasoline engines
  - Cold start emissions issues, catalyst temperature for diesel and gasoline
  - Turbocharger response issues

Instructors: Arjun D. Tuteja and S. M. Shahed
Fee $1595 2.0 CEUs

Variable Cam and Valve Timing (VCT) & (VVT) Webinar

6 Hours
I.D.# WB1011

This webinar will discuss the general theory and potential system benefit of varying valve timing and compare the differences between Variable Cam Timing (VCT) and Variable Valve Timing (VVT). It will cover the historical mechanisms to implement VCT and VVT systems, compared to the modern approaches. If you have a practical understanding of internal combustion technology and systems, you will gain an appreciation for VCT and VVT - its application to the automotive marketplace and its significance as it applies to improvements in the engine and overall powertrain operations.

Learning Objectives

By connecting with this webinar, you will be able to:

- Describe general theory and potential system benefit of varying valve timing
- Recognize the difference between Variable Cam Timing (VCT) and Variable Valve Timing (VVT)
- Review historical mechanisms to implement VCT and VVT systems
- Examine modern approaches to VCT and VVT systems

Who Should Attend

This intermediate level webinar is appropriate for a number of design and engineering disciplines including, but not limited to: design engineers and engineering managers, automotive engine designers, component suppliers, engine test and development engineers, design services managers, and others who require the technological knowledge to perform their respective job functions.

Prerequisites

You should have a practical understanding of current internal combustion technology and systems. An undergraduate engineering degree, or a strong technical background, is highly recommended. Basic knowledge of algebra and physics is essential.

Topical Outline

Session 1

- General Theory and Potential System Benefit of Varying Valve Timing
- Difference between Variable Cam Timing (VCT) and Variable Valve Timing (VVT)

Session 2

- Definition of the Various Operational Modifications and the Operational Benefits of Their Implementation
- Review of General Mechanisms to Implement VCT and VVT Systems

Session 3

- Modern Approaches to VCT Systems
- Modern Approaches to VVT Systems
- Practical Results

Instructor: W. Mark McVea
Fee $515 .6 CEUs

Variable Compression Ratio (VCR) Webinar

4 Hours
I.D.# WB1012

The objective of this webinar is to describe all the significance, technology and application of Variable Compression Ratio (VCR) as it applies to improvements in all facets of an automotive powertrain. The webinar will present the theoretical improvements to engine system performance and efficiency and the historical and modern approaches to VCR systems. An overview of direct injection of gasoline and diesel fuels will presented, including the historical perspective of DI technologies. Participants with a practical understanding of internal combustion technology and systems will gain an appreciation for VCR and its application to the automotive marketplace. This webinar will expose you to the emerging technologies in VCR operation that can significantly improve operational efficiencies. The fundamental science and implementation technology of the Variable Compression Ratio and Direct Injection will be presented. You will learn how the Engine Control Module (ECM) uses information related to the operational status to implement real-time running efficiency of the engine and how the ECM affects changes in the operation of the engine through the control systems that manage its operation. With this understanding, you will be able to derive your own set of improvement criteria that could be made to address the limitations of current engine technology.

Learning Objectives

By connecting with this webinar, you will be able to:
- Describe theoretical improvements to engine system performance and efficiency
- Identify historical mechanisms to implement VCR technology
- Describe modern approaches to VCR systems
- Outline practical results

Who Should Attend

This intermediate level webinar is appropriate for a number of design and engineering disciplines including, but not limited to: design engineers and engineering managers, automotive engine designers, component suppliers, engine test and development engineers, design services managers, and others who require the technological knowledge to perform their respective job functions.

Prerequisites

You should have a practical understanding of current internal combustion technology and systems. An undergraduate engineering degree, or a strong technical background, is highly recommended. Basic knowledge of algebra and physics is essential.

Topical Outline

Session 1
- Variable Compression Ratio (VCR) Engine Design
- Theoretical Improvements to Engine System Performance and Efficiency
- Historical Mechanisms to Implement VCR

Session 2
- Modern Approaches to VCR Systems
- Practical Results

Instructor: W. Mark McVea
Fee $395 .4 CEUs

Advanced Diesel Particulate Filtration Systems 61
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Advanced Diesel Particulate Filtration Systems

2 Days
I.D.# C0502

As diesel emissions regulations have become more and more stringent, diesel particulate filters (DPF) have become possibly the most important and complex diesel aftertreatment device. This seminar covers many DPF-related topics using fundamentals from various branches of applied sciences such as porous media, filtration and materials sciences and will provide the student with both a theoretical as well as an applications-oriented approach to enhance the design and reliability of aftertreatment platforms. Structure, geometry, composition, performance, applications and optimizations of DPFs are some of the main topics covered in this advanced level seminar. Computer simulation techniques for analysis and optimization of DPF performance are also demonstrated.

Learning Objectives

By attending this seminar, you will be able to:

- Discuss fundamental, moderate and advanced topics on DPF structure, geometry, composition, performance, applications and optimizations
- Formulate porosity, permeability, inertial loss coefficient, flow resistance descriptors, different particulate transport modes (diffusional, interceptive), etc. to develop models for predicting backpressure of DPF
- Recognize different modes of particulate filtration regimes in DPF
- Select, design, utilize and optimize DPF for various light duty and heavy duty aftertreatment applications
- Predict, via modeling and simulations, various important DPF performance features (backpressure, peak regeneration temperature, etc.) as well as to analyze their failure modes and thus enhance the reliability of diesel exhaust aftertreatment platform designs

Who Should Attend

This seminar is designed for engineers, scientists, investigators and consultants involved in researching, developing, applications, designing or optimizing diesel exhaust aftertreatment components and systems. Individuals from technical and regulatory institutions as well as individuals from OEMs, suppliers, emissions service companies, research facilities and universities will gain modern knowledge of diesel filter performance.

Prerequisites

Students should have some technical insight into the performance of exhaust emission aftertreatment. Attendees with science or technology background (mechanical/chemical engineering, chemistry, physics) will benefit substantially from this seminar.

Topical Outline

DAY ONE

Porous Media Basics for Diesel Particulate Filters

- Pore space and structure definitions (definitions of relevant length scales, derivation of "pore metrics" such as correlation lengths, lineal path distributions.)
- Simplified representations of structures (unit cell models based on granular, cylindrical and composite collectors.)
- Flow resistance descriptors (Darcy permeability, Forchheimer coefficient, inertial loss coefficient as functions of wall micro-geometry, cell density, wall thickness, plug length)Filtration Concepts for Diesel Particulate Filters
- Particle transport and deposition phenomena -- Condensed vs. vapor phases in diesel exhaust; Diesel fractal soot aggregate basics; Diffusional transport; Thermophoretic transport; Direct interception mechanism; Inertial transport mechanism; Other phenomena (electrical effects, sticking, entrainment by exhaust flow)
- Continuum filtration theory -- Deep-bed filtration regime; Cake filtration regime reconstruction of filter media
- True-to-the-geometry representations (digital reconstruction of filter media, micro-flow simulation with Lattice-based techniques and discrete particle dynamics. Examples applied to granular ceramic extruded filters, sintered metal filters, foam filters and fibrous textile filters.)Diesel Filter Types: Materials and Configurations in Practice
- Materials aspects
  - Ceramics -- Oxide based: Cordierite, Mullite, other (Tialite/ Aluminum Titanate, etc.); Non-oxide based: Recrystalized Silicon Carbide (R-SiC), Siliconized Silicon Carbide (Si-SiC), Silicon Nitride
  - Metallics (high temperature alloys) -- Sintered grains and fibers
- Configurations
  - Wall-flow honeycombs (square, triangular, symmetric vs. asymmetric channels.)
  - Pleated, foiled (sheet-based) designs
  - Fibrous, textile cartridges
  - Foam-based designs
  - Flow-through particulate collectors

DAY TWO

Applications, Performance Optimization and Modeling of Diesel Particulate Filters

- Filter backpressure/particulate loading -- Porosity, permeability, pore structure issues; Role of catalyst coatings; Filter size effects (length, diameter, cell density, wall thickness); Microstructure of soot deposits (physical and chemical properties); Soot deposition conditions and role on soot structure: Steady state, transients, cycles; Modeling aspects
- Filter Regeneration
  - Soot reactivity and structure -- Oxidation mechanisms (thermal, catalytic, NO2); Kinetic descriptions
  - Types of regeneration technologies -- Raising exhaust temperature by post-injection and/or by exhaust-port injection in combination with DOxC; Fuel borne additive-assisted regeneration; Catalyst coating-assisted regeneration; Reactive species-assisted regeneration (NO2-assisted, non-thermal plasma, etc.)

- Simulation Techniques for Diesel Particulate Filters -- Brief history of DPF performance modeling; Backpressure -- Theory, insights and lessons; Modeling: demonstrations, validations; Regeneration -- Theory, insights and lessons; Modeling: demonstrations, validations
- Ash Effects -- Ash production, transport, deposition and thermal history; Ash effects on filter thermal management, catalyst activities, and filter sizing

Instructors: Athanasios Konstandopoulos and Mansour Masoudi

Fee $1225 1.3 CEUs

Catalytic Converters: Design and Durability

2 Days
I.D.# 98017

The introduction of catalytic converters in 1975 has helped to breathe fresh air into the once-dismal arena of automotive emissions by reducing the hydrocarbons, carbon monoxide, and oxides of nitrogen by over 90%! This seminar explores the development of catalytic converters and the key inventions that made them viable, along with recent advances in converter technology required to meet stringent emissions regulations for both light-off and underbody converters. Applications of converter design to gasoline-powered cars, trucks and motorcycles will be presented. Also covered in this seminar are the durability and performance characteristics of both ceramic and metallic catalyst supports and certain design tools that help optimize the converter performance.

Attendees will receive a copy of Ron Heck's book, *Catalytic Air Pollution Control: Commercial Technology*.

Learning Objectives

By attending this seminar, you will be able to:
- Describe why ceramics as structural materials behave differently than metals and how such differences affect product design and performance
- Design catalytic converters that have adequate durability to meet performance and reliability requirements in the field
- Work with advanced catalyst systems which help meet stringent emissions regulations e.g. LEV, ULEV, and SULEV
- Examine field failures and conduct root cause analyses to help improve converter design

Who Should Attend

This course is designed for mechanical, metallurgical and chemical engineers, materials scientists, and chemists involved in heterogeneous catalysis, who are interested in handling, assembling, and failure analysis of catalytic converters.

Prerequisites

Participants should have a basic familiarity with automotive emissions for gasoline engines.

Topical Outline

DAY ONE (Instructor: Ron Heck)
- Brief Historical Background
- Fundamentals of Catalysis
  - Definition of catalyst
  - Characteristics of catalysis
  - Catalytic reactions
  - Catalyst preparation & characterization
  - Catalyst durability
  - Reaction controlling mechanisms
  - Catalytic reactor design
- Automotive Catalysis
  - Historical background
  - Engine emissions
  - Three-way catalysis (TWC)
  - Engine control - oxygen sensor
  - Role of Ceria
  - Catalyst monitoring (OBD)
  - Palladium TWC technology
  - Vehicle test procedures
- Automotive Catalysis Advanced Technologies
  - New standards
  - Cold start technologies
  - Close coupled catalyst
  - Hydrocarbon traps
  - Electrically heated catalysts
  - Metallic honeycombs
  - UEGO air/fuel sensor
  - ULEV vehicle design
  - SULEV/PZEV vehicle design
  - Benefits of new high cell density
  - Hybrids
- Automotive Catalyst Durability Examples
  - Engine aging protocols
  - Sintering
  - Masking
  - Poisoning
  - Attrition
- Lean Burn Engines
  - Background
  - NO x removal methods
  - NO x decomposition
  - NO x catalytic reduction
  - NO x traps
  - Selective removal with NH 3
- Brief Summary
- PremAir® catalyst
  - Reactions
  - Applications
  - Design parameters
  - On-road experience
  - Catalyst durability
  - OBD requirements
  - Credit potential

DAY TWO (Instructor: Suresh Gulati)
- Brief Historical Background
- Design of Catalyst Support
  - Performance requirements
  - Support material and structure
  - Ceramic beads
  - Ceramic honeycombs
  - Geometric properties
  - Physical properties
  - Design parameters
  - Substrate sizing
- Substrate/Washcoat Interaction
  - Washcoat distribution
  - Composite properties
  - High temperature behavior
  - Comparison with substrate properties
- Thin Wall Substrates

- Design options
- Properties and performance
- Effect of washcoat
- Packaging considerations
- Square vs. nonsquare cells

• Packaging Design
- Isostatic strength of coated substrate
- Wiremesh and mat properties
- Durability requirements
- Canning techniques
- Inner vs. outer ribs
- Selection of mat and mount density
- Nonintumescent and hybrid mats
- Failure modes and prevention
- Advanced packaging designs

• Thermal Shock Resistance
- Temperature gradients
- Thermal stresses
- Failure modes and prevention
- Thermal shock tests
- Thermal fatigue

• Ceramic vs. Metallic Substrates
- Geometric properties
- High temperature strength and creep resistance
- Comparative performance

• Applications
- Passenger car
- Gasoline truck
- Motorcycles

Instructor: Suresh Gulati & Ronald Heck
Fee $1335 1.3 CEUs

Catalytic Converters: Design and Durability e-Seminar

I.D.#PD130405 (CD-ROM version only)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this 10 hour, 45 minute e e-seminar option offers an alternative way to receive the same instruction as the live classroom learning without the expense of travel and time away from the workplace. The course offers 12 video modules accompanied by a handbook.

View the complete program brochure and demo at http://www.sae.org/e-seminars/cat_converters.

What You Will Receive:

- Dr. Heck's textbook, "Catalytic Air Pollution Control: Commercial Technology"
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)
- Three (3) CDs
- Course Handbook (bound, paperback)

Instructors: Suresh Gulati & Ronald Heck
Fee $595 1.1 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Evaporative and Refueling Emission Control

2 Days
I.D.# C0928

All gasoline powered vehicles and equipment create exhaust and evaporative and refueling emissions. Unlike exhaust emissions, which occur only when the engine is operating, evaporative emissions (evap emissions) occur all the time. Controlling evap emissions to PZEV levels is as challenging as controlling exhaust emissions. It becomes even more important in the case of plug-in hybrid electric vehicles (PHEV) and extended range electric vehicles (EREV) which generate evaporative fuel vapors, but have no place to burn/consume the vapors when the engine does not operate for extended periods of time. Constantly changing evaporative regulations including new test procedures for accommodating future EREVs and PHEVs vehicle evap systems, new test fuels to reflect changing commercial gasolines, identifying and controlling new sources of fuel vapor emissions, etc., require that individuals working in this area have a solid understanding of both regulatory and system design issues for evap emissions control. This comprehensive seminar introduces the participants to the principles of gasoline evaporative fuel vapor generation (diurnal, hot soak, running loss, and refueling) from the vehicle fuel tank, fuel vapor storage in activated carbon canisters, and fuel vapor desorption and consumption in engine combustion. The seminar begins with an analysis of gasoline and gasoline/ethanol blends and estimation of their vapor pressures and vapor generation. In-depth analysis of various vapor generations as a function of fuel properties (ethanol content, Reid Vapor Pressure, etc.) and ambient conditions will be presented. Activated carbon canister design, OBD II leak detection, hydrocarbon permeation, and CARB and EPA evaporative test procedures will also be covered. Participants will have the opportunity to apply the knowledge gained by designing a sample evaporative and refueling emissions control system in class. Participants are asked to bring a calculator for use in classroom exercises.

Learning Objectives

By attending the seminar, you will be able to:
- Identify various sources of evaporative fuel vapor emissions
- Predict the effects of ethanol on evaporative emissions
- Estimate diurnal and refueling vapor generation
- Analyze the differences in the test procedures: U.S., Europe, and Asia
- Explain activated carbon canister operation: loading, purging, vapor redistribution, and back-purge
- Identify potential solutions to induction hydrocarbon emissions
- Estimate the effect of altitude on evaporative emissions

Who Should Attend

This course is designed for engineers in all fields related to the design and development of evaporative and refueling emission control systems including platform fuel system design engineers for fuel tanks, onboard refueling vapor recovery systems, evaporative emission control canisters, fuel vapor lines, vapor purge lines, purge and vent valves, etc. Air induction system design engineers dealing with induction hydrocarbon adsorbers, powertrain fuel delivery design engineers responsible for canister purge vapors, powertrain calibration engineers responsible for evaporative canister purge and evaporative emission diagnostics, and environmental engineers who deal with state and federal emission regulations, will all find the seminar valuable.

Prerequisites

An undergraduate engineering degree or strong technical skills with some knowledge in basic organic and physical chemistry is required.

Topical Outline

DAY ONE
- Introduction
  - Evaporative and refueling emission control system
  - Why and how to control fuel vapor emissions
- Fuel and Fuel Vapor Pressure
  - Hydrocarbon fuels
  - Oxygenated fuels and non-ideal solutions
  - Estimation of vapor pressures of ideal (hydrocarbon fuels) and non-ideal solutions (oxygenated fuels)
  - Flexible Fuel Vehicles (FFV) and fuel commingling
  - Vapor pressure and boiling point estimation
- Fuel Vapor Generation
  - Diurnal, hot-soak, running loss
  - Refueling - liquid seal and mechanical seal, hot tank/cold dispensed fuel, cold tank/hot dispensed fuel, RVP, air entrainment and vapor recirculation, etc.
  - Effect of altitude on vapor generation and fuel boiling in running loss test
  - Effect of oxygenates on fuel vapor generation and fuel boiling in running loss test

DAY TWO
- Carbon Canisters
    - Adsorbents and isotherms
  - Activated carbons
  - Adsorption/desorption phenomena
  - Canister vapor loading, purging, redistribution, and back-purge
  - Canister design
- Evaporative and Refueling Emission Control System Design
  - Test procedures - EPA & CARB 3-day test, EPA-ORVR, EPA & CARB 2-day test, ECE and other global EVAP test procedures, etc.
  - Canister sizing - determine optimum size
  - Purge air volume requirement
- Miscellaneous Evaporative Emission Control Topics
  - Hybrid and plug-in hybrid evaporative emission control
  - Pressurized/sealed and bladder fuel tank for evaporative emission control
  - Evap OBD II leak detection
  - Permeation losses - effects of materials, temperature, fuel composition, etc.

Instructor: Sam Reddy
Fee $1225 1.3 CEUs

Exhaust Flow Performance and Pressure Drop of Exhaust Components and Systems

1 Day
I.D.# C0235

Designing more efficient and robust emission control components and exhaust systems results in more efficient performance, reduced backpressure and fuel penalty, and higher conversion efficiency. This course will help you to understand the motion of exhaust flow in both gasoline and diesel emission control components including flow-through and wall-flow devices such as catalytic converters, NOx adsorbers, diesel oxidation catalysts, diesel particulate filters as well as flow through the overall exhaust system. Discussions will also cover: flow recirculation in inlet cones, flow maldistribution and its effect on conversion efficiency in flow throughs, non-uniform particulate deposit in diesel filters, and roots of non-uniformity in flow distribution due to exhaust system design such as bends.

Learning Objectives

By attending this seminar, you will be able to:
- Describe how exhaust stream is distributed in flow-throughs in gasoline or in diesel emission components and in wall-flow components (catalytic converters, NOx adsorbers, DOC, diesel particulate filters), including in inlet cones, exit cones, bends, elbows, flow constrictions, and in other components of an exhaust system
- Design exhaust systems yielding higher conversion efficiency, lower backpressure, faster light-off, and optimal performance
- Design diesel particulate filter systems yielding more uniform soot distribution in filters, thus lowering both filter backpressure and its peak regeneration temperature
- Describe connections between flow distribution and thermal performance such as light-off and radial and axial temperature gradients

Who Should Attend

This seminar is intended for engineers, managers, designers, researchers and technical associates who wish to gain deeper insight into developments and optimization of exhaust systems and components. This also includes professionals involved with catalyst and emission components and exhaust sensors.

Prerequisites

Any professional with a technical insight (and not necessarily a technical education) will be capable of comprehending most or all of the course contents.

Topical Outline

- Flow-throughs (e.g. catalytic converters or NOx adsorbers)
  - The basics: flow distribution; roots of and various contributors to pressure drop; effect of geometry; effect of surface area, length and diameter; role of catalyst; etc.
  - How to optimize the performance
  - How to measure the pressure drop
- Wall-flows (e.g. diesel particulate filters)
  - The basics: flow distribution; roots of and various contributors to pressure drop; effect of geometry such as wall thickness, cell density, plugs, and aspect ratio; transport and deposit of particulate in filters and its effect on the filter performance; role of exhaust flow on regeneration
  - How to optimize the performance
  - How to measure the pressure drop
- Inlet and exit cones: flow recirculation in cones and its effect on backpressure and performance (e.g. conversion efficiency, particulate deposit, light-off, etc.)
- Similar analysis of other exhaust system components such as pipes, bends, elbows, and constrictions and expansions in the path of the exhaust flow

Instructor: Mansour Masoudi
Fee $725 .7 CEUs

Selective Catalytic Reduction for Diesel Engines

2 Days
I.D.# C0913

Stringent requirements of reduced NOx emission limits in the US have presented engineers and technical staff with numerous challenges. Several in-cylinder technical solutions have been developed for diesel engines to meet 2010 emission standards. These technologies have been optimized and have yielded impressive engine-out results in their ability to reduce emissions to extremely low levels. However, current and state-of-the-art in-cylinder solutions have fallen short of achieving the limits imposed on diesel emissions for 2010. To help meet emissions requirements, the catalyst industry has developed exhaust emission reduction technologies with impressive levels of performance. These technologies include hydrocarbon selective catalytic reduction (SCR), NOx absorber catalysts, and urea SCR. This seminar will begin with an explanation of NOx formation in diesel engines and in-cylinder methods for reducing these emissions. The aftertreatment systems for NOx reduction will be explained and the advantages and disadvantages of these emission reduction technologies will be discussed. In this two-day seminar, the primary focus is on urea SCR and its technology will be fully examined. The important chemical reactions and methods for improving SCR performance by encouraging desirable reactions and avoiding undesirable reactions are explained. Additionally, the components and control of a urea SCR system are detailed and the necessary sensors for its control are described. The SAE paper, *Laboratory Testing of Urea-SCR Formulations to Meet Tier 2 Bin 5 Emissions*, is included in the course materials.

Learning Objectives

By attending this seminar you will be able to:
- Identify how NOx is formed in diesel engines
- Identify the in-cylinder means for reducing NOx
- Evaluate NOx aftertreatment technologies for diesel exhaust.
- Describe the characteristic of selectivity in catalytic aftertreatment
- Apply selectivity to urea SCR
- Describe the features and components of a complete urea SCR system
- Learn how to optimize the control of a urea SCR
- Distinguish the differences between various catalytic SCR formulations

Who Should Attend

This seminar will benefit engineers and technical staff who are developing urea aftertreatment systems for diesel engines, including catalyst engineers who supply NOx aftertreatment systems to the diesel industry. Also benefitting will be suppliers of other NOx reducing technologies, such as EGR components and fuel injection systems, as well as on-highway and off-highway diesel engine technical staff.

Prerequisites

Attendees should have knowledge of how a diesel engine operates, including its 4-stroke operation. Additionally, attendees should have basic knowledge of the emission formation mechanism in internal combustion engines.

Topical Outline

DAY ONE
- Introduction
  - On-Highway diesel emission regulations
  - Non-Road diesel emission regulations
  - Passenger car diesel emission regulations
  - Light-Truck diesel emission regulations
  - EURO IV Regulations
  - EURO V Regulations
  - NOx regulations in Japan
  - Drivers for controlling NOx
- NOx Formation in Diesel Engines
  - Diffusion combustion model
  - The Zeldovich Mechanism
  - Pressure/Crank angle diagram
  - Heat release rate
- In-Cylinder Means for NOx Reduction
  - Injection timing retard
  - Multiple injections/combustion cycle
  - Charge air cooling
  - Exhaust gas recirculation
- NOx Aftertreatment Systems for Diesel Engines
  - Lean NOx Catalysts (LNC), DeNOx Catalysts, HC SCR
  - Lean NOx Trap (LNT), NOx Adsorber Catalyst (NAC also NAK), and NOx Storage Reduction (NSR)
  - Selective Catalytic Reduction (SCR) using urea reductant
  - Derivatives: Ammonium Carbamate, Combination LNT/SCR
- Urea SCR Technology
  - Chemical reactions
  - Advantages/Disadvantages of the urea SCR system
  - Notable demonstration

DAY TWO
- Components of the Urea SCR System
  - Catalyst -- Extruded substrate; Coated substrate
  - Catalyst Type -- Vanadia/Titania/Tungsten; Iron Zeolite; Copper Zeolite
  - Catalyst volume and space velocity considerations
  - Urea injection system -- Air-Assist systems; Airless systems
  - NOx sensors
  - Urea specifications and suppliers
- System Calibration and Control Considerations
  - Effect of NH3/NO
  - Effect of NO2/NO
  - Ammonia slip
  - Exhaust architecture
- Regulatory and Market Considerations
  - Urea Infrastructure -- Bottles; Dispensers; Co-Fueling
  - End-user and urea refills
  - The Japanese experience
  - The European experience
  - Plans for USA manufacturers
  - Commercial vehicle market projections
- Urea Production and Distribution
  - The A.D. Little Report
  - The European experience
  - Passenger car diesel emission regulations
  - Light-Truck diesel emission regulations
- SCR Options and Configurations for Future NOx Limits
  - On-Highway heavy-duty diesels
  - Non-Road diesel engines
  - Passenger car diesels
  - Light-Truck diesels
  - Cold weather operation
- Closing and Evaluations

Instructor: Magdi Khair
Fee $1245 1.3 CEUs

Alternative Fuels: Impact on SI and CI Fuel Systems, Distribution and Storage 66
Fundamentals of Automotive Fuel Delivery Systems 66
Microbial Contamination in Aviation Fuel and Aircraft Fuel Systems 67
Motor Fuel: Technology, Performance, Testing, and Specifications 68

Alternative Fuels: Impact on SI and CI Fuel Systems, Distribution and Storage

2 Days
I.D.# C0729

Microbial contamination and material compatibility present significant issues for alternative fuels, causing costly operational problems for suppliers, distributors and end-users. Fouling, corrosion, sulphide spoilage and increased water content can lead to filter plugging, blocking of fuel lines and injectors and consequently cause excessive wear and failure of engines and systems components. This course is a primer for those professionals who desire to learn how new fuel and fuel blends could potentially impact the operation and reliability of engines powered by oxygenated gasoline, desulfurized diesel fuel and biodiesel fuel blends. Attendees will learn the basics about fuel chemistries, material compatibility and how the increased susceptibility to water and microorganisms can affect equipment operation and reliability.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the events that have shaped our current fuel policies
- Compare the differences between petroleum and biomass fuel chemistries
- Detect fuel and potential system material compatibility issues
- Describe how fuel systems could potentially be at greater risk for problems due to the presence of microorganisms
- Detect and remediate problems associated with microbial contamination of fuels
- Improve the overall operational reliability of power systems that utilize diesel and biodiesel fuels

Who Should Attend

This seminar is appropriate for fuel systems design engineers, fuel quality managers in refinery, pipeline and terminal operations, engine fuel quality managers, and maintenance technicians.

Prerequisites

Attendees should have a basic understanding of fuels and fuel systems.

Topical Outline

DAY ONE
- Fuels
  - Brief overview of fuel history -- Introduction of fuels for spark ignition and compression ignition engines; Events and policy that shaped fuels in the United States
- Overview of Fuel Chemistries
  - Petroleum fuels -- Feedstocks and production
  - Biomass fuels -- Feedstocks and production
  - Unique chemical differences
- Material Compatibility
  - How is material compatibility defined?
  - Metals vs. non-metals
  - Factors that contribute to the corrosion of metals and non-metals
  - Examples of material compatibility issues
- Microorganisms
  - Brief overview of the operational and economic impact of microorganisms to the gasoline, diesel and biodiesel industry
  - Brief description of microorganisms related to fuels
  - Requirements for microorganisms to survive in a fuel storage and distribution system
- Diesel Fuel Storage and Distribution
  - Entry and movement of microorganisms throughout the diesel fuel storage and distribution network
- Detection of Microorganisms
  - Types of detection equipment and procedures
  - Practicum

DAY TWO
- Remediation of Microorganisms
  - Microbial pesticides approved for use in fuels
  - USEPA regulations governing the sale of microbial pesticides
  - Characteristics of an efficacious microbial pesticide
  - Methods for treating storage and distribution systems
- Surveillance and Testing
  - Benefits of a routine surveillance program
  - Developing a surveillance program

Instructor: Ed English & Howard Chesneau
Fee $1225 1.3 CEUs

Fundamentals of Automotive Fuel Delivery Systems

2 Days
I.D.# C0303

The key to a vehicle's overall operation is the superior, quality design of its major moving subsystems. Automotive gasoline and diesel fuel delivery systems in particular must be virtually malfunction free for all components for the entire vehicle prescribed service life. Fuel systems must be robust and precise enough to store and deliver the appropriate amount of fuel to power the engine. These stringent requirements necessitate a basic understanding of the subsystem working principles, functionalities and interrelated components.

This course provides a basic yet thorough examination of technical issues involved in automotive gasoline and diesel fuel delivery. Participants will acquire a fundamental understanding of the current technology and requirement guidelines and apply some of the principles through an in-class project and exercises. Examples of frequently encountered technical issues of fuel delivery systems shall also be discussed. The course is designed to encourage discussion, insights, and possible solutions into the engineering problems

encountered in the gasoline and diesel fuel delivery systems and components.

Learning Objectives

By attending this seminar, you will be able to:
- Organize, differentiate and interpret the fundamental concepts, features and applications of fuel delivery systems
- Describe general gasoline and diesel fuel delivery system functionality
- Compare and differentiate individual components comprising the subsystem
- Identify interconnections of system components
- Apply general gasoline and diesel fuel system requirement guidelines

Who Should Attend

You should attend if you are an engineer or engineering manager involved in design, research, testing or implementation of automotive fuel delivery systems. Engine designers, suppliers of fuels and fuel delivery system components, and polymer engineers may benefit as well.

Prerequisites

An engineering degree in any discipline would be beneficial.

Topical Outline

- Introduction
  - Overview
  - General expectations
- Fundamental Fuel Delivery Systems
  - SI engine fuel delivery systems -- Gasoline; Alternative fuel
  - Diesel engine fuel delivery systems -- Conventional unit injector system; Electronic controlled intensifier systems; High pressure common rail systems
  - Fuel Cell -- Solid oxide fuel cell; Proton exchange fuel cell
  - Advanced fuel delivery system concept -- Variable valve lifting; Cylinder deactivation
- Fuel Types & Properties
- Fuel Delivery Subsystem Working Principles
  - Delivery modules -- Return systems; Returnless; Mechanical returnless fuel delivery system (MRFS); Electronic returnless fuel delivery system (ERFS)
  - Fuel pump assemblies
  - Injector assemblies
  - Injection types -- Multi-point injection (MPI); Sequential multi-point injection (SMPI); Direct injection (DI); Common rail diesel injection (single injection event; Multiple injection events; Rate shaping); Homogeneous charge compression injection (HCCI) for diesel
  - Fuel pressure regulation
  - Onboard refilling vapor recovery system (ORVR) and vapor management
  - Fuel level indication mechanism
  - Fuel filtration -- Pump/module inlet filtration; Inline filtration; Integrated filtration system
  - Fuel delivery metering -- High pressure end; Inlet metering
- Fuel Delivery System OEM and Government Regulatory General Requirements
  - Functionality requirements
  - FTP highway and urban cycles
  - Durability requirements
  - Safety requirements
  - Permeation requirements
  - Contamination life requirements
  - Static charge and abatement techniques
- Fuel Delivery System and Components Evaluation and Testing Methods
  - Fuel tank
  - Fuel lines
  - Delivery module
  - Pump
  - Injector
  - Regulator
  - ORVR valve
  - Fuel level gauge
  - Fuel filter
  - Vapor canister
  - Fuel delivery driver module
  - Leak testing
  - Electrical static discharge testing
  - Permeation testing
- Summary

Instructor: Dr. Xiaojian Tao

Fee $1225 1.3 CEUs

Microbial Contamination in Aviation Fuel and Aircraft Fuel Systems

1 Day
I.D.# C0728

Microbial contamination in aviation fuel creates biomats that clog filters and scavenge systems, coat fuel quality indicator systems (FQIS) probes, and lead to structural corrosion, impacting the operational and economical aspects of turbine powered fixed wing and rotary wing aircraft. From inaccurate fuel level readings to aborted take-offs and air interrupts, microorganisms can wreak havoc on the entire aircraft and the system operations. Attendees will learn how microorganisms enter and survive in the fuel distribution and storage network, and how a routine surveillance program can manage risk and mitigate lost profits. Students will have the opportunity to experience hands-on techniques to detect and remediate contamination in aviation fuel systems.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the impact of microorganisms on aircraft fuel systems
- Explain how microorganisms survive in an aviation fuel environment
- Determine how microorganisms enter the fuel storage and distribution system
- Detect and remediate microbially contaminated fuel systems
- Improve the overall operational reliability of aircraft and reduce maintenance costs

Who Should Attend

This seminar is appropriate for aircraft fuel systems design engineers, aviation fuel quality managers in manufacturing, storage and distribution facilities, aircraft fuel quality managers, and aircraft maintenance technicians.

Prerequisites

Attendees should have a basic understanding of fuels and fuel systems.

Topical Outline

- Microorganisms
  - Brief overview of the operational and economic impact of microorganisms to the aviation industry
  - Regulatory, FAA Flight Standards Information Bulletin for Airworthiness (FSAW) FSAW 05-08A "Air Carrier Implementation of Inspections for Fuel Microbial Contamination"
  - Brief description of microorganisms related to aviation fuel
  - Requirements for microorganisms to survive in a fuel storage system
  - Aircraft fuel system water scavenger maintenance and periodic aircraft fuel tank sump draining
- Aviation Fuel Storage and Distribution
  - Entry and movement of microorganisms throughout the aviation fuel storage and distribution network
  - The Impact of Microorganisms on Aircraft
  - Detection of Microorganisms
  - Types of detection equipment and procedures
  - Practicum - test methods and equipment -- Culture test; Immuno assay test; Bioluminescence test
- Remediation of Microorganisms
  - Microbial pesticides approved for use in aviation fuel
  - USEPA regulations governing the sale of microbial pesticides in the U.S.
  - Characteristics of an efficacious microbial pesticide
  - Methods for treating storage and distribution systems
  - Industry practice for introducing a microbial pesticide into aircraft
- Surveillance Program
  - Benefits of a routine surveillance program
  - Developing a surveillance program

Instructors: Ed English & Howard Chesneau
Fee $725 .7 CEUs

Motor Fuel: Technology, Performance, Testing, and Specifications

3 Days
I.D.# 98003

Fuel composition has had to change with the advent of more stringent emission regulations. Reformulated gasoline (RFG), for example, is vastly different from gasoline of even ten years ago. Tightening regulations on diesel emissions will dramatically change both diesel fuel and engine design. This three-day seminar will review the fundamentals of motor fuels, combustion and motor power generation. The primary content of the course provides a basic introduction to the technology, performance, evaluation, and specifications of current gasoline, diesel, and turbine fuels. The first day of the course begins with a brief review of the evolution of motor fuel through 100 years of performance and specification.

Learning Objectives

By attending this seminar, you will be able to:
- Describe how fuel compositional variables affect engine performance
- Interpret test data to determine if fuel meets required specifications and regulations
- Determine the purpose and mode of action of performance additives
- List the important processes in motor fuel
- Communicate effectively with others working with motor fuels
- Have a working knowledge of motor fuel composition, properties, and performance -- a necessity for engine designers, and fuel and additive formulators.

Who Should Attend

This course is intended for engine design engineers who need a basic understanding of the fundamental performance properties of motor fuels and additives. The course is also intended for formulators who need to understand the relationships of fuel performance and composition to properly design fuels and additives to meet current and future needs. Engine testing personnel; petroleum company employees; Federal, State, and Local Regulatory personnel, laboratory supervisors; and fuel marketing personnel would also benefit.

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

DAY ONE
- Introduction and History of Motor Fuels
- Overview of Motor Gasoline
  - Gasoline composition, chemistry, production, blending
  - Spark ignition engine and effect of fuel quality on performance
  - Gasoline volatility and combustion
  - Influence of composition on storage stability and engine deposit formation

DAY TWO
- Oxygenated Blend Components and Emissions
- Gasoline Specifications
- Overview of Diesel Fuel
  - Diesel composition, chemistry, production, blending
  - Diesel engine and effect of fuel quality on performance
  - Fuel characteristics influencing combustion and emissions
  - Low temperature and other fuel characteristics
  - Fuel additives

DAY THREE
- Alternative Fuels, Future Trends, and Directions
- Diesel Specifications
- Gaseous Fuels for Engines
  - Natural gas combustion, performance, and emissions
  - LPG combustion, performance, and emissions
  - Alternative fuels, future trends, and directions
- Racing Fuels
  - General considerations
  - Hydrocarbon fuels
  - Alcohol fuels
  - Special fuels
- Future Trends in Fuels
  - Alternative fuels
  - Future trends and directions

Instructor: Kenneth Kipers
Fee $1645 2.0 CEUs

Advanced Topics in Seat Suspension Design and Human Body Vibration Control 69
Human Factors in Flight Decks: Design and Certification 69
Occupant/Interior Vehicle Packaging: Designing for the Customer 70

Advanced Topics in Seat Suspension Design and Human Body Vibration Control

2 Days
I.D.# 97007

The objective of this two-day seminar is to provide the latest technology and research on testing and evaluation of ride comfort and proposed seat suspension design. Attendees will focus on how to evaluate and control human response to various types of vibration in different vehicles. Models of the seat and operator subjected to various types of input including impulses, multi-frequency sinusoidal types of vibration, and random excitation will be addressed as well as the examination of current seat suspension designs using passive, semi-active optimization and control strategies.

Learning Objectives

Upon completion of this seminar, attendees will be able to:
- Identify modeling techniques of seat/driver/passengers
- Review seat suspension optimization
- Discuss ride comfort quantification
- Describe sensor selection, data acquisition, calibration and filtering
- Compare active versus semi-active suspension
- Recognize how to further evaluate seat comfort dynamics that contribute to better seat design

Who Should Attend

This seminar will be especially beneficial to those involved in seat design and those evaluating seat ride dynamics and how vibration affects the human body.

Prerequisites

An engineering background in a related field and some knowledge of human body vibration is recommended.

Topical Outline

- Modeling of Seat/Passenger
  - Two mass model
  - Three mass model
  - Evaluation of stiffness and damping coefficients of the seat
  - Evaluation of stiffness and damping coefficients of the driver/passenger
  - Generalized seat/driver model
  - Road profile and input conditions
- Dynamic Analysis of Several D.O.G. Systems
  - Formulation of the equations of motion
  - MATLAB™ models development
  - State space representation
- Human Operator/Driver Characteristics
  - Experimental analysis of ride comfort
  - Acceleration response
  - Energy absorption and fatigue
  - Transmissibility
  - ISO standards
- Acceleration Transfer Function Response and Human Stiffness and Damping Identification
- Optimization Techniques
  - Definition of constraints
  - Constrained optimization
  - Use of MATLAB TM as a tool for optimization
- Seat Suspension Optimization
  - Search for optimum suspension design
  - Design issues and hardware constraints
- Control Strategies

Instructor: Farid M.L. Amirouche

Fee $1225 1.3 CEUs

Human Factors in Flight Decks: Design and Certification

1 Day
I.D.# C0952

Advances in technology continue to lead to progressively more complex aircraft and flightdeck designs. The complexities of the modern day aircraft must be balanced with the cognitive and physical capabilities and limitations of the pilots that fly them. Aviation Human Factors is recognized as a discipline that addresses these challenges. This seminar is designed for engineers and other aviation professionals seeking a fundamental understanding of human factors and ergonomics and how the discipline applies to the design and certification of the flightdeck. FAA and EASA regulations and guidance material will also be examined in an effort to help participants understand the system integration challenges and how to incorporate human factors throughout the design and certification processes.

Attendees will receive the text, *Human Factors Methods: A Practical Guide for Engineering and Design*, written by Neville A. Stanton.

Learning Objectives

By attending this seminar, you will be able to:
- Define human factors and ergonomics as it relates to flight deck design
- Recognize the importance of human factors and ergonomics
- Develop the ability to incorporate human factors into the design process
- Explain the relationship of human factors and ergonomics to FAA regulation
- Discuss human factors and ergonomics in certification
- Identify tools and evaluation techniques

Who Should Attend

This course is designed for and will benefit avionics, electrical, and mechanical engineers working directly in the field of flightdeck design. Additionally, individuals desiring an understanding of how human factors and ergonomics interface with various other engineering and related disciplines will benefit by attending this seminar.

Prerequisites

Practical understanding of flightdecks.

Topical Outline

- Introduction
  - Background for class
- Defining Human Factors and Ergonomics
  - Value of human factors
- Incorporating Human Factors in the Design Process
  - Guidance material (GAMA and HFDS)
  - Human Factors Certification Plan
  - Other areas of incorporation i.e. maintenance, tech pubs
- Regulations and Guidance
  - FAA regulations and guidance materials
  - EASA regulation CS25.1302 and AMC25.1302
  - 14 CFR Part 1230 Protection of Human Subjects
- Tools
  - Cognitive Workload (Bedford scales, NASA-TLX, Modified Cooper-Harper)
  - Usability (SUS)
  - Human Error (HET and SHERPA)
  - Ergonomics and Anthropometry
- Application of Evaluation Techniques
  - Cognitive Workload Scale -- Tool protocol; Usage; Data collection; Analysis

Instructor: Cindy Miller
Fee $795 .7 CEUs

Occupant/Interior Vehicle Packaging: Designing for the Customer

2 Days
I.D.# C0108

One of the most important aspects in the design of the vehicle is in creating an interior compartment that accommodates the needs of the customer base. Occupant and interior packaging involves: determining the necessary amount of vehicle interior space for the customer, arranging interior and structural components in order to enhance the performance of the customer, and increasing overall satisfaction, comfort, accommodation and safety for all occupants. The occupant and interior packaging process relies on the sciences of human factors and ergonomics in order to design for the customer.

Learning Objectives

By participating in this seminar, the attendee will:
- Develop an awareness of "Designing for the Customer"
- Gain an understanding of the importance of designing the interior package to fit the needs and requirements of the customer
- Determine how to identify the target customer
- Determine how to accommodate the target customer in the vehicle's interior
- Learn how to utilize human factors/ergonomics principles and techniques in the vehicle design process
- Recognize the key differences between the current industry paradigm and occupant packaging based on the customer

Who Should Attend

This seminar is designed for individuals at all levels who are involved in the design, development, and evaluation of vehicle interior systems including: interior systems/cockpit module suppliers, design engineers, product engineers and product development teams, human factors/ergonomics specialist, electronics engineers, marketing, and product planners.

Prerequisites

Participants should have an undergraduate degree and some exposure to vehicle interior systems.

Topical Outline

DAY ONE
- Foundation for Occupant/Interior Vehicle Packaging
  - What is occupant/interior vehicle packaging?
  - Importance of occupant/interior packaging in the vehicle development process
  - Occupant/interior vehicle packaging methodology: "Designing for the Customer"
- Identify the Target Customer
  - Developing a customer (user) profile
  - Identifying the needs and requirements of the customer
  - Interactive case study

DAY TWO
- Accommodate the Target Customer in the Interior Compartment
  - What is accommodation?
  - Physical representation of the target customer: Anthropometry and its use in vehicle design
  - "Inside-Out" vs. "Outside-In" design philosophy approach: determining the occupant/interior envelope
  - Design and location of primary controls
  - Design and location of secondary controls
  - Visibility: field of view and controls/displays
- Emerging Industry Trends and Technology: Impact on Occupant/Interior Packaging
  - Impact of CAD/CAM/CAE virtual prototyping simulation technology on occupant/interior vehicle packaging
  - "X"-by-Wire - mechanical to electrical inputs
  - Impact of telematics

Instructor: Deborah D. Thompson
Fee $1225

Modern Fluids for Crankcase Engines: An Overview.....71
Improving Fuel Efficiency with Engine Oils.....72

Modern Fluids for Crankcase Engines: An Overview

2 Days
I.D.# C0704

Lubricating fluids are the lifeblood of modern engines, performing numerous vital functions from reducing system friction, temperature, and fuel consumption to minimizing tailpipe emissions. This comprehensive seminar covers the latest developments in lubricating fluids technologies and explores the relationships between lubricating fluids and emissions, after-treatment devices, bio-fuels, and fuel economy. Fundamentals of crankcase lubrication, including the properties and performance requirements of global base stocks and lubricants will be covered.

The seminar will further explore the need for lubricating systems to possess thermal and oxidative stability sufficient to withstand the rigors of low-heat-rejection, high performance diesel engines or other modern engines equipped with various emission control devices. Case studies will be utilized to demonstrate the existence of overlapping phenomena aimed at extending oil life and protecting key mechanical components.

Learning Objectives

By attending this seminar, you will be able to:

- Describe how various classes of additives commonly used in crankcase lubricants impact:
  - wear of bearings, pistons, and piston rings
  - friction and fuel consumption
  - corrosion
  - piston cleanliness
  - swelling of seals
  - hydraulic media in fuel systems, such as hydraulically-actuated electronically-controlled unit injector system (HEUI).
- Recognize the limitations and technical trends in new base stocks and additive technologies
- Compare performance characteristics of lubricants designed for passenger cars manufactured in N. America, Europe or Japan
- Identify key lubricant requirements for protecting heavy duty diesel engines
- Select and optimize fluids for various light duty and heavy duty after-treatment applications
- Recognize differences between API, ACEA, and ILSAC lubricant categories

Who Should Attend

This seminar is designed for engineers, scientists, investigators and consultants involved in designing or optimizing mobile or stationary powertrains. Individuals interested in understanding the role of crankcase fluids in extending useful life of the overall systems, minimizing emissions and reducing fuel consumption will find the seminar beneficial.

Prerequisites

Attendees should have a background in science or technology and some technical familiarity with performance of engines and emissions. No previous exposure to organic chemistry is required.

Topical Outline

DAY ONE

- Introduction to Engine Lubricant Formulations
  - What are motor oils?
  - Standardized tests of new oils (SAE J300)
  - Used oils testing
- Lubrication Fundamentals
  - Functions of a lubricant
  - Friction
  - Lubrication regimes (Steinbeck Curve)
  - Wear modes
  - Viscosity
- Base Oils
  - Classes of crude oils
  - Conventional refining processes
  - Base oil categories
  - Affect of base oils on performance of engine oils
- Additives
  - Composition of motor oils - historical perspective
  - Lubricant additives industry
  - Engine oil additives -- Dispersants and dispersant VI improvers; Detergents and overbased detergents; Oxidation inhibitors; Wear inhibitors; Rust inhibitors; Friction reducers; Viscosity improvers; Factors promoting wear and deposits formation; Dispersion of particles in diesel and gasoline engine oils

DAY TWO

- Global Lubricant Specifications
  - Classification of motor oil by performance category
  - API service categories
  - Development of a new diesel engine oil category: PC10
  - Motor oil classifications- API doughnut
  - ACEA European oil specifications for gasoline and diesel engines
- Extended Service Intervals (ESI)
  - Maintenance intervals and engine life
  - Effect on lubricant formulations
- Fuel Economy
  - Diesel vs. gasoline engines test procedures
  - Lubricant role in friction reduction
- Global Trends in Emission Specifications and Exhaust Control Systems
  - Gasoline engines
  - Diesel engines
  - Fuel quality concerns
- Examples of Lubricant Interactions with Exhaust Systems
  - Three-way catalysts
  - Diesel particulate filters

Instructor: Ewa Bardasz
Fee $1285 1.3 CEUs

Improving Fuel Efficiency with Engine Oils

2 Days
I.D.# C0914

Improving vehicular fuel efficiency is of paramount importance to the global economy. Governmental regulations, climate change and associated health concerns, as well as the drive towards energy independence, have created a technical need to achieve greater fuel efficiency. While vehicle manufacturers are focusing efforts on improved combustion strategies, smaller displacement engines, weight reduction, low friction surfaces, etc., the research involved in developing fuel efficient engine oils has been less publicized. This seminar will highlight the role of lubricants in improving fuel efficiency and provide strategies for selecting the best oil for a given application. The course begins with a brief overview of the fuel consumption regulations and global perspective of passenger car lubricants and diesel oil specifications in North America, Europe and Asia. Limitations and advantages of various methods to measure fuel consumption in a variety of bench tests, dyno tests and actual vehicles will be presented. Fundamentals of fluid lubrication regimes, as well as detailed aspects of oil formulations which have significant effects on reduction in mechanical friction, such as base oil selection, viscosity grade choice and impact of friction modifiers, will be covered. The performance characteristics of fresh oil versus used oil and lubrication of coated surfaces will also be discussed. Finally, the impact of various emission control devices on overall diesel fuel consumption will be described.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the effects of mechanical friction on engine efficiency
- Summarize the pros and cons of various test methodologies used to measure engine friction
- Articulate the limitations in various fuel consumption test methodologies
- Select oils based on frictional control performance
- Describe the role of oil degradation on fuel economy and engine wear
- Evaluate lubricant interactions with low friction surfaces

Who Should Attend

This seminar is designed for engineers, scientists, investigators and consultants involved in designing or optimizing mobile or stationary powertrains. Individuals interested in understanding the role of engine oils in reducing fuel consumption will find the seminar beneficial. Automotive decision makers will also benefit by gaining an understanding of the limitations of fuel economy testing methods.

Prerequisites

Attendees should have a background in science or technology and some technical familiarity with performance of engines. No previous exposure to organic chemistry is required.

Topical Outline

DAY ONE
- Reducing Fuel Consumption
  - Regulations - N. American, Europe and Asia
  - GHG emissions and climate change
  - Petroleum based fuels - availability
  - Biofuels - availability and global trends
- Fundamentals of Engine Friction
  - Gasoline engine
  - Diesel engine
- Methodology - Part 1: How to Measure Engine Friction
  - Examples of bench tests
  - Examples of engine tests
- Methodology - Part 2: How to Measure Fuel Consumption in Real Life Conditions
  - Gasoline vehicles
  - Diesel trucks

DAY TWO
- Fuel Economy Derived Lubricant Specifications
  - N. America - API specifications
  - United Europe - OEM specifications
  - Japan - OEM specifications
- Lubrication Fundamentals
  - Lubrication regimes
  - Stribeck curve
- Lubricant Components - Effects on Fuel Consumption
  - Base oils
  - Viscosity grades
  - Friction modifiers
- Fuel Economy Retention
  - Impact of used oil on fuel consumption vs. engine wear protection
- Lubrication of Low Friction Surfaces
  - Coatings
  - Engineered surfaces
- Impact of Diesel Emission Control Devices on Overall Fuel Consumption

Instructor: Ewa Bardasz
Fee $1225 1.3 CEUs

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Patent Litigation in the U.S.: What You Need to Know Webinar 76
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Product Liability and The Engineer 78
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Root Cause Problem Solving: Methods and Tools Webinar 79
Strategic Leadership 80
Successfully Working in Virtual Teams 81
Systems Engineering for Front Line Leadership 82
The Role of the Expert Witness in Product Liability Litigation 82
Understanding the FAA Aircraft Certification Process 83

Aerospace Program Management - It's More than Scheduling and Delivery

3 Days
I.D.# C0818

Effective and efficient management of today's complex and integrated programs requires both the refinement of interpersonal and basic leadership skills as well as the application of appropriate technologies and tools. This seminar is intended to introduce basic program management skills and techniques to first-line and mid-level leaders to help them comfortably and confidently assume their role and to aid in assuring program success. Areas of special concentration will include: role of project management, communication, interpersonal skills, schedule management, interfacing with other units, Task Scoping (Estimating, Pricing, Financial Measures, etc.), project management software use, compliance reporting, risk management and more. This seminar will include lecture, dialog, and case-study approaches. Active participation of the class attendees will ensure a dynamic baseline for learning and honing valuable skills.

Learning Objectives

By attending this seminar, you will be able to:
- Communicate more effectively in all media - verbal, written, and electronic modes
- Refine interpersonal skills as they relate to dealing with diverse personal perspectives, attitudes, and motivational techniques
- Develop and utilize task schedules
- Demonstrate effective management of all resources (people, tools, and budgets)
- Apply techniques for scoping programs/projects (resource needs, schedules, level of tasking, etc.) and effectively monitor and measure progress
- Identify critical milestone events and how to develop alternate schedule recovery plans
- Utilize basic project management tools and techniques more effectively

Who Should Attend

This course is designed for current and prospective Program/Project Managers with a level of experience ranging from in-training to mid-level program management leadership.

Prerequisites

Practical understanding of desktop software applications is useful as well as general knowledge of basic financial principles.

Topical Outline

DAY ONE
- Introduction to Program/Project Management
- Clarifying and Giving Identity to Tasks
  - Who are the stakeholders? What do they want?
  - What are the resource allocations? (budgets, tools, facilities, personnel)
  - What constitutes program/project success?
- Communication Skills Essentials
  - Elements of effective presentations (verbal, e-mail, internet)
  - Appreciation of differing perspectives and how to integrate them
  - Interpersonal skills
- Interfacing with Other Units
  - Use of integrator personnel
  - Importance of shared goals as well as shared responsibilities

DAY TWO
- Establishing and Developing of Performance Schedules
  - Ensuring dependencies are identified and commitments are defined
  - Determining critical milestones and potential impacts
  - Introduction to use of commercial software tools
- Creating Meaningful Performance Metrics and Monitoring Techniques
  - The "critical life signs" of a program/project (cost, schedule, quality)
  - Role of program/project integrator and methods of in-process performance monitoring
  - Keeping all stakeholders informed and satisfied
- Compliance Reporting, Test Plans, and Contingencies
  - Regulatory documents and reports
  - Test plans and configuration control
  - FAA certification
  - Use of "critical life signs", milestones, and monitoring
  - Notification of problems and re-plans to stakeholders
  - Refining the art of asking for and receiving help

DAY THREE
- Managing the Individual Components of the Program/Project
  - Financial aspects (pricing, ROI, ROIC, etc.)
  - Marketing coordination, warranties, and after-market support
  - Using metrics to correct "critical life sign" deficiencies
  - Risk - assessment, abatement, and management
- Motivation and Rewards
  - Effective use of non-financial rewards for team members
  - Ensuring full participation and best contribution from each team member
  - Valuing others and letting them know it
- Workshop
  - Using program/project management techniques and tools, perform trial tasks as assigned
  - Discuss and critique workshop tasks
- Conclusion
  - Importance of "unlearned" leadership attributes (integrity, honesty, people sensitivity)
  - Business and personal ethics

Instructor: Drexel L. Rutledge
Fee $1545 2.0 CEUs

Engineering Project Management

2 Days
I.D.# 99003

Project Management and Advanced Product Quality Planning (APQP) are two critical techniques used in product development in the mobility industry today. This seminar will bring these techniques together in an easy to understand format that goes beyond the typical concept of constructing timelines and project planning, by exploring not only the AIAG APQP process, but also specific aspects of PM processes. Students will gain a solid foundation in the essential principles of Project Management and APQP.

Students will immediately apply learned skills by taking a sample project through all phases of the Project Plan using actual industry documents. Realistic issues, problems and time constraints are introduced throughout the exercise to stimulate actual project concerns. Each workshop exercise uses documents specific to the particular areas of study such as Statement of Requirements and Statement of Work, Timeline development and reacting to changing situations such as time crash. Discussion of the major milestones of typical OEM APQP processes, to include PPAP. The workshop is structured so that students must operate in teams and the time constraints allow students to see firsthand the effects of improper delegation of work assignments.

Attendees will receive a copy of the book, *PMBOK® 4 - Project Management Body of Knowledge* (4th edition) by the Project Management Institute (PMI).

Learning Objectives

By attending this seminar, you will be able to:
- Define the importance of each of the nine Bodies of Project Management Knowledge and the essential components of APQP by Phase
- Properly evaluate Statement of Requirement, Statement of Work and Work Breakdown structures
- Apply the different timeline methodologies: Milestone, Gantt, Network (PERT) and Critical Path
- Recognize the minimum essential elements of a Robust Project Plan
- Utilize different types of meeting and conflict resolution strategies, formulate an effective meeting summary and action list, and conduct an actual Design Review
- Recognize the current U.S. and international legislation and directives which impact today's technology development and manufacturing environment

Who Should Attend

New Project Managers, Lead or Design Release Engineers, Project Managers requiring refresher training or other individuals involved with projects will benefit by attending. The course is best suited for individuals in the mobility industry and specifically operating as Tier 1 - 3. Students should be familiar with how projects are currently managed in their company so they may ask questions relating to their specific problem areas.

Topical Outline

- The Project Management Process
  - Definition, outline and overview of the differences between 3rd and 4th editions
  - Project constraints
  - The nine bodies of Project Management Knowledge
  - Project Management and ISO
- Project Plan Life Cycle
  - Three types of life cycles: Product, Project, Project Management
  - Comparison of project management and the automotive APQP process
  - Major elements of each APQP phase
- Project Management Techniques
  - Principles of Integration Management
  - Defining, constructing, and recognizing the differences between Statement of Requirement, Statement of Work and Work Breakdown structures
  - Developing scope of work for conceptual-based (R&D) customers
  - Review of the various types of Work Breakdown Structures (WBS) and a guide to WBS development
  - Beyond lessons learned - Project Best Practices and the TGR/TGW database
  - Documentation requirements necessary to support the PM/APQP processes
- Resource Planning
  - Choosing an organizational structure to support effective Project Management
  - Roles and responsibility matrix (RASIC)
  - Creating a useful Staffing and Resource Plan
  - Special considerations for small projects
- Sequence Planning
  - Milestone Charts
  - Gantt Charts
  - Network Diagrams
  - PERT
  - Critical Path Method (CPM) and use of float/slack time
  - Techniques to address Fast Tracking and Crashing
- Project Costing and Tracking
  - Project cost analysis methods and estimating methods
  - Recognizing and dealing with Scope Creep
  - Control techniques -- Requirements for an effective Change Management System; Negotiating the difference between Phase and Design Reviews; Earned Value Analysis (EVA); Effective meeting techniques; Forming and leading project teams; Structure of effective Phase and Design Reviews; Recognizing and resolving internal and external conflict
- Project Risk Management
  - Components and construction of an effective Risk Management Plan
  - Risk qualification and quantification techniques -- Developing effective checklists; Expected Values Matrix; Probability and Impact Matrix; Product liability using the FMEA and HAZOP
- Procurement Management
  - Understanding partner supplier relationships
  - Suppliers rating techniques
  - Suppliers skill requirements

Instructor: Angelo E. Mago
Fee $1340 1.3 CEUs

Leading High Performance Teams

2 Days
I.D.# C0410

Product development is organizationally a complex undertaking that requires effective coordination within a company and between companies. During product development, teams are confronted with a number of ongoing organizational challenges and there is a high potential for conflict between participants in the process. This course addresses teamwork and other "soft-side" factors that largely determine whether product development

programs are successfully completed on schedule. The content is relevant for both OEMs and suppliers.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the importance of effectively managing 'soft-side' issues that cause problems and delays during product development programs
- Employ successful practices of chartering and launching teams
- Implement techniques to successfully lead and facilitate effective teams
- Effectively troubleshoot problems on a team and employ techniques to remain productive
- Implement proven tips for conducting effective team meetings

Who Should Attend

Engineers and business people involved in various product development team activities will find the subject matter practical and useful. The content is of particular value to professionals from engineering, manufacturing, purchasing, quality, marketing, and finance functions in ground vehicle OEMs and suppliers.

Topical Outline

- Designing High Performance Team
  - Characteristics of effective teams
  - Systems aspects of team design
  - Addressing systemic variables
  - Identifying key stakeholders
  - Establishing the team's charter
- Leadership and Group Dynamics
  - Responsibilities of the team leader
  - Understanding human behavior in groups
  - Motivating team members
  - Establishing a productive team culture
  - Developing team support
  - Productive and destructive team roles
  - Effective communications
  - Influence of personality styles
- Launching the Team
  - Stages of team development
  - Pre-meeting considerations
  - Selecting the team
  - Common reasons meetings fail
  - Managing the first team interface
  - Establishing group norms
  - Structuring the agenda
- Making Sound Decisions
  - Situational analysis: problems, decisions and polarities
  - Common errors in decision making
  - Essential steps in the decision process
  - Quality and acceptance factors in decision making
  - When to use and avoid group consensus
  - Identifying the decision makers
  - Facilitating consensus decisions
- Flawless Facilitation
  - Recognizing and defusing common group problems
  - Managing conflict and providing feedback
  - Mind mapping, story boarding and other techniques
  - Making work assignments
  - Assessing group performance
  - Concluding the meeting

Instructor: Joseph Doyle
Fee $1225 1.3 CEUs

Managing Engineering & Technical Professionals

3 Days
I.D.# C0608

In the fast paced and competitive environment of today's global economy, the work of technical professionals is often the difference between success and failure in an organization. Providing leadership for engineers is uniquely challenging, and the transition from working engineer to first-line technical supervisor is one of the most difficult career challenges that an engineer may face. First-time engineering supervisors and mid-level managers who wish to sharpen their skills and learn new techniques for guiding, coaching, and motivating working engineers, technicians, and designers will find this seminar valuable. A mix of lecture and attention-grabbing exercises are used to develop intense and lasting learning results.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the basic value proposition of management: what managers bring to an organization that makes them worthwhile
- Avoid the most common errors that supervisors and managers make
- Describe the evolution of management thought, and utilize the latest proven concepts for improving the performance of people in complex organizations
- Explain the issues that drive the psychology of effective leadership and develop greater emotional intelligence
- Implement strategies to enhance your skills in meeting management, coaching, and performance review that are essential in today's professional workplace

Who Should Attend

Engineers and technical professionals who are either recently promoted into a management position, or have some experience as a manager but would like to learn how to become more effective will benefit from attending this workshop. The concepts and skills developed during this interactive experience will be of interest to those involved in product development, manufacturing, service, or quality engineering, and all related technical activities in automotive, aerospace, manufacturing, and off-highway industries.

Topical Outline

DAY ONE
- The Management Perspective - How Managers Earn Their Keep
  - The value proposition of management
  - The "Peter Principle" and how to avoid this trap
  - Understanding the most important errors that managers commonly make - and how to steer clear of major supervisory pitfalls
  - Why people usually struggle to cooperate, and how you can reduce this
- What You Need to Know about Today's Workforce
  - The evolution of leadership thought, and why recent events have significantly changed effective leadership methods
  - Understanding what leadership is really about
  - Why teamwork and cooperation are necessary in modern corporate structures
  - How you can generate consistent focus and daily commitment among technical and engineering professionals
  - Playing "The Tower Game" - applying focus and commitment
- The Psychology of Successful Modern Leadership
  - Process centered leadership: getting sustained results
  - Task and relationship balances

- Why "Output Leadership" is ineffective and counter-productive
- Different kinds of team models - and which is most effective
- How to reduce the influence of "bad" politics in an organization through constructive decision making processes

DAY TWO
- The Psychology of Change
  - Why change is often stressful
  - Five stages of change
  - How to make change exciting and interesting
- Emotional Intelligence: Building an Effective Leadership Style
  - Why "emotional intelligence" is important - the research results
  - The five elements of emotional leadership
  - How to practice and develop greater emotional intelligence
  - Solving typical meeting problems with emotional intelligence
- Coaching in Supervision
  - Building trust
  - Coaching roles
  - Improving communication for constructive coaching
- Using Meeting Time Effectively
  - Five key issues for successful meetings
  - How teamwork breaks down in meetings, and how to correct this

DAY THREE
- Dealing with Practical Issues
  - Dealing with difficult people
  - Learning how to delegate effectively
- Basic Negotiation Principles
  - Soft & hard negotiating approaches
  - Win-win negotiation
  - Positions, interests, & goals
- How to Make Performance Reviews Constructive
  - Legal requirements
  - Style issues
  - 360 reviews

Instructor: Michael A. Anleitner
Fee $1595 2.0 CEUs

Patent Law for Engineers

1 Day
I.D.# 88007

This information-packed seminar focuses on the intricacies of patents, patent infringement litigation and patent licensing. Attendees will explore the important subjects of obtaining U.S. and foreign patents, maintaining U.S. and foreign patent rights, enforcing patent rights, defending against patent rights asserted by competitors, and licensing patent rights for revenue. After this seminar, you will effectively understand patents and ways to protect your company's valuable inventions. Your new knowledge will help your company maintain and enhance its position in the marketplace.

Learning Objectives

By attending this seminar, you will be able to:
- Assess which product developments and improvements are potentially patentable
- Describe the process for obtaining and maintaining patent protection
- Cite the anatomy of, and costs associated with, a patent infringement lawsuit
- Identify the opportunities associated with patent licensing
- Summarize patent system reform proposals

Who Should Attend

Participants should have a mid- to upper-level managerial role. Research and development, in-house legal staff members such as in-house lawyers, patent agents, or patent liaisons will especially benefit.

Topical Outline

- Introduction to Patents and Patent Law
  - Explanation of why patents have become so important to business and why there has been a dramatic increase in the number of patent lawsuits and magnitude of damages awards in these patent lawsuits
  - Definition of a Patent
  - Eligibility for Patent Protection
- Obtaining Patent Protection
  - U.S. Protection -- Conception and Reduction to Practice; Prior Art Searches; Preparing an application; Prosecuting the application; Ownership of patent applications/patents
  - Foreign Protection
- Maintaining Patent Protection
  - Maintenance fees
  - Foreign working requirements
- Enforcing Patent Rights
  - Notice letters
  - Infringement suits
  - Licensing
- Patent Infringement Litigation
  - Proving infringement
  - Willful infringement
  - Defenses to allegations of infringement
  - Remedies for any infringement
- Licensing Patented Technology
  - Types of License Grants -- Exclusive; Non-exclusive
  - Permissible limitations
  - Impermissible limitations
  - Royalties

Instructors: Russell E. Levine or David K. Callahan
Fee $725 .7 CEUs

Patent Litigation in the U.S.: What You Need to Know Webinar

I.D.# WB0940

In today's economic environment, patents have become an increasingly important asset for both individuals and corporations. More and more, individuals and corporations, including those in the automotive and aerospace industries, are recognizing that revenue can be generated from their patent rights, whether those rights consist of a single patent, a family of patents or an entire portfolio. Indeed, some companies do not make or sell products; their entire revenue is derived from the licensing of their patents. Suffice it to say, licensing revenue has become a significant source of value in the global intellectual property economy. This webinar will tell you what you need to know about U.S. patent litigation and will provide in-depth insights into the practical realities of patent disputes in the U.S. You will learn what's involved in a patent case, including the issues that the patent owner has to prove, e.g. infringement, and the issues the accused infringer has to prove, e.g., invalidity. You will increase your awareness of the role of the judge and the jury in patent cases and you will hear about the increasing use of alternative dispute resolution mechanisms, such as mediation, to resolve patent disputes. Among

other topics, this course also will increase your appreciation for the time it typically takes to go from the filing of a case to trial, and the fees and expenses associated with the case.

Learning Objectives

By connecting with this webinar, you will be able to:
- Obtain an overview of U.S. patent litigation
- Explain the basic legal principles for liability and damages in patent cases
- Gain insights into how patent disputes are resolved
- Predict the fees and expenses associated with bringing and/or defending a patent case in the U.S.
- Anticipate the scope of discovery in, and/or business disruption arising from, a U.S. patent case
- Peek into the future of potential patent law reform

Who Should Attend

This course is geared toward executives, in-house counsel, in-house patent agents, and senior managers across industries, such as automotive and aerospace. Participants may be both U.S. and non-U.S. -- anyone who needs help in understanding what to expect and what the realities are should they become involved in U.S. patent litigation.

Topical Outline

Session 1
- Overview of Patent Litigation
  - Issues the patent-owner has to prove
  - Issue the accused infringer has to prove
- What is the Scope of Discovery?
  - Documents, including e-documents
  - Depositions
  - Third parties (e.g. customers, suppliers)
  - Confidentiality of discovery materials
- Who Decides Liability and Damages?
  - Jury
  - Judge
  - Mediator/Arbitrator

Session 2
- How Long Does it Take from Filing to Trial?
  - District Courts
  - ITC
- How Much Does it Cost?
  - Fees and expenses
  - Contingency fees
  - Recovery of fees and expenses
- What Changes are on the Horizon?
  - Supreme Court
  - Patent law reform

Instructor: Russell E. Levine
Fee $395 .4 CEUs

Principles of Cost and Finance for Engineers

3 Days
I.D.# C0828

In today's corporate environment of shrinking budgets, required structural cost reductions, sharing of global designs/services, and pricing pressures, it is critical that engineers possess a working knowledge of engineering economics principles. To fully understand the economic viability of engineering decisions, engineers need to find the appropriate balance between design alternatives, resulting costs, and impact on their enterprise. This seminar introduces participants to the cost, finance and economic concepts and their applications to products and services. This three-day course provides you with practical information normally obtained through university level economics and business management courses and will help you to maximize efficiencies from both an engineering and economics perspective.

Note: Attendees are requested to bring with them a business or scientific calculator capable of doing exponential calculations.

Learning Objectives

By attending this seminar, you will be able to:
- Make and justify financial decisions using sound economic principles
- Use current economic strategies to reduce costs and improve productivity
- Estimate capital and manufacturing or services costs
- Identify the relationship between direct and marginal costs in the decision-making process
- Execute strategies for resource allocation and cost-control measures
- Identify viable project alternatives with respect to materials, processes, and tooling
- Analyze make-buy and buy-lease options and make decisions based on the best financial strategies

Who Should Attend

This seminar will benefit engineers having responsibilities in manufacturing, maintenance, research, design, product and process development, program and project management, troubleshooting, and materials management. Additionally, individuals in non-engineering disciplines, including marketing and general management, will benefit from an introduction to the engineering perspective.

Prerequisites

Individuals holding an engineering degree in any discipline, combined with experience in the transportation or similar industry will benefit the most from this course.

Topical Outline

DAY ONE
- Process & Responsibility for Determining Cost
- Understanding Finance and Accounting Basics
  - Finance and accounting terminology
  - Financial statements -- Balance sheets; Income statements; Cash flow statements
  - Ratios: finance and performance
  - Sources of capital
  - Allocation of capital
- Time Value of Money and Decision Making
  - Interest: simple and compounded
  - Inflation

- Worth: present and future values
- Return On Investment -- Minimum acceptable rate of return; Internal rate of return; Discounted payback period; Contribution Margin & Net Income
- Benchmarking
- Case Study

DAY TWO
- Cost Impact on the Enterprise
  - Cost of capital -- Dividing financial resources; The costs of financing
  - Cost of Ownership -- Depreciation; Accelerated cost recovery; Depletion
  - The influence on tax obligations
- Make-Buy and Buy-Lease Decisions
  - Cost -- Capital; Manufacturing; Productivity
  - Responsibilities for capital
  - Replacement or repair
- Case Study

DAY THREE
- Elements of the Production Process
  - Costs -- Material; Labor; Overhead
  - Pricing influences -- Quality; Competition
- Costing Strategies
  - Activity Based
  - Throughput
  - Absorption
  - Direct
- Determining costs
  - Direct/variable
  - Indirect/fixed
- The Breakeven Relationship
- Cost Control Alternatives
  - Materials
  - Processes
  - Location
  - Purchasing
- Case Study

Instructor: James Masiak
Fee $1545 2.0 CEUs

Product Liability and The Engineer

1.5 Days
I.D.# 82001

In the past few decades, product liability law has dramatically changed the manufacturer's outlook in the design and manufacture of product. The concept of safety and reliability has been altered from a purely engineering/manufacturing concept to a legal/manufacturing approach. This new approach requires an understanding of legal concepts as related to the manufacturing and design process. The engineer's role has shifted to include a safety audit analysis to minimize the existence of a product defect and/or to defend the product in a way that is responsive to the legal concerns. An overnight assignment will be made by the instructor. It will consist of problems drawn from actual cases and a group project that examines the design, instructions, and warnings of a product.

Learning Objectives

By attending this seminar, you will be able to:
- Relate legal concepts as they apply to the manufacturing/design process
- Use safety audit analysis techniques to minimize or eliminate product defects during design, thus reducing product liability
- Discuss defense of product from a legal perspective
- Recognize the importance of potential liability as it relates to the manufacturer

Who Should Attend

Persons responsible for product design, including managers and designers; corporate risk managers; persons responsible for developing and approving product instructions and warnings; marketing personnel; production and quality assurance managers and personnel; personnel responsible for product safety and those persons, including lawyers, who oversee and manage product liability issues.

Prerequisites

Participants should have an undergraduate engineering degree or commensurate experience in manufacturing or product liability.

Topical Outline

(Day two will end at approximately 1:00 p.m.)
- Legal Concepts
  - Negligence: elements, defenses
  - Strict liability: section 402A (elements, defenses)
  - Warranties: express, implied
- Analysis of Defect
  - Meaning of unreasonable danger
  - Production defect
  - Design defect
  - Defect by words
- Designing for Reasonable Safety
  - Products' use, users & environment
  - Product safety audit
- The Role of Standards in Design
- Warnings
  - Guidelines for design & warnings
  - Functions & use
- Problem Analysis by Participants
- Review of a Product Design by Participants

Instructor: Charles F. Seyboldt
Fee $1155 1.0 CEUs

Program and Risk Management

2 Days
I.D.# C0409

This course presents a proven eight-step method for program planning and control, including: definition of customers' requirements, roles of the program team, determination and flowcharting of program tasks, scheduling and costing, quality aspects of critical tasks, and risk management. Easy to grasp, each of the eight steps evolve from common-sense questions that should be answered for any program, regardless of size or complexity.

With shortened development cycles and greater reliance on information in programs, this course emphasizes the value of communication within a program team, between the team and functional areas, and between the team and the program customer. Since the appropriateness of communication vehicles vary depending on purpose and audience, alternative modes of communication and change control are discussed.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the eight-step method for program planning and control
- Implement the eight-step method to improve program outcomes as measured by cost, schedule and quality
- Make plans and progress visible to team members and to the program customer

Who Should Attend

Engineers and business people involved in various product development team activities will find the subject matter practical and useful. The content is of particular value to professionals from engineering, manufacturing, purchasing, quality, marketing, and finance functions in ground vehicle OEMs and suppliers.

Topical Outline

- Program and risk management overview
  - Process approach to planning programs
  - Competition drives us to perform better
  - Why programs sometimes fail
  - Reference materials and website
- Defining program outcomes and measurables
  - Building quality and performance targets into program planning
  - Financial impact of poor planning
  - Roles and responsibilities of project team members
  - Design reviews
  - Product performance measurement
  - Program/project metrics
- Team formation and task planning
  - Team development
  - Roles and responsibilities
  - Matrix management
  - Meeting management
- Scheduling work
  - Critical Path calculation
  - Fast tracking
  - Developing a baseline schedule
  - Gantt chart creation
  - Software tools for scheduling
  - Software tools for program management
- Resource planning
  - Resource planning (quantity, skills, resource conflicts, anticipating needs)
  - Adding contingencies
  - Constraint management
- Risk Management
  - Proactive assessment and mitigation of risks
  - Types of risk
  - Failure mode and effects analysis applied to programs/projects
- Optimizing work performance
  - Spheres of influence and control
  - Cause-effect diagrams
  - Assessing critical information flows
  - Managing human performance
  - Responsibility matrix (RASIC)
- Project initiation
  - Establishing a war room
  - Authorization to begin
  - Meeting management
- Tracking program performance

Instructor: Murray Sittsamer
Fee $1265 1.3 CEUs

Root Cause Problem Solving: Methods and Tools Webinar

8 Hours
I.D.# WB0931

Tough times require searching for things that we can change and making them better. But so often problems are solved with 'band-aids' and not root cause solutions. This approach is getting too expensive and at best only helps companies tread water. To combat these issues and adopt a fresh approach, teams can use the methods and tools of Root Cause Problem Solving to first view problems as opportunities for improvement, identify root causes and implement solutions to prevent recurrence. Benefits include improved quality and customer satisfaction, reduced operation costs, and greater employee knowledge of work processes. This proven 8-step approach to problem solving will help improve operational and financial performance by identifying causes and implementing solutions to significant or recurring problems. This approach to problem solving is used by many major automotive manufacturers.

Learning Objectives

By connecting with this webinar, you will be able to:
- Describe the 8-Step Problem Solving Methodology
- Define the difference between Symptom and Root Cause
- Use tools and techniques to solve problems
- Evaluate effectiveness of problems solving efforts
- Describe the role of problem solving in continuous improvement
- Write an action plan to apply problem solving to a specific concern

Who Should Attend

This course is applicable to those directly working in or responsible for performance improvement of any definable, repetitive process, e.g. manufacturing, design, logistics, purchasing, sales, or distribution, including:
- Manufacturing managers, supervisors and team leaders
- Manufacturing engineers
- Design engineers
- Quality engineers and technicians
- Technical managers
- Project team leaders
- Problem solving and quality improvement facilitators
- Anyone whose role includes problem solving; therefore all supervisors and lead personnel

Topical Outline

Session 1
- Overview
  - Following a process approach
  - What is a problem?
  - Inhibitors to effective problem solving
  - 8-step problem solving process overview
- Step 1: See the Problem as an Opportunity
  - Framing the problem solving effort
  - Identifying team members
  - Team roles
- Step 2: Describe the Problem
  - Symptoms vs. Causes
  - Methods for describing the problem
  - Using and charting data
  - Problem Is/Is-Not analysis

Session 2
- Step 3: Implement Containment
  - Protect the Customer

- Process Control Plan
- Step 4: Recognize Potential Root Causes
  - Identifying possible causes
  - Process Maps
  - Cause-Effect diagrams
  - 5-Why tool

Session 3
- Step 5: Design Solution
  - Solutions that don't work
  - Process Controls and Error Proofing
  - Standardized Work
- Step 6: Implement Permanent Corrective Actions
  - Plan the work
  - Complete system changes
  - Verify effectiveness

Session 4
- Step 7: Prevent Recurrence
  - Was the problem eliminated?
  - Layered audits
  - Leverage learnings with FMEA
- Step 8: Recognize Efforts
  - Team debrief and lessons learned
  - Evaluate and celebrate success
- Summary
  - Sufficiency checklist for effective problem solving
  - Continuous Improvement

Instructor: Murray Sittsamer
Fee $585 .8 CEUs

Strategic Leadership

3 Days
I.D.# C0620

As a strategic leader, it is your responsibility to ensure that your organization is moving in the right direction. Executives and high-level managers must have the practical insight necessary to address competitive business challenges. Each segment of this three day course is designed to impart simple, but powerful lessons that will equip participants to more fully engage in strategic discussions, ask pertinent questions, facilitate critical decisions and shape high performing organizations. In addition, the course provides students with a personal leadership profile that illustrates their strengths and potential limitations. Participative exercises assist emerging executives with practical and effective methods of gaining organizational credibility and avoiding common errors in strategic leadership.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the role and responsibilities of strategic leadership
- Manage the critical factors that drive the success and failure of business strategies
- Anticipate the longer term impact of strategic initiatives
- Attain credibility and support as you assume the helm of a new operation
- Avoid common errors made by leaders in transitioning to higher levels of responsibility
- Select the most effective approaches when framing strategic decisions
- Think strategically and systemically as you plan organizational change
- Influence the emergence of a more positive and functional corporate culture
- Eliminate turf battles, dropped balls and organizational duplication of effort
- Analyze and correct dysfunctional organizational dynamics
- Manage the strengths and limitations of your personal leadership style

Who Should Attend

This seminar is designed for executives, senior level managers, and engineering managers or technical specialists who are called upon to formulate or provide input into strategic decisions and business strategies.

Topical Outline

- Introduction to Strategic Leadership
  - What exactly do we mean by leadership?
  - Who is and is not a leader?
  - At what point do we become leaders?
  - Critical elements of leadership support
  - Managing versus leading - is there really a difference?
  - Critical factors in assessing leadership performance
  - The relationship between leadership, strategy, human behavior, decision-making and organizational systems
- Understanding the Human Dimension
  - Similarities between animal behavior and human behavior
  - Influence of brain structure on human behavior
  - Creating long term employee motivation
  - Rules of thumb for predicting human behavior in organizations
  - Recognizing the symptoms of pathological leadership
  - Managing and defusing dysfunctional behavior
- Assuming the Helm
  - Managing the transition to a new workgroup
  - Common and avoidable errors of leadership
  - Developing and maintaining the support of your workgroup
  - Simple, but effective steps to improve workgroup performance
- Shaping Corporate Culture
  - Understanding the critical components of corporate culture
  - Forming productive organizational norms
  - How leaders contribute to dysfunctional cultures
  - Establishing a high performance work environment
- Creating Organizations that Work
  - Creating an organizational charter
  - Selecting an effective management team
  - Thinking systemically
  - Importance of managing image and expectations
  - Creating meaningful performance indicators
  - Eliminating turf battles and duplication
  - Limitations on the application of common systems
- Facilitating Strategic Decisions
  - Critical distinctions between problems, decisions and polarities
  - How to properly frame a decision
  - Selecting the decision makers
  - Common errors in decision making process
  - Essential elements of effective decision making process
  - Knowing when the decision has been made
- The Leader's Role in Creating Effective Strategies
  - What exactly is a strategy?
  - Why business strategies fail
  - Internal and external considerations
  - What constitutes effective strategy?
  - Anticipating the impact of adaptive responses
  - Framing strategic initiatives
  - Barriers to strategy implementation
- Leading Strategic Change
  - Planning a change initiative
  - Critical variables in organizational change
  - The leader's role in fostering change

- Anticipating and dealing with resistance
- Culture as a barrier to change
- Political Reality versus Dysfunctional Idealism
  - Gaining credibility in executive circles
  - Sources of leadership power
  - How power is gained and lost
  - The importance of building networks and relationships
  - How to avoid getting derailed
- Lessons of History for Strategic Leaders
- Developing a Leadership Profile
  - Charting your personal leadership profile
  - Identifying your leadership assets and liabilities
  - Creating a plan of action

Instructor: Joseph Doyle
Fee $1585 2.0 CEUs

Successfully Working in Virtual Teams

2 Days
I.D.# C0943

Managing engineering teams in the best of circumstances is often a challenge. In virtual and distributed teams, these challenges can be significant. Today's engineering teams consist of members participating from various sites and cities. In some cases, teams are formed among members from across the globe, bringing with it its own set of unique social and cultural differences and creating new challenges for team members and those that lead them. With shrinking corporate budgets and more demands of employees' time, organizations are increasingly reliant on virtual teaming as a necessary means by which to deal with increased customer expectations, competition, time, pressure, and rapid change. While virtual teams can provide real benefits to organizations, they often present new challenges to project leaders who are not prepared for the realities of getting things done at a distance. Research systemically shows that virtual teams suffer from a high failure rate: Enthusiasm is simply not enough. This seminar features cutting-edge information and critical tools to enable you to overcome the barriers of distance, cultural diversity and lack of time, while maintaining communication through collaborative technology. It will help you develop the tools necessary to manage distributed teams while strengthening working relationships and operational effectiveness across multiple sites supported by team members you rarely see "face-to-face".

Learning Objectives

By attending this seminar, you will be able to:
- Identify the unique characteristics of successful global virtual teams
- Develop a culture of team spirit and community within virtual teams
- Recognize the importance of effective team start up, team leadership and team processes
- Evaluate how cross-cultural differences affect team performance
- Understand the various individual "team styles" within a team
- Evaluate the range of collaborative technologies and how to put a communication plan in place
- Recognize essential elements of trust and why trust is critical to success
- Identify the critical success factors for high performance distributed teams

Who Should Attend

Engineers, technical professionals and business people who work in distributed environments will find the subject matter practical and useful. Human resource and education / training professionals who prepare people to work successfully in these environments will also find particular value in this content. It is also appropriate for university faculty interested in preparing students for success in a changing workplace environment.

Prerequisites

There are no specific prerequisites required.

Topical Outline

DAY ONE
- Virtual/Distributed Team Working
  - Defining virtual team working
  - Why companies use virtual teams
  - The realities of effective virtual team working
  - Reasons why many virtual teams fail
  - Proficiency framework for successful virtual teams
- Optimizing Team Roles
  - Insight into the Belbin team roles model
  - How did the concept originate?
  - Characteristics of each of the roles
  - Application of the Belbin model to our virtual team work
- Working With Cross Cultural Diversity
  - Examining the pros and cons of diversity in a virtual team
  - What do the cultural experts say?
  - The "Cultural Onion" - a useful framework for examining culture
  - Cultural profiling - recognizing cultural differences and how to manage them
  - Effective Global Communication - International/Offshore English
  - How to adapt to the needs of non-native speakers
  - Developing perceptiveness, transparency and listening for communicating in an unfamiliar cultural context

DAY TWO
- Effective Distributed Team Start Up, Team Leadership, and Team Processes
  - Aligning diverse and distant individuals to a common vision, goals and methodologies
  - Making the activities of the team visible to the rest of the organization
  - Combating confusion, ambiguity, conflict and isolation with team members
  - Tracking work flow and knowing the specific questions to ask off-site teams that will tell you how things are really going
- Selecting and Optimizing the Right Technology
  - Initiating a communication contract
  - Hardware and software needs for team members
  - Storage of documents (team website, shared file, etc.)
  - Acquisition of new technology (groupware, electronic meeting rooms, etc.)
- Communication Technology: E-Mail
  - E-mail protocol for distributed global teams
  - Achieving balance between high context and low context e-mail styles
  - Dealing with conflict and problems in e-mails
  - Writing an e-mail that achieves universal clarity
  - What do your e-mails say about you?
  - Real business e-mails from different countries
- Trust in a Virtual Team
  - What is the essence of trust?
  - Why is trust crucial to the success of a distributed team?
  - Type of trust required by diverse members
  - How can we build trust when we don't see each other?

- Examining the 10 trust criteria and their importance for an effective global virtual team
- Identifying behaviors and actions required to build and maintain trust

Instructor: Johanna Hassan Hollowich
Fee $1225 1.3 CEUs

Systems Engineering for Front Line Leadership

2 Days
I.D.# C0902

Systems Engineering is a proven and effective way of coordinating the complexity of major projects in the design and manufacture of aerospace products. This two day seminar will provide the front line leader with high level insights into the key issues associated with the successful implementation of the Systems Engineering process on any program, large or small. Key issues addressed in this seminar will include:

- The value of a System Engineering Management Plan (SEMP)
- The need for a fully integrated Systems Engineering Master Schedule (SEMS) and a Systems Engineering Detail Schedule (SEDS)
- The establishment of multidiscipline teams
- The effective use of reviews
- Integrating the responsibilities of Project/Program Management with Systems Engineering
- The effective use of simulation tools
- Following a systematic approach to System Development Systems Engineering is used to insure that designs meet customer's requirements and also efficiently manage the all important cost, schedule and risk elements associated with the design, manufacture, test, delivery and support of product end items and their associated deliverables. Understanding the principles associated with this widely accepted and structured process can significantly enhance the success of project leadership.

Learning Objectives

By attending this seminar, you will be able to:

- Describe basic key issues associated with the Systems Engineering process
- Define and use Systems Engineering terminology
- Describe how to propose, plan and estimate Systems Engineering based programs and their deliverables
- Apply lessons learned regarding high performing Systems Engineer teams
- Define the Systems Engineering "Big Picture" and the environmental needs to make execution successful

Who Should Attend

This seminar is designed for first line engineering team leadership. Senior managers responsible for the oversight of multiple integrated product teams as well as chief engineers, program managers and project managers will also find value in this course.

Prerequisites

A basic understanding of disciplines associated with managing the design, development, manufacture, delivery and support of a product is required.

Topical Outline

DAY ONE

- Systems Engineering Basics
  - Systems engineering overview
  - Becoming a high performing systems engineering leader
  - Systems engineering ethics
- Systems Engineering Process Outputs
  - Systems engineering management plan (SEMP) -- Technical program planning and control element; Systems engineering processes used element; Engineering specialty integration element
  - Systems engineering master schedule (SEMS)
  - Systems engineering detail schedule (SEDS)

DAY TWO

- Systems Engineering Process Reviews and Interfaces
  - Multidisciplinary teams (integrated product teams or IPTs)
  - Effective use of reviews -- Red, pink etc teams; Independent cost evaluations (ICE); Preliminary design reviews (PDRs); Critical design reviews (CDRs); Independent non-advocate reviews (INARs); Program management reviews (PMRs)
  - Integrating with project/program management
- Systems Engineering Tools and Workshop
  - Establishment of common tools and databases
  - Simulation tools
  - A systematic approach to system development
  - Workshop - team project

Instructor: Howard (Lon) Scott
Fee $1225 1.3 CEUs

The Role of the Expert Witness in Product Liability Litigation

1.5 Days
I.D.# 92054

According to the Federal Rules of Evidence, an expert witness is anyone who can assist the trier of fact (the jury) in understanding any issue in dispute at trial. The witness' ability to give this assistance can be derived from any specialized training, education, background, or experience. To be effective in providing this assistance, however, requires that the expert witness understand the true role that he or she is to play both before and at the trial. This seminar will address the critical issues that every person who may be, has been, or is, an expert witness must understand to assist both the attorney and the product manufacturer, regardless of which side the expert serves.

Learning Objectives

By attending this seminar, you will be able to:

- Employ the risk/utility balancing process necessary for effectively addressing the issue of design defect
- Recognize the critical elements that govern the interaction between human behavior and product behavior
- Apply the technical/legal elements that will enhance your effectiveness as an expert witness

Who Should Attend

This seminar is intended for anyone who is or may become an expert witness in product liability litigation. In-house experts typically have engineering, engineering management or field technician responsibilities. In addition, insurers, risk managers, corporate product safety personnel, attorneys and those who manage product

liability litigation will benefit from insight into selecting and using expert services and witnesses more effectively and efficiently.

Topical Outline

(Day two ends at 1:00 p.m.)
- The Legal Framework of Negligence and Strict Liability
- The Relationship Between the Attorney and the Potential Expert Witness
- Investigation of an Accident Years After an Occurrence
- Developing the Background Necessary to Understand the Product and its Environment
- Understanding How to Allege or Refute the Existence of a Product Defect
- Analyzing the Role of Human Behavior and its Relationship to the Cause of an Accident
- Guidelines for Effective Presentation Before Trial and on the Witness Stand
- The seminar will also include overnight problem assignments and a demonstration of direct and cross-examination of an expert witness.

Instructor: Charles F. Seyboldt
Fee $1155 1.0 CEUs

Understanding the FAA Aircraft Certification Process

2 Days
I.D.# C0821

The task of certifying an aircraft or part can be overwhelming given the lengthy process and the many steps that are required. Understanding the process can greatly enhance the outcome and reduce unnecessary delays or frustrations. This course will provide an overview of the Federal Aviation Administration (FAA) organizational structure, its policies, guidelines and requirements leading to Type and Supplemental Type airworthiness approvals. It will also cover the rule-making process and rules applicable to aircraft parts and products. The course will define the roles and responsibilities of the Aircraft Certification Office (ACO), Manufacturing Inspection District Office (MIDO), Flight Standards District Office (FSDO), and the Aircraft Evaluation Group (AEG). Type and Supplemental Type Certification (TC and STC) processes, and Change Product Rule for alterations and modifications to previously type certified aircraft will be discussed. FAA rule-making process will be examined including review of FAA Orders, Notices, Advisory Circulars and other guidance material.

Learning Objectives

By attending this seminar, you will be able to:
- Manage certification programs more efficiently, schedule the required milestones accordingly, and identify problems and address them promptly
- Describe the principles of Type Certification and Supplemental Type Certification requirements and process
- Converse intelligently and enter negotiations with others involved in FAA certification programs
- Describe the FAA system, FAA orders, Advisory Circulars, FAA rule making process
- Define what exemptions and special conditions are and how to obtain them
- Identify the difference between airworthiness standard and operational rules

Who Should Attend

This course is designed for engineering and certification managers, design engineers, airworthiness and certification engineers, quality assurance inspectors and engineers, program managers, consultants, Federal Aviation Administration designated engineering and airworthiness representatives (DER and DAR) and other technical administrative personnel involved in FAA certification activities. The course will help newcomers to aircraft certification as well as experienced attendees better understand the certification process and be able to present and negotiate certification matters with the Federal Aviation Administration Aircraft Certification Office.

Topical Outline

DAY ONE
- FAA History, Organization and Hierarchy
  - FAA certification “lingo”
  - FAA system organizational chart and hierarchy
  - How regulations are developed
- FAA Roles and Responsibilities
  - Aircraft Certification Office
  - Manufacturing Inspection District Office
  - Flight Standard District Office
  - Aircraft Evaluation Group
- Issue Papers - What They Are and How They Are Used
  - Exemptions
  - Special conditions
  - Equivalent level of safety
- Certification Basis
- Change Product Rule

DAY TWO
- Type Certificate Data Sheet - The “Birth Certificate” of an Airplane
- Documents and How to Develop Them
  - Airplane Flight Manual Supplements
  - Instructions for Continued Airworthiness
  - Type Inspection Authorization
  - Request For Conformity
  - Certification Plan
  - Conformity Plans
- FAA Advisory Materials
- Support Documents
  - Parts Manufacturing Authorization
  - Technical Standard Order
  - Field approvals
  - FAA Form 337 approvals
  - 8110-3 approvals
- Type and Supplemental Type Certification Process
  - Certification Plans and FAA coordination
  - Data generation and approvals
  - Conformity inspections
  - Testing
  - Approvals

Instructor: Ken Farsi
Fee $1225 1.3 CEUs

Design for Manufacture and Assembly (DFM/DFA) 84
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Design for Manufacture and Assembly (DFM/DFA)

2 Days
I.D.# C0418

This seminar provides a functional understanding of the principles involved in conducting a Design for Manufacture/Design for Assembly study. DFM/DFA can support both manual and automated processes resulting in significant cost savings through simpler designs with fewer components. Related topics include workstation layouts, ergonomic considerations and errorproofing. Actual examples from the automotive industry are used to support the lecture and participants complete actual design efficiency using the DFM/DFA worksheet.

Learning Objectives

By attending this seminar, you will be able to:
- Recognize and list the benefits of the DFM/DFA method in creating product designs which support manufacturing processes leading to short and long term product cost savings
- Outline a Robust Manufacturing Plan that optimizes and simplifies product design without sacrificing quality
- Objectively determine which designs would be suitable as DFM/DFA candidates
- Perform the essential stages of a Design for Manufacture process including the analysis required to overcome typical manufacturing difficulties encountered in product design
- Construct an actual DFM/DFA worksheet and calculate design efficiency using an instructor provided project

Who Should Attend

Product Engineers, Designers and Managers, Manufacturing and Tooling Engineers, and Project Managers who desire to understand DFM/DFA as a product design tool to increase manufacturability of product assemblies. The course is best suited for individuals in the manufacturing industry and is beneficial to OEMs and Tier suppliers.

Topical Outline

DAY ONE
- Introduction to DFM/DFA and DFM/DFA objectives
  - DFM, DFA and Product Life Cycle
  - Six Steps of the DFM/DFA Life Cycle Model
  - DFM and DFA advantages and challenges in a Product Development environment
- Design Considerations
  - Creating the DFM/DFA Environment
  - Guidelines for selecting DFM candidates
  - Integrating FMEA and DFM/DFA
  - Material Selection process
  - Project Cost Estimation
  - DFM Worksheet, Tables and Terms Defined
  - Minimizing part count using the Minimum Part Criteria
  - Finalizing the Critical Design Characteristics
  - DFM introductory project Day Two
- Design Considerations (cont)
  - Operator Interface Considerations - Handling, Insertion, and Fastening issues
  - Calculating initial design efficiencies
  - Prioritizing Design Improvement efforts using the Worksheet codes
  - Finalizing DFM project
- Process Considerations
  - Workplace Layout
  - Methods of Assembly
  - Lean Production Metrics
  - Errorproofing
- Introduction to DFM Concurrent Costing
- Total cost savings through DFM and DFA

Instructor: Angelo Mago
Fee $1225 1.3 CEUs

Fundamentals of Statistical Process Control

2 Days
I.D.# C0553

As competition for market share increases, so does the need to monitor processes and quality to ensure top-notch products. This hands-on seminar will provide you with the skills to apply and maintain statistical process control to assist your organization in the improvement of various processes to achieve higher percentage yield or higher quality products or services. Quality characteristics (process outputs to track), measurement systems, sampling strategies, types of control charts, construction of control charts, and control chart interpretation will be covered. The determination of the key process parameters and controlling them to provide consistent results will improve quality and lower costs, in particular, scrap and rework costs. Statistical theory and depth are kept to a minimum while you learn how to utilize the tools.

Attendees will receive a copy of the *Statistical Process Control Manual* (SPC-3, 2nd Edition) by the Automotive Industries Action Group.

Learning Objectives

Upon completion of this seminar, you will be able to:
- Describe the purpose and uses of SPC
- Select the best measurement system to use for a specific application
- Identify an appropriate process sampling strategy
- Determine the basic type of control chart to use
- Collect data and construct basic control charts
- Interpret control chart results

Who Should Attend

Quality managers, engineers, and technicians, project engineers, manufacturing engineers, technical specialists and anyone with responsibility for product or process control who want to apply SPC in the workplace should attend this seminar. Individuals seeking to attain the Certified Quality Engineering status within the American Society for Quality will find this course particularly helpful.

Prerequisites

Participants should have at least high school mathematical and graphing skills, and a good technical understanding of products, processes, and measuring devices in their work environment.

Topical Outline

DAY ONE
- Introduction
- Viewpoints and Determinants of Quality
- SPC: Part of a Product Quality System
  - SPC philosophy: prevention versus detection
  - Process control system
  - Causes of variation: common and special
  - Reactions to causes of variation
  - Requirements and specifications
  - Control charts: SPC tools
  - Benefits of SPC
  - SPC implementation process
- Quality Characteristic Determination
  - Everything is a process
  - Process flowchart and functions
  - Quality characteristics generation -- intermediate/final; variable/attribute
  - Critical characteristics determination -- final customer requirements; subsequent process requirements
  - Process example
- Quantification (measurement) of Quality
  - Types of characteristics -- variable; attribute
  - Methods of measurement and measurement systems
  - Measurement system capability
- Sampling Strategy
  - Sample size
  - Sample frequency
  - Sample structure
- Quality Planning Workshop
- Basic Control Chart Types
  - Variable: X and R charts -- AIAG example; workshops

DAY TWO
- Basic Control Chart Types (continued)
  - workshops
  - process capability indices (Cp & Cpk)
- Attribute
  - np chart - number defective -- AIAG example; workshops
  - c chart - number of defects -- AIAG example; workshops
- Basic Chart Interpretation
  - Basic decision rules
  - Process responses -- jumps, steps, shifts; trends; cycles
- Documented process changes

Instructor: Phillip J. Ross
Fee $1265 1.3 CEUs

Introduction to Failure Modes & Effects Analysis for Manufacturing Processes, Assembly Processes & Service (Process FMEA)

1 Day
I.D.# 90033

This seminar introduces the participant to the analytical process in which potential failure modes, failure effects and causes of failure are identified. Criticality and risk analysis concepts are also covered for dealing with the effects of failure. Analysis is used to identify corrective actions that may be used to eliminate failure modes or minimize the effect of failure. Additionally, the analysis may be used to identify controls necessary to prevent failure occurrence. This course covers the AIAG standardized format for FMEA and the succeeding SAE Standard for FMEA, J1739, which is included in the course materials. There is considerable overlap between this course and I.D.#90034 - Introduction to Failure Modes and Effects Analysis for Product Design (Design FMEA). See course I.D.#92002 - Introduction to Failure Modes & Effects Analysis for Product Design & Manufacturing Process Design (Product & Process FMEA) if you are interested in both Product & Process FMEA.

Learning Objectives

By attending this seminar, you will be able to:
- List the benefits, requirements and objectives of an FMEA
- Explain the steps and methodology used to analyze a Process FMEA
- Compare a variety of tools utilized when performing an FMEA
- Identify corrective actions or controls and their importance in minimizing or preventing failure occurrence
- Review the objectives of the SAE Standard for FMEA, J1739

Who Should Attend

This seminar is designed for the manufacturing engineer, process assurance engineer, reliability engineer, test engineer, quality engineer, development engineer, logistics/support engineer and their management or anyone responsible for the design and development of manufacturing, assembly or service processes in the completion of a Process FMEA.

Prerequisites

Individuals attending the seminar should have a basic understanding of the manufacturing/assembly process and design principles.

Topical Outline

- Introduction & Overview
  - Definition
  - General discussion -- requirements for analysis; uses/objectives of analysis; benefits
  - Timing & relationships -- level of analysis (detail); design FMEA versus process FMEA
- Performing a Design FMEA & Process FMEA
  - Pre-analysis activities -- determine customer requirements - quality function deployment (QFD); environmental conditions/considerations; determine required functions; develop block diagrams; process flow diagrams
  - Basic analysis methodology -- approach; sequence
  - Criticality/risk analysis (prioritization)
  - Typical forms used & examples
- Problems Encountered
  - Application

  - Timing
  - Prioritization
- Fault Tree Analysis as a Support Tool
  - Introduction - approach; FMEA relationship
  - FTA sequence
  - Analysis overview - symbols; examples; workshop
  - Limitations
  - Benefits
- Application
  - Combined FMEA/FTA examples
  - Detained FMEA examples
  - FMEA/FTA comparisons
- Using the Results
  - Logistics support analysis (LSA)
  - Failure prevention analysis (MPA)
  - Test planning
- Other Related Methods/Tools
  - Design review
  - Checklists
  - Lessons learned
  - Design of experiments (DOE)
  - SPC
  - Design for assembly (DFA)
  - Value engineering
  - FMEA software
- Keys for Successful Implementation
  - Activity as process versus a task
  - Analysis by group/team versus individual -- roles & responsibilities; use of facilitators
- FMEA & Product Liability

Instructor: E. Harold Vannoy
Fee $785 .7 CEUs

Metal Forming

2 Days
I.D.# 85012

This seminar covers metal forming and related manufacturing processes, emphasizing practical applications. From forged or P/M connecting rods to tailor-welded blank forming, metal parts are integral to the automotive industry. As a high value adding category of manufacturing, metal forming is increasingly important to the core competency of automobile manufacturers and suppliers. A thorough survey of metal forming processes and metal forming mechanics will be performed, including bulk deformation, sheet-metal, and powder metallurgy operations. Design considerations are fully integrated into the course and are presented with every process. A large number of real-world case studies are presented to the attendees to emphasize course content.

Attendees will receive a copy of the book, *Manufacturing Engineering Technology*, co-written by instructor Steven R. Schmid.

Learning Objectives

By attending this seminar, you will be able to:
- Identify the unique characteristics of metals that lead to plastic deformation as a processing strategy
- Explain the processes involved in metal forming mechanics, materials, and tribology
- Analyze the interrelationships between various factors that influence the quality of manufactured products
- Describe sheet metal characteristics and forming
- Describe the wide variety of processes used to shape and deform metals, including forging, rolling and extrusion; sheet metal forming, shearing and stamping; powder metallurgy processes and assorted other processes

Who Should Attend

This course is designed for engineers who are involved in metal forming and other related manufacturing processes.

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

DAY ONE
- Overview of Solid Mechanics and Materials Science Topics of Importance to Metal Forming
- Tribology of Metal Forming: Friction, Lubrication and Wear
- Bulk Deformation Processes
  - Forging: open die and closed-die (impression) forging; machinery description and capabilities; forging process layout and die design; heading, coining, piercing and upsetting operations; swaging
  - Rolling: flat rolling process, including Orowan model; control of product quality including surface finish and gage control; rolling equipment and capabilities; shape rolling; ring rolling
  - Extrusion and drawing: direct, indirect and hydrostatic extrusion; cold and hot extrusion; die design; defects in extrusion; drawing equipment and mechanics; limiting drawing ratio

DAY TWO
- Sheet Metal Forming Processes
  - Sheet metal shearing: mechanics of shearing, burr formation, blanking operations, fine blanking
  - Sheet metal bending: types of bending operations and equipment; springback calculation and control; tube bending
  - Sheet forming operations: deep drawing and ironing; stretch forming; bulging, rubber forming and hydroforming; roll forming of sheet; spinning; incremental forming; explosive, peen and other specialty forming processes; stamping operations and die design
  - Sheet metal formability: limiting drawing ratio for deep drawing; sheet metal formability; forming-limit diagrams
- Powder Metallurgy Processes
  - Compaction through pressing, cold and hot isostatic pressing and metal injection molding; sintering mechanics and processes; coining and finishing

Instructor: Steven R. Schmid
Fee $1365 1.3 CEUs

Sheet Metal Stamping: Robust Formability

2 Days
I.D.# C0713

Preventing future problems and troubleshooting existing problems in today's stamping plants requires greater stamping process knowledge. The link between inputs and outputs isn't as clear as many think, increasing the need for detailed understanding of the variables involved. This course discusses the key inputs and outputs associated with sheet metal stamping, including important elements for controlling the process and making it more robust. The course reviews sheet metal characteristics and their application, especially from a

formability standpoint, using many automotive-related examples. Common issues such as springback, dent resistance, and process differences among mild steel, high strength steel, bake hardenable steel, and aluminum are discussed. Stamping die types and functions, in particular the types of dies used in draw forming, are explained. Mechanical presses and lubrication are briefly discussed as other variables in the process. Other processes, including tube and sheet hydroforming, and progressive dies are covered in less detail.

Learning Objectives

By attending this seminar, you will be able to:

- Describe steps and elements of the stamping process
- Identify common grades of sheet metal and their applications
- Specify key mechanical properties and their relationship to product quality
- Identify important inputs and outputs of the stamping process
- Describe important aspects of process control
- Read and interpret sheet metal strain analysis and forming limit diagrams

Who Should Attend

Anyone who wants to know more about sheet metal stamping, from new hires in the industry, to product design engineers who design sheet metal parts, to manufacturing engineers, supervisors, and others working at a stamping plant, will benefit from this seminar. Those with plant floor experience who are lacking a solid understanding of the how's and why's will also benefit.

Prerequisites

Participants should have some technical math background and have a basic understanding of the stamping process.

Topical Outline

DAY ONE

- The Stamping Process
  - Inputs vs. outputs
  - Steps: from coil to assembly
  - Process control and quality
- Stamping Dies
  - Draw forming process -- Die types and functions; Die materials; Die design and construction
  - Other types of forming (tube and sheet hydroforming, progressive dies, etc)
- Stamping Presses

DAY TWO

- Sheet Steel
  - Mechanical properties
  - Grade designations
- Sheet Aluminum
  - Mechanical properties
  - Grade designations
- Sheet Metal Formability
  - Forming limit diagram
  - Circle grid and thinning strain analyses
  - Applications

Instructors: John Stolter and Edmund Herman
Fee $1225 1.3 CEUs

Catalog Key

Instructor-led programs | Online courses | ACTAR approved | Part of a Certificate Program Curriculum

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Advanced High Strength Steels for Vehicle Weight Reduction

2 Days
I.D.# C0916

Growing environmental awareness, the need for more fuel efficient vehicles, and safety performance are driving vehicle manufacturers to explore new innovations in Advanced High Strength Steels (AHSS). The body of a modern passenger car constitutes approximately 40% of the total vehicle weight and the chassis frame constitutes up to 25% of the total weight, demonstrating a significant opportunity for overall vehicle weight reduction. Advanced High Strength Steels have only recently been applied to vehicle design and usage, but predictions have been made that future vehicles (i.e., 10 years out) could be using greater than 50% AHSS for up to a 25% weight advantage at equal or less cost, versus current body and chassis structures. This seminar will focus on identifying appropriate applications of AHSS in the body and chassis for vehicle weight reduction. Recent steel applications will be presented, including factors which contributed to the appropriateness of using Advanced High Strength Steel versus mild steels or Conventional High Strength Steels (CHSS). Advantages of AHSS, as well as obstacles that may impede its use will be covered. Relative performance of alternate materials for weight reduction, particularly aluminum alloys, will be explored. A number of examples from industry will be presented to demonstrate the types of analyses which will have to be performed to lead to successful applications of AHSS. Extensive reference will be made to advanced analysis and testing methods without going into the details of the methodology. Finally, a future roadmap of AHSS applications will be presented.

Learning Objectives

By attending this seminar, you will be able to:
- Specify which key steel parts are candidates for conversion to Advanced High Strength Steels
- Implement strategies for overcoming the impediments to AHSS utilization
- Select vehicle architectural elements to accommodate AHSS
- Compare AHSS with other light weighting materials and strategies
- Assess where your products are with respect to the most up-to-date steel strategies

Who Should Attend

This seminar is designed for any automotive or automotive supplier engineer who needs to expand his/her knowledge of alternative steels. The content is broadly applicable to body/chassis design release engineers, engineering support (e.g., safety, testing, CAE, etc.) engineers, research engineers, and low/middle engineering management.

Prerequisites

Participants should have an engineering degree and several years of automotive engineering experience.

Topical Outline

DAY ONE
- Steel Usage: Background and Status
  - Steel categorization and mechanical properties
  - Drivers of AHSS -- Safety enhancement; Demands for improved fuel economy; Cost reduction/avoidance; Environmental responsibility; Dentabiltiy/durability improvements
  - Snap shot of potential future usage
- Impediments and Enablers for the Successful Utilization of AHSS
  - Formability and springback
  - Welding
  - Fatigue and durability
  - Role of CAE in successful implementation -- Retention of stiffness; Accurate safety simulation
  - Material variability
  - Serviceability and repair
- Alternate Materials and Strategies
  - Materials overview
  - Steel for affordable weight reduction
  - Class exercise in fundamental mechanics
  - Lambda factor

DAY TWO
- AHSS Procurement & Availability
  - Steelmaking processes for AHSS
  - AHSS cost inputs
  - Productivity, quantity and order quantity considerations
  - AHSS and carbon steel pricing comparisons
  - Availability constraints - coated sheet steels, grades, cross sections
  - Recommendations for specifying and purchasing
- Case Studies for the Application of AHSS
  - IMPACT Project
  - FABRICATE project
  - Auto/Steel Partnership - door project
- Part by Part AHSS Conversion Strategies
  - Body
  - Chassis

Instructors: Paul E. Geck and Richard J. Cover
Fee $1225 1.3 CEUs

Aerospace Coatings and Corrosion Control: Materials and Applications

3 Days
I.D.# C0819

Advancing technologies command a continual understanding of current coating materials and applications. Coating suppliers are being called upon to provide new and innovative coating technologies that address aesthetics, excellent durability and environmental issues. Coating users are also increasingly under pressure to economize their operation and offer corrosion resistant and highly durable and functional coated aircraft parts. It is crucial that those involved in product design and manufacture understand and implement techniques that support industry demand. This course addresses information and processes regarding current products and future trends in the aerospace industry. An interactive, learner controlled instruction style, with an emphasis on problem solving discussions, makes it easy for attendees to obtain answers to specific questions.

Learning Objectives

By attending this seminar, you will be able to:

- Identify the latest developments in aerospace coatings selection and corrosion prevention methods and processes
- Select aerospace and advanced coatings, primers and composites based on an understanding of their properties, as well as costs and application methods
- Ascertain the durability of coatings and corrosion phenomena and describe how to prevent corrosion by the systems approach
- Implement cost savings through the use of more efficient processes and judicial selection of materials
- Reinforce your mastery of troubleshooting and apply problem solving techniques

Who Should Attend

Aerospace manufacturing personnel including process engineers, design and specification engineers, quality control, technical service, chemists and technical sales personnel dealing with finishing, coating and corrosion prevention will benefit from this seminar.

Prerequisites

This course benefits current users with some coatings, chemistry, and application background.

Topical Outline

DAY ONE

- Aerospace Coatings
  - How to engineer the outcome
  - Protective exterior and interior coatings
- Adhesion of Coatings
  - What is adhesion?
  - Requirement for a good adhesion
  - Methods of promoting and maintaining adhesion
  - Effect of adhesion on durability and corrosion resistance of coatings
- Surface Pretreatment
  - Surface nature and characteristics
  - Reasons and benefits of surface pretreatment
  - How to select a proper surface treatment process
  - Selection and application of primers, adhesion promoters and corrosion inhibitors
  - Surface cleaning
  - Mechanical and physical treatments
  - Conversion coatings
  - Anodizing treatment of aluminum
- Functional and Decorative Platings
  - Selection of platings and properties
  - Performance of chrome, copper, nickel, zinc, electroless nickel, and alloys
  - Plating plastics
  - Corrosion protection via platings

DAY TWO

- How to Design for Corrosion Control
  - Material selection
  - Process variables
  - Structural design
  - Intact and non-intact protection methods
- Corrosion and Corrosion Prevention
  - Fundamentals of corrosion
  - Corrosion types and mechanisms
  - Corrosion of aluminum alloys
  - Corrosion of ferrous metals
  - Corrosion of magnesium and alloys
  - Methods of preventing corrosion
  - The effect of coatings variables on corrosion
- Corrosion Protection by Coatings
  - How coatings protect and why they fail
  - Factors affecting corrosion protection of coatings
  - Selecting coatings for corrosion protection
  - Approaches for replacing chrome treatments
  - Approaches for preventing corrosion
  - Avoiding corrosion by structural design
  - Methods of evaluating corrosion protection of coatings
- Selection, Properties and Application of Liquid Organic Coatings
  - Coating types and properties
  - Selecting compliant liquid coatings
  - Advanced technologies
  - Possible service life prediction
  - Recent developments and future trends
- Waterborne Coatings
  - Advantages and limitations
  - Understanding of waterborne coatings
  - Special consideration for waterborne coatings application
  - Selection, merits, application and process variables
  - How to convert to waterborne coatings

DAY THREE

- Powder Coatings
  - Current status of powder coatings
  - When and where to use powder coatings
  - Advantages and limitations
  - Powder types and properties
  - Selecting powder coating and application methods
  - What does it take to convert to powder coating
  - Performance and troubleshooting
- Coating Composites and Plastics
  - Working with plastics
  - Nature and paintability of composites and plastics
  - Selection of plastics: functional and decorative properties
  - Special considerations for coating plastics: what to watch for
  - Surface treatment of plastics and composites
  - Selecting coatings for plastics
  - Requirements for coating defect-free plastic parts
  - Coating application and troubleshooting
  - Factors affecting application methods
  - Performance of coatings on plastics
  - Evaluation of coatings of plastics
- Durability and Testing of Coatings
  - Why do paints fail

- Factors affecting the performance of coatings
- Mechanisms of paint failure
- Possible methods of coatings life prediction
- How to extend the life of a coating
- How to test coatings for specific applications
- Evaluation of coatings
- Coatings Case Histories

Instructor: Jamil Baghdachi
Fee $1545 2.0 CEUs

Automotive Coatings: Materials & Applications

3 Days
I.D.# 97023

Coating suppliers are being called upon to provide new and innovative coating technologies that address aesthetics, durability and environmental issues. As a result, many types of coatings and application methods have become available which are not widely known but which will become standard practice in the near future. The purpose of this seminar is to share information regarding future trends in the industry. An interactive, learner controlled instruction style, with an emphasis on problem solving discussions, makes it easy for attendees to obtain answers to specific questions.

Learning Objectives

By attending this seminar, you will be able to:
- Summarize the latest developments in the areas of coatings and corrosion prevention methods and processes
- Select automotive finishes, primers, plastics, and become familiar with their properties, as well as costs and application methods
- Describe the durability of coatings and corrosion phenomena and learn how to prevent corrosion by the systems approach
- Implement cost savings through the use of more efficient processes and judicial selection of materials
- Receive unbiased technical opinions on what works, what does not and why
- Reinforce your mastery of troubleshooting and problem solving capabilities

Who Should Attend

Manufacturing personnel, process engineers, design and specification engineers, quality control, technical service, chemists and technical sales personnel dealing with finishing, coating and corrosion prevention will benefit from this seminar. It is appropriate for current users with limited to very good knowledge of coatings operations, who need or want to learn fundamentals, current trends, and new technologies.

Topical Outline

DAY ONE
- Automotive Coatings--How to Engineer the Outcome
  - Decorative and protective functions
  - Class A Exterior Finishes
  - Protective and interior coatings
  - Properties
  - Applications
  - Durability
- Adhesion of Coatings
  - Requirement for a good adhesion
  - Methods of promoting and maintaining adhesion
  - Effect of adhesion on durability and corrosion resistance of coatings
- Surface Pretreatment
  - Surface nature and characteristics
  - Reasons and benefits of surface pretreatment
  - How to select a proper surface treatment process
  - Selection and application of primers, adhesion promoters and corrosion inhibitors
  - Surface cleaning
  - Mechanical and physical treatments
  - Conversion coatings
  - Anodizing treatment of aluminum
- Electrocoating
  - Corrosion protection via electrocoating
  - Electrodeposition types, processes and applications
  - Performance properties and economics
- Functional and decorative platings
  - Selection of platings and properties
  - Performance of chrome, copper, nickel, zinc, electroless nickel, and alloys
  - Plating plastics
  - Corrosion protection via platings

DAY TWO
- How to Design for Corrosion Control
  - Material selection
  - Process variables
  - Structural design
  - Intact and non-intact protection methods
- Corrosion and Corrosion Prevention
  - Fundamentals of corrosion
  - Corrosion types and mechanisms
  - Methods of preventing corrosion
  - The effect of coatings variables on corrosion
- Corrosion Protection by Coatings
  - How coatings protect and why they fail
  - Factors affecting corrosion protection of coatings
  - Selecting coatings for corrosion protection
  - Approaches for preventing corrosion
  - Avoiding corrosion by structural design
  - Methods of evaluating corrosion protection of coatings
- Selection, Properties and Application of Liquid Organic Coatings
  - Coating types and properties
  - Selecting compliant liquid coatings
  - Advanced technologies
  - Possible service life prediction
  - Recent developments and future trends
- Waterborne Coatings
  - Advantages and limitations
  - Understanding of waterborne coatings
  - Special consideration for waterborne coatings application
  - Selection, merits, application and process variables
  - How to convert to waterborne coatings
- Powder Coating for Automotive Applications
  - Current status of powder coatings
  - When and where to use powder coatings
  - Advantages and limitations
  - Powder types and properties
  - Selecting powder coating and application methods
  - What does it take to convert to powder coating
  - Performance and troubleshooting

DAY THREE
- Finishing Automotive Plastics
  - Working with plastics
  - Nature and paintability of plastics
  - Selection of plastics: functional and decorative properties

- Special considerations for coating plastics: what to watch for
- Surface treatment of plastics and composites
- Selecting coatings for plastics
- Requirements for coating defect-free plastic parts
- Coating application and troubleshooting
- Factors affecting application methods
- Performance of coatings on plastics
- Evaluation of coatings of plastics

- Surface Defect Characterization and Prevention
  - Sources and examples of defects
  - Types and causes of defects
  - Methods of preventing defects
- Durability and Testing of Coatings
  - Why do paints fail
  - Factors affecting the performance of coatings
  - Mechanisms of paint failure
  - Possible methods of coatings life prediction
  - How to extend the life of a coating
  - How to test coatings for specific applications
  - Evaluation of coatings
- Coatings Case Histories

Instructor: Jamil Baghdachi
Fee $1545 2.0 CEUs

Automotive Plastics: Principles of Materials & Process Selection

2 Days
I.D.# C0135

Plastic - any class of synthetically-produced organic compounds capable of being molded and hardened into a specific shape or form. This course is designed to offer a basic understanding of plastics and plastic processing. Using plastics can be simple, but there is much more behind producing high performance plastic parts. This seminar will walk you through the molding process, provide a comprehensive look at the variables in the manufacturing mix, and review characteristics of typical automotive plastics such as PP, PVC, ABS, and more. This seminar will also cover troubleshooting molding mistakes and alternative processes, and review the selection of an application's appropriate plastic material. Material presented is both an excellent foundation for further development and an extensive update for those already working in the field.

Learning Objectives

At the completion of this seminar, attendees will be able to:
- demonstrate an understanding of typical automotive plastics and primary and application-specific plastics processing methods
- recognize key plastics terminology and parameters related to plastics
- explain alternative molding processes
- prevent or reduce molding mistakes
- understand the molding cycle
- troubleshoot the processing operation

Who Should Attend

This seminar is designed for those who are new to automotive plastics, as well as those who have some experience. The program will benefit product designers, process engineers, purchasing agents, project engineers, manufacturing engineers, material engineers, and sales and marketing professionals.

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

DAY ONE
- Introduction to Injection Molding
  - Process description
  - Product description
  - Business overview
- The Injection Molding Machine
  - Clamp systems
  - Plastication unit
  - Screw
  - Controls
- The Molding Cycle
  - Pressure in process
  - Velocity generation, including mold filling, mold packing, cooling, ejection, material melting and material handling.

DAY TWO
- Typical Injection Molding Mistakes
  - Melt temperature
  - Material drying
  - Contamination
  - Over packing
  - Incomplete fill
  - Oversized machines
  - Undersized machines
  - Temperature control
- Mold(s)
- Function
  - Forming
  - Cooling
- Basic Design Requirements
  - Clamp slots
  - Ejection "hole"
  - Support
  - "Seal-off"

Instructor: Robert G. Speirs
Fee $1225 1.3 CEUs

Designing with Glass

1 Day
I.D.# 85008

The understanding of brittle behavior is a prerequisite to efficient product design with glass, glass-ceramic, and ceramic-type materials. This short course will address the weakness of brittle materials and how it may be overcome; it will highlight the design principles for brittle materials and contrast them with those for ductile materials. The seminar will review the design tools, e.g. stress analysis, finite element analysis, photo-elastic methods, and experimental stress analysis, and illustrate how they may be applied to automotive, aircraft and consumer products. Formulas for mechanical stresses due to bending, twisting, and impact loads in beams, plates and tubes will be reviewed. Similarly, thermal stresses in above structures due to transient and steady state temperature changes will be estimated using simple equations. The role of fracture mechanics and failure analysis will be discussed from the point of view of product liability. Hands-on demonstration of glass failure and examination of fracture surface will be carried out in the classroom. Glass specimens with different

surface abrasions will be fractured to illustrate the impact of flaw severity on long-term reliability. The fundamentals of glass behavior under mechanical and thermal loads will be emphasized. In particular, the strength and fracture properties of glass, glass-ceramics, and ceramics will be reviewed. Also discussed will be available commercial techniques for improving strength and fracture properties to make glass more attractive as a structural material. This will be followed by a review of design methodology and its application to glass and ceramic products in automotive, aircraft, space, consumer, and construction industries. The issue of product liability involving glass products and how to minimize it via product design will be addressed.

Learning Objectives

By attending this seminar, you will be able to:
- Explain why glass as a structural material behaves differently than metals or plastics and how such differences affect product design
- Design glass components or structures that have adequate safety built into them to meet reliability requirements in the field
- Examine fracture origin and estimate failure stress from mirror size
- Improve design strength of glass articles by three times or more

Who Should Attend

This course is designed for mechanical, metallurgical and chemical engineers, materials scientists and those involved in handling, assembling, and failure analysis of glass products.

Prerequisites

Participants should have background or experience in handling, analyzing, examining or working with glass products.

Topical Outline

- Silica Structure
  - Silicon-oxygen bond
  - Bond length and bond angles
  - Si-O-Si tetrahedron
  - Random network theory
  - Water molecule
  - Crack tip morphology
- Silicate Glasses and Their Properties
  - Mechanical properties -- Elastic modulus; Hardness; Strength; Toughness; Fatigue
- Strength of Inorganic Glasses
  - Brittle nature of glass
  - Strength and weakness of glass
  - Griffith flaw
  - Types of strength
  - Factors affecting strength
  - Statistical nature of strength
  - Strength of annealed glasses
  - Strain tolerance of brittle materials
- Thermal Tempering
  - Tempering fundamentals
  - High temperature properties -- Expansion and viscosity; Air quenching; Temporary tension; Beneficial stresses
- Stress Relaxation
  - Shear and volume relaxation
  - Relaxation time
  - Strain
  - Annealing and softening points
  - Stress release vs. viscosity
- Fracture Process
  - Fracture of glass
  - Slow, medium and fast crack growth
  - Fracture surface and energy
  - Fracture mirror
  - Failure stress
  - Estimate of product life
- Reliability of Glass Products
  - Long term reliability
  - Size effect
  - Surface strength and variability
  - Failure probability
  - Threshold strength
  - Fatigue life
- Formulas for Bending and Thermal Stresses
  - Bending of beams and plates
  - Pressurization of tubes
  - Twisting of tubes and rods
  - Impact loading of plates
  - Thermal stresses in plates and tubes
- Automotive Glass
  - Properties of float glass
  - Air vs. tin side
  - Surface flaws and their origin
  - Fatigue degradation
  - Windshield design and analysis
  - Importance of edge quality
  - Stone damage
  - Delayed failure

Instructor: Suresh T. Gulati

Fee $725

7 CEUs
3 ACTAR CEUs

Engineering Alloys: Properties and Applications

3 Days
I.D.# C0010

This seminar focuses on the characteristics and properties of engineering alloys, and their practical applications in aerospace and other industries where they are utilized. It will enhance attendees' professional skills in design, manufacturing and repair technologies. The relationships between alloy processing, microstructure and properties will be explained and discussed. Microstructures evolving from various heat treatment schedules, and a variety of processes ranging from casting, forging, extrusion, hot isostatic press to powder metallurgy will be compared to illustrate their effects on mechanical properties.

Aluminum alloys, from 2024 to 7075 are widely used in low temperature lightweight structures, and reciprocal engine parts. This seminar will discuss their product forms, strengthening mechanisms, environmental durability, and mechanical properties. Titanium alloys are used for various aircraft parts and other structural components because of their lightweight and strength. The microstructure of a titanium alloy varies dramatically when subject to different heat treatment schedules, and so do the subsequent mechanical properties. These changes will be discussed along with examples of real-life applications. Ferrous alloys including stainless steel and cast iron are used for their respective unique characteristics. Properties and applications of these alloys will be discussed. Ni-base alloys, for example Inconel 718, are often referred to as superalloys due to their durability of strength at elevated temperatures. Alloy strengths at high and low temperatures are attributable to different strengthening mechanisms. These factors directly affect part and structure failure modes and fractography; transgranular at low temperature, and intergranular at high temperature.

The suitability of individual engineering alloys for specific applications are contingent on the controlling critical factors in each case. Fracture toughness and tensile properties are the determining factors if an engineering alloy is used for static structure at room temperature. Low cycle fatigue resistance is the critical factor to determine if an engineering alloy is suitable for a rotating part. Creep and stress rupture characteristics are the properties to be checked before any alloys can be safely used for high temperature applications. This course will provide attendees with knowledge to evaluate available engineering alloys, judging from their critical properties, for specific applications.

Attendees are encouraged to bring in their own real-life cases.

Learning Objectives

Upon completion of this seminar, attendees will be able to:
- Recognize the effects of materials processing on microstructure and properties
- Formulate proper heat treatment schedules of A1, Ti, ferrous alloys and Ni-base superalloys for their respective applications
- Judge the suitability of an engineering alloy for a specific part or structure
- Demonstrate a high professional knowledge in general applications of engineering alloys

Who Should Attend

Executives, managers, design, manufacturing and quality-control engineers, and technicians in aerospace industries, from airframe and engine manufacturers to airline maintenance facilities and repair stations will benefit by attending this seminar to enhance their professional knowledge in aviation metallurgy. Managers, engineers and technical people from automotive, railroad and the highway industries, and of metallurgical, or power plant utility companies will also benefit from this seminar by broadening their comprehensive knowledge in engineering alloys for their respective applications.

Prerequisites

No specific prerequisite is required, however, some familiarity with engineering alloys would be beneficial.

Topical Outline

Alloy Characteristics and Mechanical Properties
- Alloy Structure and Product Form
  - Structure of engineering alloys
  - Miller Indices, slip systems and defects
  - Effects of process and product form on mechanical properties
- Alloy Phase Formation and Identification
  - Phase diagram
  - Isothermal transformation and continuing cooling curves
  - Microstructure evolution
- Tensile Properties and Hardness Measurement
  - Tensile test and stress-strain curve
  - Theoretical shear strength
  - Hardness measurement
- Fracture Toughness
  - Fracture toughness in design and failure analysis
  - Ductile to brittle transition
- Low-cycle and High-cycle Fatigue Life Prediction
  - Low cycle fatigue life prediction
  - High cycle life calculation
  - Goodman diagram
  - Thermal mechanical fatigue
- Creep and Stress Rupture
  - Materials behavior at elevated temperature
  - Creep test and mechanisms
- Exercise: Fatigue and Creep Life Calculations Aluminum Alloys
- Processing of Al Alloys
  - Casting, forging and extrusion, powder metallurgy process
- Al-Cu Alloys
  - Strengthening mechanisms, properties and practical applications
- High-strength Al Alloys
  - Engineering applications of Al-Mg-Zn alloys, and Al-Li alloys
- Oxidation and Corrosion
  - Environmental degradation
- Exercise: Al Alloy Selection in Engine Cylinder Design Ferrous Alloys
- Processing of Ferrous Alloys
  - Production of steels
  - Heat treatment and microstructure
  - Hardenability
- Carbon, Alloy and Stainless Steels
  - Alloy designation
  - Mechanical properties of steels
  - Corrosion protection
- Industrial Applications
  - Engine components, landing gear
- Exercise: Establishing Heat Treatment Schedules for Steels Titanium Alloys
- Heat Treatment and Microstructure
  - Phase diagram and heat treatment
  - Microstructure and mechanical properties
- Effects of Processing
  - Triple melting, hard alpha effects
- Mechanical Properties and Environmental Effects
  - Mechanical strength and physical characteristics
  - Flammability
- Engineering Applications of Ti Alloys
  - Engine compressor disks and blades
  - Dwell time creep
- Exercise: Dwell Time Fatigue Analysis Ni-base Superalloys
- High Temperature Alloy Characteristics
  - Creep and stress rupture
  - Transgranular and intergranular fracture mechanisms
- Characteristics of Ni-base Superalloys
  - Cast, forged, powder metallurgy, and single crystal
- Applications at Elevated Temperatures
  - High temperature turbine disks
  - Stress concentration
  - Coating
- Exercise: Design Project with Ni-base Superalloys Engineering Alloys Applications
- Alloy Selection in Engineering Design
  - Strength and safety requirements
  - Fatigue, fracture toughness and damage tolerance
  - Environmental awareness
  - Effects of operating conditions
- Critical Alloy Characteristics in Manufacturing
  - Ductility and superplasticity, machinability, and formability
- Alloy References
  - Alloy codes, classifications and specifications
  - Engineering alloy references
  - International alloy cross references
- Engineering Alloys and Repairing
  - Weldability, post repair heat treatment
- Case study
  - Alloy selection for engine turbine blades
  - Alloys for airframe structure
  - Candidate alloys for a rotating shaft

Instructor: Wego Wang

Fee $1545 2.0 CEUs

Fundamentals of Metal Fatigue Analysis

3 Days
I.D.# 94024

There is a potential for metal fatigue in any situation where a component is subjected to cyclic loads. Fatigue failures of various types are a key concern in increasing the reliability of products. Problems involving fatigue have become more severe with the demand for lighter weight structures and components. The effective use of fatigue analysis and predictive tools is critical for reducing the development time of new products. Two methods of metal fatigue analysis will be covered. The first is the stress-life approach. This method is used for high cycle or very long life fatigue problems where loads have fairly constant amplitude. Applications of this method include engine components, gears and shafts. The second method is the strain life approach, which is used for cases involving low cycle fatigue where loads may have a variable amplitude. Applications of this method include suspension and chassis components. The strain-life approach is also more useful when dealing with non-ferrous alloys. Other key topics to be addressed include residual stress, shot peening, cycle counting methods and environmental effects. Extensive use of example problems and case studies will be used. The overall objective of the course is for participants to gain an understanding of the phenomenon of metal fatigue and most importantly learn what methods are available to predict and prevent failures.

Learning Objectives

By attending this seminar, you will be able to:
- Differentiate various fatigue analysis methods
- Identify factors which can adversely affect fatigue behavior
- Apply processes which can be used to improve fatigue behavior
- Describe methods for analyzing fatigue at notches
- Indicate the steps necessary to determine the life of components subjected to variable amplitude loading

Who Should Attend

This course is intended for design, analysis or test engineers who deal with fatigue problems.

Prerequisites

The participant needs little if any exposure to metal fatigue analysis methods. The participant should have had the standard undergraduate courses in stress analysis and material science.

Topical Outline

DAY ONE
- Overview of Metal Fatigue and Analysis Methods
- The Stress-Life Approach
  - The S-N diagram and endurance limit
- Modifying Factors
  - Size and shape
  - Surface finish and treatments
  - Types of loading
- Mean Stress Effects
- Residual Stress and Shot Peening
- Example Problems

DAY TWO
- The Strain-Life Method
  - Limitations on the stress-life method
  - Cyclic stress-strain behavior
  - The strain-life diagram and parameters
- Mean Stress Effects
- Variable Amplitude Loading
- Damage Summing Methods
  - The Miner-Palmgren Rule
  - Non-linear methods
- Example Problems

DAY THREE
- Cycle Counting Methods
- Analysis of Notches
  - Stress-life method
  - Strain-life method
- Example Methods
- Environmental Effects

Instructor: Jess J. Comer
Fee $1595 2.0 CEUs

Introduction to Metallurgy and Its Practice

3 Days
I.D.# 99015

This seminar is designed to provide the attendee with basic information and terminology associated with the science and engineering of metals and alloys. Long the province of the professional metallurgist, this discipline now finds an ever-increasing number of engineers and technicians educated and trained in other fields who are required to make judgments concerning alloy compositions and processing routines with little or no formal background in metallurgy. Realizing that the properties of metals and alloys are determined by their microstructures and, in turn, that microstructure is controlled by thermal and mechanical processing, this seminar begins with a brief examination of the way in which metal atoms interact and bond to form a basic crystal structure. The casting and solidification of pure metals is examined briefly as a prelude to an explanation of the way in which alloys solidify. The concepts of solid solutions and phase diagrams are introduced in terms of common alloy systems such as steels and aluminum-base alloys. Thermal and mechanical processing methods for strengthening and toughening alloys are discussed, with special emphasis on the microstructure alterations that account for the changes in the properties of steels as a result of heat treatment. Precipitation hardening in alloys based on nonferrous metals (such as aluminum) is also explained.

After introducing the concepts and practices associated with control of microstructure, the relationships between microstructure and mechanical properties (hardness, strength, toughness, ductility, fatigue life, etc.) will be discussed and related to industrial practices for such processes as cold working, hardening and tempering of steels, and annealing. The methods used to test for mechanical properties will be reviewed and such terms as yield strength, tensile strength, fatigue limit, CVN toughness, and others will be explained.

This seminar will dispel some of the "witchcraft and black magic" often attributed to the practice of metallurgy. A better appreciation of the basics of the field will benefit those persons who find themselves involved in the specification and processing of metals as well as in quality control functions.

Learning Objectives

Upon completion of this seminar, participants will be able to:
- Recognize and define key elements of terminology used in metallurgical practice
- Associate the control of the structure of metals and alloys with the properties that they exhibit
- Associate processing techniques with control of microstructure
- Describe and interpret the results of mechanical property testing of metals

Who Should Attend

Although no formal prerequisites for this seminar are needed, the content will be most appreciated by those engineers, shop supervisors, and technicians who work with metal specification, design, processing, and quality functions. The seminar is designed to provide some background and knowledge to help these individuals understand how and why metal properties respond to processing. This seminar is also recommended to those engineers who may have taken one or two materials science and engineering courses during their undergraduate programs and want to refresh their memories regarding some concepts and terminology related to the practice of metallurgy.

Topical Outline

- Brief Overview of the Field of Metallurgy and Materials
- Metals in the Solid State
  - Nature of crystals and the metallic bond between atoms
  - Effect of bonding on properties (elastic stiffness, thermal expansion, melting temperature)
  - Definition of crystal structures and their significance in metals and alloys
  - Important defects in metal crystals (vacancies, dislocations)
  - Grains and grain boundaries in metals
- Solidification of Pure Metals
  - As-cast structures (grain formation)
  - Casting defects (gas porosity, shrinkage cavities)
- Metal Alloys
  - Concept of solid state solubility
  - Phase diagrams
  - Development of microstructure during solidification
  - Equilibrium solidification
  - Inhomogeneous structures (coring) and alloy casting defects
  - Ferrous alloys
  - Nonferrous alloys
- Heat Treatment of Steel
  - Definition and designations for steels
  - The Fe-Fe3C phase diagram
  - Austenitizing
  - Influence of cooling rate on microstructure and hardness -- microstructures (pearlite, bainite, martensite); IT and CCT diagrams; annealing and normalizing; hardening by quenching and tempering; hardenability of steels (response to quenching); tempering quenched steels to improve ductility and toughness
  - Surface hardening by carburizing and induction
- Precipitation (Age) Hardening
  - Fundamentals
  - Age hardening of aluminum alloys
- Mechanical Properties of Metals and Alloys
  - Origin of mechanical properties in metal structures -- role of crystal defects (dislocations); role of microstructure
  - Definition and testing of mechanical properties (hardness, yield strength, tensile strength, ductility, toughness, fatigue life)
- Fabrication of Metals by Deformation Processing
  - Effects of cold working on structure and properties -- strain hardening; annealing to stress relieve and soften after cold work
  - Effects of hot working on structure and properties
  - General deformation methods (rolling, forging, drawing, etc.)
- Open Discussion of Issues Related to Metallurgy in the Transportation Vehicle Industry
- Summary and Wrap-up

Instructor: Darrell W. Smith
Fee $1545 2.0 CEUs

Material Selection and Testing for Plastics

2 Days
I.D.# C0134

Today's necessity for quickly delivering products to market limits product development time and leaves less room for error and 're-dos.' With so many plastic materials available, it is crucial that those involved in product design understand resin properties and how they affect part design and manufacturability. To help you make the best plastic choices the first time, this seminar provides an overview of polymer chemistry, explains the methods for testing properties of plastics and presents a method of systematic selection that will optimize your plastics material selection process.

Learning Objectives

At the conclusion of this seminar, attendees will be able to:
- Understand the properties of plastic materials
- Know what types of instruments are used in testing
- Demonstrate methods used to test the properties of plastic materials
- Possess the technical background necessary to select the optimum resin for a given application
- Apply measurements to the standards and specifications so the material and design meet an application's service requirements

Who Should Attend

This seminar will benefit product and part designers, engineers, engineering managers and those involved in the development of plastic parts. Specifically designed to enhance on-the-job effectiveness for professionals at all levels of plastics part development, this course will provide an invaluable foundation for selecting plastic materials and understanding their capabilities and limitations.

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

DAY ONE
- Introduction to Plastic Materials
  - Definitions
  - Thermoset vs. thermoplastics
  - Good (and bad) characteristics
  - General properties
  - Brief history
  - Economic "position" (commodity vs engineering vs specialty)
- Plastics-General Overview
  - Materials form
  - Shipment sizes
  - Pre-compounded vs blended
  - Drying/storing
  - Handling
  - Grades and lots

- Regrinding and reuse
- Polymer Chemistry Introduction/Review
  - Molecular weight
  - Distribution, dispersity index
  - Morphology
  - Molecular configuration
- Process Related Property Variations
  - Drying
  - Shrinking
  - Rheology
  - Additives

DAY TWO
- Properties of Plastics
  - DIN vs ASTM
  - Data shifts
  - Tests and their procedures
  - Chemical resistance
  - Optical properties
  - Color analysis
  - Weathering resistance
  - Abrasion resistance
  - Flammability
  - Electrical character
  - Chemical (analytical) testing
- Processing Properties
  - Melt index
  - Capillary remoter
  - Shrinkage
  - Thermal diffusion character
- Simple Plastics Materials Selection
  - Product needs assessment
  - Systematic selection
- Typical Materials Selection Errors
- Plastics Materials Review
  - The "Big Eight"
  - Commodity polymers
  - Engineering polymers
  - Rubbers and elastomers

Instructor: Robert G. Speirs
Fee $1225 1.3 CEUs

Mechanical Properties of Materials

2 Days
I.D.# C0007

Whether the materials being utilized are metals and alloys, ceramics, polymers, or composites, specifications on mechanical properties usually must be met. Such properties may include elastic stiffness (modulus), yield and tensile strengths, hardness, ductility, toughness, fatigue life, and creep strength. This seminar introduces the origin of these properties in materials and discusses the testing procedures and methods used in their determination. The various classes of materials behave in different ways when subjected to loads that can cause deformation and/or fracture to occur. The way in which the atoms or molecules are bonded together and the arrangement of these units relative to each other are the determining factors in the response to loading. Beginning with a brief overview of the more important categories of mechanical properties, the origin of these properties in crystalline solids such as metals and some ceramics will be discussed. The unique mechanical behavior of thermoplastic polymers will be reviewed and related to the molecular structure of these materials.

The testing of materials will be described with initial emphasis on the tensile test for metals and polymers. The definitions of engineering stress and strain as well as true stress and strain will be presented as part of this discussion. The extraction of strength, ductility and elastic modulus data from a tensile test will be explained, as will strain (work) hardening in metals and the effects of temperature of properties. Tests for hardness, toughness, fatigue, and creep will be covered, as well as bend testing (flexural strength) of ceramics and other brittle materials. Polymer properties will be discussed in terms of the category of polymer involved (thermoplastics, thermosets, elastomers), with clarification of the viscoelastic nature of deformation in these systems and the influence of temperature on behavior.

The seminar will conclude with group work sessions aimed at calculation of properties from raw test data and assessment of the significance of the calculations. An understanding of the origin and testing of mechanical properties in materials will be of benefit to those who deal with product design and materials specifications. The seminar will assist in clarifying the interactions among properties and the structural bases upon which these interactions are founded.

Learning Objectives

Upon completion of this seminar, participants will be able to:
- Associate the various mechanical properties of materials with the structures that they exhibit
- Recognize and define the more important types of mechanical properties in materials
- Associate the test method used with the type of mechanical property to be measured
- Describe the manner in which mechanical properties are determined from raw test data

Who Should Attend

No formal prerequisites for this seminar are needed. However, the content will be most meaningful to those engineers and technicians who deal with specification and testing of mechanical properties of materials, or to those who simply wish to obtain a more thorough understanding of properties, their origin, and the tests that are conducted to determine them.

Topical Outline

- General Description of Mechanical Properties
  - Definitions of stress and strain
  - Modulus of elasticity (stiffness)
  - Strength (yield, ultimate, fracture)
  - Specific strength and modulus
  - Hardness, ductility, toughness, fatigue, creep
- Origin of Properties in Metals and Crystalline Ceramics
  - Atom bonding related to properties
  - Crystal structures and defects (dislocations) -- Influence on properties; Interaction with microstructure; Movement under stress
- Tensile Test
  - Engineering stress and strain
  - True stress and strain
  - Interpretation of stress-strain curve -- Modulus; Tensile and yield strength; Ductility (% elongation, % reduction of area); Strain hardening; Effect of temperature (flow stress)
- Hardness Tests
  - Comparison of methods and scales
  - Microhardness tests
- Impact Testing for Toughness
  - Relation to true stress-true strain curve
  - Effect of temperature
  - Ductile-brittle transition in important alloys
- Fatigue Testing

- Definition of fatigue terminology
- Cyclic loading patterns
- S-N curves
- Rotating beam test
- Low and high cycle fatigue

- Creep Testing
  - Nature of creep
  - Effect of applied stress
  - Effect of temperature
  - Interpreting creep (stress-rupture) test results
- Testing of Ceramics
  - Bend test (flexural strength)
  - Fracture toughness
- Properties of Polymers
  - Thermoplastics -- Viscoelastic deformation; Anelastic recovery (strain rate effects); Effect of polymer structure (crystallinity, chain branching, etc.); Glass transition
  - Thermosets
  - Elastomers
- Group Work Session (property calculations/interpretation)
- Summary and Wrap-Up

Instructor: Darrell W. Smith
Fee $1225 1.3 CEUs

Metal Corrosion and Its Prevention

2 Days
I.D.# 99006

Corrosion accounts for billions of dollars in losses to a variety of metallic structures and products annually. This seminar provides insight into corrosion, its underlying causes, and potential solutions, topics which are important to all engineers involved with the design and specification of metal components and structures. Elementary concepts related to the more common types of corrosion will be reviewed, as well as the various methods available for minimizing corrosion in metals. This course will conclude by examining at least two corrosion case histories of interest to engineers involved in transportation vehicle design.

Types of corrosion to be described in this seminar include galvanic corrosion (dissimilar metals), concentration cell corrosion, crevice corrosion, stress corrosion, and corrosion-assisted fatigue. In addition, "uniform" corrosion will be discussed as it applies to such common occurrences as the general rusting of steel. Methods of corrosion protection include cathodic protection from sacrificial anodes and impressed DC voltage, anodic protection, inhibitors, and coatings. The effectiveness and limitations of these techniques will be discussed.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the basic electrochemical concepts of corrosion
- Identify the primary methods that can be used to prevent or minimize corrosion
- Define the nature of an actual corrosion problem and recommend a workable solution

Who Should Attend

Automotive, aircraft, off-highway and marine engineers involved in design, production, and quality functions that have an interest in corrosion and corrosion prevention in metal components and assemblies will benefit from this seminar. Since corrosion can only be adequately understood from electrochemical considerations, it is strongly recommended that each attendee has completed at least a one-semester course in college chemistry in which he/she was introduced to basic electrochemistry.

Topical Outline

DAY ONE
- General Introduction to Corrosion
- Electrochemical Nature of Corrosion
  - Anode-cathode relationships
  - Electrode potentials
  - Electromotive and galvanic series
- Rates of Corrosion
  - Measurement and specification
  - Polarization effects
  - Prediction
  - Passivity and environmental effects
- Corrosion Cells
  - Metal composition
  - Electrolyte concentration
  - Stress
- Forms of Corrosion
  - Uniform attack
  - Galvanic (dissimilar metals)
  - Crevice Corrosion
  - Pitting
  - Intergranular attack
  - Corrosion-assisted fatigue
  - Stress corrosion and hydrogen embrittlement
- Corrosion Problems and Calculations (Workgroups)

DAY TWO
- Corrosion Environments
  - H_2O and aqueous solutions
  - Acids and bases
  - NaCl and seawater
- Methods of Corrosion Prevention
  - Overview
  - Component design
  - Coatings
  - Cathodic protection
  - Anodic protection (passivation)
  - Inhibitors
  - Materials selection and treatment
- Video - "Corrosion in Action"
- Case Studies in Corrosion of Metals
  - Corrosion in the automotive industry
  - Corrosion in aluminum and aluminum alloys
  - Steel weldment corrosion
- Summary and Open Discussion

Instructor: Darrell W. Smith
Fee $1155 1.3 CEUs

Steel Heat Treatment

2.5 Days
I.D.# 99016

Numerous steel components in the automotive industry and its related vehicle manufacturing industries are heat treated in order to obtain the required final properties and/or to enhance their ease of fabrication. In addition, much of the tooling used by these industries for fabrication of components is also heat treated. The practice of heat treating is based on sound metallurgical principles that govern the changes in the microstructure of steel when it is heated and subsequently cooled under controlled conditions. Some knowledge and appreciation of these principles as they are applied to commercial heat treating operations is very helpful in the design and specification of heat treating procedures as well as in the solution of problems arising from poor heat treating practices.

This seminar will focus specifically on the heat treatment of steel. Fundamental background will be presented that will connect the ways in which microstructures (and therefore the properties) of steels are altered due to various types of thermal processing. Following an introduction to austenitizing (initial high temperature heating) and an examination of the various ways in which austenite transforms at lower temperatures, the influence of steel composition on heat treating response and properties will be discussed. These fundamentals will be emphasized in discussions of commercial heat treatments designed to either soften or harden steels, including annealing, normalizing, spheroidizing, austempering, marquenching, and conventional quenching and tempering. Common methods for surface hardening of steel, including carburizing and induction hardening, will also be examined.

Steel heat treating is a critical processing technology in the production of most vehicles. This seminar will provide an opportunity to study heat treating from a logical and basic point of view. In turn, the attendee will come away with a more thorough understanding of the microscopic events that occur during thermal processing of steel, and how critically important it is to control these events to obtain acceptable and reproducible properties.

Learning Objectives

By attending this seminar, you will be able to:
- Recognize and define the relationships between the microstructure of steel and its mechanical properties
- Associate the various possible structures and properties of steels with the composition of the alloy and the heat treating practice used
- Describe the metallurgical changes that accompany various commercial heat treatments
- Formulate logical fundamentally based solutions to real steel heat treating problems encountered in the industry

Who Should Attend

Some prior exposure to steel heat treatment will be helpful for the attendee. Such exposure may be from job-related activity, a home-study course, or other training instrument. The seminar will be of benefit to those persons whose on-the-job activity is in some way associated with steel heat treatment and properties. The level of the presentation will appeal most to the engineer and skilled technician level, and will be of interest to heat treating and components vendors to the industry as well as those involved directly with vehicle production, engineering, and quality control.

Topical Outline

DAY ONE
- General Introduction to Steel Heat Treating
- Definition and Classification of Steels
- Plain carbon and alloy steels
- Steel designations (AISI-SAE classification system)
- Metallurgical Fundamentals Related to Steels
- Crystal structure changes in iron and steel
- Carbon as an alloying element with iron
- The Fe-Fe 3C phase diagram
- Phases and microstructures in steels
- Rate of Microstructure Change During Heat Treatment
- Isothermal transformation
- Transformation during continuous cooling
- Alloying element effects on heat treating kinetics

DAY TWO
- Hardenability of Steels
  - Definition of hardenability
  - Influence of alloying elements
  - Considerations of steel thickness and cooling rates
  - Quenching media
  - The Jominy end-quench test for hardenability
  - "H" steels (specified hardenability limits)
- Review of Mechanical Properties
  - Strength and hardness
  - Ductility and toughness
  - Fatigue
- Commercial Heat Treating Processes
  - Annealing
  - Quenching and tempering
  - Marquenching
  - Austempering

DAY THREE (ends at approximately 12:00 noon)
- Surface Hardening of Steels
  - Unaltered surface composition (carburizing, carbonitriding)
  - Altered surface composition (induction, flame, laser)
- Workgroups — Solutions to Heat Treating Problems
- Summary and Wrap-Up

Instructor: Darrell W. Smith
Fee $1545 1.7 CEUs

Strictly Snap-Fits - Developing World-Class Plastic Part Attachments

2 Days
I.D.# C0201

This seminar provides attendees with an in-depth understanding of snap-fit technology. Seminar material covers everything from the minimum design requirements to lock feature selection and diagnosis of common problems. Attendees will acquire the knowledge to develop snap-fit applications that are optimized for reliability, manufacturing, assembly and customer usage. A new module introduces management and organizational concepts leading to a 'snap-fit capable' organization. Attendees are encouraged to bring their own examples and applications for discussion. Sample parts are provided to support a hands-on activity and attendees are encouraged to bring their own examples and applications for discussion.

Attendees will receive a copy of the instructor's book, *The First Snap-Fit Handbook*, second edition.

Learning Objectives

At the conclusion of this seminar, attendees will be able to:
- Explain how a snap-fit attachment functions as a complex system of features.
- Identify the minimum design requirements for a successful snap-fit attachment.
- Apply a process for developing fundamentally sound application concepts before committing to a final design.
- Recognize a wide variety of integral locking features and identify which is appropriate in a given application.
- Apply tricks of the trade which are otherwise learned through trial and error.
- Apply rules of thumb as well as analysis procedures for lock feature design.
- Recognize basic processing and material considerations for snap-fits.
- Follow a process for diagnosing common snap-fit problems.
- Define a snap-fit capable organization.

Who Should Attend

Engineers and designers with responsibility for designing, developing or testing plastic parts and applications engineers who must integrate parts into systems. Novices looking for an understanding of the basic principles of snap-fits as well as experienced designers/engineers will benefit from learning this systems approach to snap-fit technology. Managers of product design/development groups will also find the material useful for product development planning, establishing performance requirements, supplier/client interactions and guiding development projects.

Prerequisites

Participants should have an engineering or design degree or experience in plastic part design.

Topical Outline

DAY ONE
- Overview of the Attachment Level Â® Construct
  - The key requirements of a snap-fit application
  - Elements
- Constraint Features
  - Locator features
  - Lock features
  - Lock feature selection
- Enhancements
  - Assembly
  - Activating and using snap-fits
  - Performance
  - Manufacturing
- Fundamental Snap-fit Concepts
  - Constraint
  - Decoupling

DAY TWO
- Feature Design and Analysis
  - Pre-conditions for feature analysis
  - Material property data needed for analysis
  - Cantilever hook design rules of thumb
  - Initial strain evaluation
  - Adjustments to calculations
  - Cantilever hook analysis
  - Modifications to the insertion and retention face profiles
  - Other feature calculations
- The Snap-Fit Development Process
  - When is snap-fit appropriate?
  - Benchmarking
  - Generating multiple concepts
  - Analysis and design
- Diagnosing Snap-Fit Problems
  - Introduction
  - Rules for diagnosing snap-fit problems
  - Attachment level diagnosis
  - Feature level diagnosis
- The 'Snap-Fit Capable' Organization
  - Harmful beliefs
  - Suggested initiatives
  - A proposed capability plan
- Class summary
- Evaluation

Instructor: Paul Bonenberger
Fee $1325 1.3 CEUs

Racecar Data Acquisition and Analysis 100
Race Engine Calibration for Optimal Performance e-Seminar 101
Race Engine Calibration for Optimal Performance 101

Racecar Data Acquisition and Analysis

2 Days
I.D.# C0829

Data acquisition is an invaluable tool for establishing racecar and driver performance. The technology, once used by high-end racing teams with considerable financial resources only, has found its way to all racing disciplines during the past decade. Today, systems are available that provide an enormous amount of data logging capabilities, even to the club racer. This two day seminar covers the latest available technologies and teaches the participants how to analyze the data logging system's output and convert this knowledge into a key advantage on the racetrack. The seminar begins with a general introduction into data acquisition and measurement technology. The participants will then learn how to analyze the driver activities and use this analysis to improve driver performance. Vehicle performance analysis is extensively covered with an emphasis on vehicle balance, stability, wheel loads and weight transfer, aerodynamics and shock absorbers. The seminar concludes with the application of simulation software within the data logging environment. Numerous practical examples will be provided and the participants will receive detailed course notes and illustrations.

Attendees will also receive a copy of Jörge Segers' textbook, *Analysis Techniques for Racecar Data Acquisition*.

Participants are expected to bring a laptop computer with Microsoft Excel to the seminar for class exercises.

Learning Objectives

By attending this course attendees will be able to:
- Choose the appropriate hardware for your data acquisition system
- Identify the basics of electronically measuring physical parameters
- Designate the best way to visualize and organize your data for efficient analysis
- Diagnose problems from logged data
- Compare the performance of different drivers and cars
- Determine a vehicle's balance from logged data
- Perform aerodynamic measurements on a vehicle
- Analyze and alter the transient vehicle balance through damper tuning
- Calculate, measure, and analyze wheel loads
- Plan an appropriate race strategy
- Create a simulation model of your racecar and correlate the simulation results to logged data

Who Should Attend

This seminar will benefit anyone in the racing community wishing to expand their knowledge about racecar data acquisition and analysis. Engineers, crew chiefs, drivers, mechanics, and motorsport engineering students will benefit from the real-world examples and applications. In addition, individuals responsible for vehicle performance measurements in the passenger car industry will benefit from the data acquisition and analysis techniques presented in this seminar.

Topical Outline

DAY ONE
- Introduction: Why Data Logging?
  - Course outline, brief description of topics
  - Diagnostics
  - Performance analysis - driver
  - Performance analysis - vehicle
  - Vehicle development
  - Simulation
  - Running logs
  - What to measure?
  - Data categories
  - Data system cost
- Measurement Basics
  - A/D conversion
  - Measurement accuracy
  - Types of sensors
  - Data acquisition hardware - current trends
  - Sensor configuration
  - Wiring
  - Troubleshooting
- Different Ways to Display Data: Their Advantages and Disadvantages
  - Time/Distance plot
  - Statistics
  - Histograms
  - XY plots
  - Mathematical channels
  - Filtering
  - Data export
  - Templates
  - Data organization
- The Car's Vital Signs: Problem Diagnostics
  - Primary task of the data engineer
  - Data organization for effective troubleshooting
  - Dashboard warning signals
  - Telemetry
  - Tire pressure monitoring
  - Engine fuel mixture
- Comparing Performance: The Lap Overlay
  - Determining where time is gained or lost
  - Time compare channels
  - Improving the accuracy of the lap overlay with damper position sensors
  - Improving the accuracy of the lap overlay with GPS
  - Segment times and what we can learn from them
- Analyzing the Driver
  - Techniques for objective driver performance assessment
  - Comparing yourself to the competition
  - Driver coaching techniques with data acquisition
  - Acceleration
  - Braking
  - Gearing
  - Cornering
  - Driving lines
  - Consistency
  - Video logging
- Analyzing the Car
  - Acceleration
  - Braking
  - Gearing
  - Cornering

DAY TWO
- Vehicle Balance and Stability
  - The traction circle
  - Diagnosing oversteer/understeer
  - Quantifying the car's roll stiffness distribution
- Aerodynamics
  - Air density
  - Drag measurements
  - Downforce measurements
  - Straightline testing procedures
  - Aero measurements on the racetrack
  - Ride height measurement
- Shock Absorbers
  - Damping basics
  - Using the shock speed histogram for damper tuning
  - Establishing the road profile
  - Determining damper forces
  - Frequency analysis
- Wheel Loads and Weight Transfer
  - Lateral weight transfer
  - Longitudinal weight transfer
  - Banking and grade effects
  - How to measure wheel loads
- Race Strategy
  - Fuel consumption
  - Tire wear
- Simulation Tools
  - What is lap time simulation?
  - What advantages can a good lap time simulation model bring?
  - Introduction to Chassissim
  - Building up the model - getting the data
  - Circuit modeling
  - Model evaluation with data logging
  - Using simulation during races or test days
  - Suspension kinematics simulation
  - Interaction between data logging software and kinematics simulation
- Seminar Evaluation and Conclusion

Instructor: Jörge Segers
Fee $1305 1.3 CEUs

Race Engine Calibration for Optimal Performance e-Seminar

I.D.#PD130701ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this four and a half hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. This course offers six video modules; more than two hours of bonus material and software demonstrations; and a glossary of acronyms, accompanied by a handbook.

View the complete program brochure and demo at http://www.sae.org/e-seminars/raceenginecalibration.

What You Will Receive:

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf's, subject to DRM)
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Ronald D. Matthews
Fee $265 .7 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Race Engine Calibration for Optimal Performance

1 Day
I.D.# C0602

The engine control module (ECM, or on-board computer) is the tool used to control the fuel injection rate, fuel injection timing, ignition timing, rate of exhaust gas recirculation (EGR), and other functions. The task of "programming" the ECM is much easier for a race engine than for a production engine because the calibration engineer does not need to be concerned about emissions: EGR, keeping the exhaust catalyst "happy", etc.

This course provides a practical introduction to ECMs, including the uses for the various sensors. It also covers the specific methods used to incorporate the various sensor signals into the ECM's control systems for the fuel injection rate, fuel injection timing, and ignition timing. Background information will include an understanding of the desired air/fuel ratio and optimum ignition timing. While examples are tailored around the application of the ECM to Formula SAE race engines, this course is useful for improving any engineer's understanding of the functions of the ECM for other types of race engines as well as production engines.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the functions of the crank position sensor, cam position sensor, intake air temperature sensor, manifold air pressure sensor, mass air flow sensor, exhaust "oxygen" or lambda sensor, throttle position sensor, engine coolant temperature sensor, and knock sensor
- Explain how the ECM controls the fuel injection rate, fuel injection timing, and ignition timing
- Interpret base look-up tables, multipliers, and adders
- Develop base look-up tables, multipliers, and adders

Who Should Attend

Anyone interested in engine calibration/programming the on-board computer, especially for race engines. At a minimum, classification as at least a junior in a curriculum leading to a BS degree in engineering or experience in engine development is necessary background for taking this course.

Online Bonus Segments
Attendees will have the opportunity to access online bonus segments after the seminar. Segments will contain presentations by representatives of Ricardo and Performance Electronics, Ltd.

Online Segment by Ricardo in Brief:
Throughout this seminar, Prof. Matthews discusses how an accurate engine modeling code can be used to simplify the effort

required to generate the base look-up tables. In this segment, Steve Rawnsley of Ricardo discusses their WAVE engine modeling code, an example of a state-of-the-art engine modeling program that can be used to simplify engine calibration. Seminar attendees will be given information to contact Ricardo Software if they desire a WAVE product evaluation.

Online Segment by Performance Electronics, Ltd. in Brief:
The seminar is focused on learning how to program an aftermarket Engine Control Module (ECM) to obtain optimal performance from a race engine. In this segment, Brian Lewis of Performance Electronics, Ltd., discusses their aftermarket ECM. He discusses how various aspects of their ECM are to be used given the background from Prof. Matthews' discussion.

Topical Outline

- Basic engine theory
  - Relationships between torque, brake specific fuel consumption, engine design parameters, engine operating conditions, and four fundamental efficiencies (volumetric, combustion, indicated thermal, and mechanical)
  - Effects of fuel/air equivalence ratio
  - Effects of load
  - Effects of engine speed
  - MBT and LBT
  - Goals for race engines
  - Goals for production engines
  - Correction factors
- Engine sensors--the need for and use of:
  - Crank position sensor
  - Cam position sensor
  - Intake air temperature sensor
  - Manifold air pressure sensor
  - Mass air flow sensor (if used)
  - Exhaust "oxygen" or lambda sensor
  - Throttle position sensor
  - Engine coolant temperature sensor
  - Knock sensor
- Air/fuel ratio control
  - Base pulse width look-up table for speed-density systems
  - Benefits of MAF systems
  - Multipliers
- Ignition timing control
  - Base ignition timing look-up table
  - Adders

Instructor: Ronald D. Matthews
Fee $725 .7 CEUs

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Basic Noise Control

1 Day
I.D.# 86028

Gain an understanding of the basic physical principles needed to solve noise problems. This seminar provides an introduction to the physical principles, language and fundamental techniques used to control noise. Emphasis will be placed on the practical implications of the physical principles behind noise control. A short introduction will be given to the subjective measures of noise that serve as the background for many of the noise measurement methods in common use. The control of existing product noise through the design of enclosures and barriers as well as empirical approaches to the control of noise in cooling systems & hydraulic systems will be covered. Upon completion of the seminar, the student will be able to choose the appropriate noise control mechanism (absorption, barriers, source modification) and avoid the costly over application of noise control materials, which is common in retrofit programs.

Learning Objectives

By attending this seminar, you will:
- Become familiar with the terminology used in noise control
- Gain an understanding of the basic physical principles needed to solve noise problems. Success in "noise control", like many other areas, rests with a good grasp of the fundamentals
- Gain an understanding of the materials used to control noise and vibration (how specified and applied)

Who Should Attend

This seminar is intended for engineers who have recently been assigned responsibilities in the area of product noise control. It will also be beneficial for engineering managers who must evaluate the noise control programs that are within their area of responsibility.

Prerequisites

An undergraduate engineering degree in any discipline is recommended. Material presented will be practical in nature with mathematics limited to the level encountered in a freshman-engineering program.

Topical Outline

- Introduction to Sound
  - Nature of sound
  - Decibel notation
  - Sound intensity & power
  - Propagation
- Basic Noise Control Concepts
  - Absorption
  - Reverberation
  - Barriers
- Vibration Control
  - Isolation
  - Damping
- Vehicle Noise Control
  - Noise sources
  - Materials
- Hydraulic System Quieting
  - Lines & pumps
  - Accumulators, silencers
- Cooling System Quieting
  - Fan laws
  - Fan, shroud & environmental effects
- Subjective Considerations

Instructor: Robert F. Hand
Fee $725 .7 CEUs

Noise and Vibration Measurement: Instruments and Facilities

1 Day
I.D.# 86030

Learn how to get the most accurate noise measurement data. Providing a broad introduction to the instruments and facilities used to measure noise and vibration, this seminar emphasizes the proper selection of transducers, calibration, limitations of instruments and choice of analyzers to support the project objectives. Extra emphasis will be given to the proper selection and operation of tape recording systems used to store data for later analysis. The course will also include a discussion of the design and qualifications of anechoic rooms, reverberant rooms and outdoor test sites.

Learning Objectives

By attending this seminar, you will:
- Gain an understanding of how to select appropriate instrumentation for noise measurement
- Learn the limits of equipment and facilities in getting accurate data
- Common errors in application of equipment will be discussed
- Become familiar with facility limitations
- Receive an introduction to some of the latest measurement/analysis techniques available

Who Should Attend

A minimal understanding of electronics and a mathematics comprehension at the freshman college level is required. An undergraduate degree in engineering in any subject area is also required. This course is intended for engineers who have only a limited exposure to noise and vibration measurement systems but are required to select instruments for purchase or choose the necessary instruments to gather valid data in support of a noise control program. This course would also be suitable for engineering managers who must review staff proposals for new equipment or facilities.

Topical Outline

- Noise Measurements
  - Microphones - selection & calibration
  - Windscreens
  - Sound level meters
- Magnetic Recording
  - Analog recording
  - Digital recording
- Spectrum Analyzers
  - Parallel & sweeping filters
  - Digital techniques
- Test Facilities
  - Rooms: reverberant & anechoic
  - Dynamometers
  - Test sites
- Vibration Instrumentation
  - Accelerometers: piezoelectric & piezoresistive
  - Operational limitations

Instructor: Robert F. Hand
Fee $725 .7 CEUs

Noise Diagnostics and Analysis Using Acoustic Imaging Technologies

2 Days
I.D.# C0607

The demand for better and quieter vehicles in terms of NVH performance is increasing every year. This course covers the subject of noise diagnosis using various acoustic imaging technologies including nearfield acoustical holography (NAH) and beamforming technology. Acoustic imaging technologies and traditional noise diagnostic methodologies such as using a sound pressure level meter, scanning a sound intensity probe, performing laser vibrometer measurement, and transfer path analysis (TPA) will be covered. The diagnosis of noise sources and interrelationships between sound and vibration will be fully explored and students will have the opportunity to observe demonstrations of different acoustic imaging tools such as NAH and beamforming.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the relationship between vibration and sound
- Explain the advantages and limitations of the traditional noise diagnostic methods
- Describe the benefits of the acoustic imaging technologies to diagnose noise sources
- Detect noise sources and their transmission paths using NAH

Who Should Attend

This course is designed for engineers in the road, off-road and aerospace industries who are responsible for noise mitigation. NVH engineers, as well as individuals responsible for the design of applications with associated NVH issues, are encouraged to attend.

Prerequisites

A baccalaureate degree in mechanical engineering and several years of experience in NVH are recommended.

Topical Outline

DAY ONE
- Basic Terminologies
  - Acoustic pressure, particle velocity, acoustic intensity, and acoustic power
  - Acoustic wavelength, frequency, and speed of sound
  - Acoustic far field versus near field
  - Structural wavelength, natural frequency, and natural modes
  - Monopole, dipole, and quadrupole sources
  - Airborne and structure-borne sounds
  - Interrelationships between sound and vibrations
- Acoustic Imaging Technologies and Implementations
  - Fourier transform based planar nearfield acoustical holography (PNAH)
  - Inverse boundary element method (IBEM)
  - Helmholtz equation least squares method (HELS)
  - Beamforming
- Comparisons of Acoustic Imaging Technologies
- Comparisons of Acoustic Imaging Technology and Traditional Methods
  - HELS versus Intensity Probe
  - HELS versus Beamforming
  - HELS versus Transfer Path Analysis (TPA)

DAY TWO
- Applications of Acoustic Imaging Technologies to Noise Diagnosis
  - Visualization of vehicle interior sound pressure field
  - Visualization of vehicle interior sound intensity field
  - Visualization of break squeals noise
  - Visualization of vehicle tire noise
  - Visualization of door slamming sound
  - Diagnosis of vacuum cleaner noise
- Applications of Beamforming Technology
  - Vehicle engine noise
  - Vehicle wind tunnel test
  - Vehicle pass-by noise
  - Vehicle interior noise
- Demonstrations on Using NAH and Beamforming

Instructor: Sean Wu
Fee $1225 1.3 CEUs

Sound Package Materials for Vehicle Noise Control

2 Days
I.D.# 92032

Selection of acoustical materials for vehicle interior noise reduction requires an in-depth understanding of vehicle noise, noise propagation, and the noise control properties of acoustical materials. This seminar will provide a detailed analysis of three different acoustical materials, how they are different from each other, and acoustical properties that materials should possess for optimum vehicle noise control. Attendees will also learn ways to evaluate the acoustical performance of these materials using different test methods. This seminar was formerly titled Selection, Evaluation and Measurements of Acoustical Materials for Vehicle Interior Noise.

Learning Objectives

By attending in this seminar, you will be able to:
- Recognize various types of noise problems and noise paths in a vehicle

- Identify types of acoustical materials
- Describe ways that acoustical materials work and how they differ from each other
- Distinguish test methods used to evaluate the acoustical performance of material

Who Should Attend

Designed for OEM or supplier employees responsible for various noise activities, such as design, evaluation, trouble-shooting, supplying, and/or manufacturing noise control treatments and parts, this seminar will also benefit those with responsibilities including the areas of manufacturing, design, engineering, process, noise and release engineering, supervision or management. Attendees should have an undergraduate engineering degree and a working knowledge of noise control and automotive acoustics.

Topical Outline

- Introduction and Overview
  - Defining acoustical performance of acoustical parts
  - Fundamentals
  - Sound waves and sources
  - Sound sources
  - Definition of terms
  - Human response to sound
  - Various noise and vibration instrumentation
- Noise in Vehicles
  - The noise system
  - Vehicle noise sources
  - Road and wind noise
  - Miscellaneous noise sources
- Principles of Noise Control
  - Noise control design approach - source, path, receiver
- Materials for Vehicle Noise Control
  - Absorber, including case studies and test methods
  - Barrier, including case studies and test methods and the effect of holes
  - Damper, including case studies and test methods
  - Isolator
- Different Automotive Measurements
  - Vehicle
  - Component
  - Material

Instructor: Pranab Saha
Fee $1225 1.3 CEUs

Vibration Analysis using FEA: A Hands-on Workshop

2 Days
I.D.# C0830

FEA has been used by engineers as a design tool in new product development since the early 1990's. Until recently, most FEA applications have been limited to static analysis due to the cost and complexity of advanced types of analyses. Progress in the commercial FEA software and in computing hardware has now made it practical to use advanced types as an every day design tool of design engineers. In addition, competitive pressures and quality requirements demand a more in-depth understanding of product behavior under real life loading conditions. This seminar introduces one of the advanced types of FEA: vibration analysis. By considering time dependent loads and inertial effects, vibration analysis allows for a more in-depth product simulation thus reducing product development cost and time. The course reviews basic concepts of vibration analysis and illustrates how they are implemented in FEA to simulate product behavior. The most common types of vibration analysis such as modal, time response, frequency response and random vibrations are covered. Participants will have the opportunity to practice skills learned utilizing the commercial FEA software SolidWorks Simulation.

Learning Objectives

By attending this seminar, you will be able to:
- Evaluate the importance of dynamic effects in product simulation
- Analyze inertial and damping effects in structural response
- Use vibration analysis as a design tool
- Perform time response, frequency response and random vibration analyses
- Apply proper FEA modeling techniques to model system dynamic

Who Should Attend

The seminar will be of interest to any design engineer who already uses Finite Element Analysis (FEA) as a design tool and would like to explore if and how vibration analysis with FEA may benefit the design process. It builds on participants' experience with static FEA and on knowledge of mechanical vibrations common to any mechanical engineer.

Prerequisites

Participants should have a degree in mechanical engineering and have some experience with FEA either by participating in the SAE seminar ID# 93006 - "Finite Element Analysis for Design Engineers" or through equivalent work experience.

Topical Outline

DAY ONE
- Structure vs. Mechanism
- Fundamental Assumptions in the FEA
- Verification and Validation of FEA Results
- Modal Analysis
  - Convergence of frequencies
  - Rigid body modes
  - Properties of lower and higher modes
  - Eigenvalues and eigenvectors
  - Modal superposition method
  - Modes separation
  - Modeling techniques in modal analysis
- Time Response Analysis
  - Time depended load
  - Impulse load
  - Static vs. dynamic response
  - Time response of a single degree of freedom oscillator

DAY TWO
- Frequency Response Analysis
  - Steady state harmonic response
  - Force and base excitation
  - Resonance
  - Modal damping
  - Frequency response of two degrees of freedom oscillator
- Random Vibration
  - Acceleration power spectral density
  - Interpretation of random vibration results
- Linear vs. Non-linear Vibration Analysis
- Modeling Considerations in Vibration Analysis

Instructor: Paul Kurowski
Fee $1265 1.3 CEUs

Vehicle Noise Engineering Academy: Powertrain Noise Webinar Series

36 Hours
I.D.# WB1035

Note to Corporate Customers: This comprehensive Academy program can be delivered whole or in part as an instructor led, classroom event at your facility or as a series of webinar sessions. Contact SAE Corporate Learning Solutions for a no-obligation consultation at 1-724-772-8529 or corplearn@sae.org.

The Vehicle Noise Engineering Academy covers a variety of vehicle noise control engineering principles and practice. In a multi-session webinar format, there are two specialty tracks from which you can choose, based on your area of interest: either Powertrain Noise or Vehicle Interior Noise. The Powertrain Noise track focuses on NVH issues generated by powertrain noise sources (engines, transmissions/transfer cases, accessories, exhaust, gears, axles, joints, and couplings) and the design strategies to minimize them. Throughout the series of 18 two-hour sessions, considerable attention is given to current measurement and instrumentation technologies and their effective use.

Learning Objectives

By connecting with this virtual academy, you will be able to:
- Define vehicle acoustics engineering terminology and principles
- Articulate powertrain noise terminology and principles
- Formulate a systematic approach to problem solving and measurement
- Conduct appropriate performance verification tests
- Analyze the contributing vehicle noise sources when devising noise solutions
- Produce valid measurements with noise instrumentation and accurately interpret results

Who Should Attend

This Powertrain Noise Webinar Series, a track of the Vehicle Noise Engineering Academy, will be especially valuable for engineers who address powertrain noise in the following types of vehicles: passenger cars; heavy trucks; light trucks; off-highway vehicles; farm machinery; aircraft; personal watercraft; rail transit vehicles

Topical Outline

NOTE: The following sessions are included in your registration for the Powertrain Noise Track of the SAE Vehicle Noise Engineering Academy. If you prefer , the session groupings may be available separately. Please ask your SAE Corporate Learning contact.

Pre-Academy Assignment
Recorded module, readings, and exercises on noise fundamentals, delivered in advance of the start of the Academy through the online Learning Center.

Session 1: Welcome and Introduction
- Pre-Academy Assignment: Review and Q&A
- Overview of the SAE Vehicle Noise Engineering Academy Powertrain Noise and Vehicle Interior Noise Tracks

Sessions 2-3: Fundamentals of Vehicle Sound Quality
- Review of Various Sound Quality and Noise Issues
- Human Hearing Mechanism
- Sound Quality Process
- Listening evaluation
- Recording
- Objective measures
- Relationship between listening evaluation and objective measures

Sessions 4-7: Engine Noise - Source Mechanisms and Their Control
- Combustion, Piston, Valve Train, Crankshaft, Oil Pump, Internal Gear, Timing Chain Noise
- Slider/Crank Dynamics
- Order-Number Analysis
- Intake/Exhaust Noise Control (mufflers and tuners)
- Engine Covers

Sessions 8-11: Accessory Drive, Engine Mounting, Driveline, and Transmission Noise Sources and Control
- Belt and Tensioner Noise
- Accessories Noise from Alternators, Power Steering, and Air Conditioner
- Electric Accessories such as Vacuum, Hydraulic, and A/C Pumps
- Transmission and Gear Noise
- Transmission Shift Quality
- Driveline Arrangements and Vibratory Response
- Axle and Join Noise Control Devices
- Elastomer Materials and Tuned Dampers
- Engine Mounting Systems

Sessions 12-15: Digital Signal Processing Applied to Automotive Noise Analysis
- Introduction to FFT Analysis and Digital Filters
- Rotating Machinery and Order-Number Analysis
- Time-Frequency Methods
- Fundamentals of Multi-Input-Multi-Output (MIMO) System Analysis
- Forces and Sources in MIMO Systems
- Introduction to Data Classification and Pattern Recognition

Sessions 16-18: Diesel Engine Noise Control and Automotive System Integration
- Diesel Engine, Combustion, and Surface Radiation Noise
- Oil Pan: Radiated Sound and FE Modeling
- Gear Train Noise Issues
- Drive-by Noise Comparison
- Diesel Engine Design Consideration
- Oil Pump Noise
- Systems Integration
- Examples of Proper and Poor Designs

Instructors: Alan D. Stuart, Pranab Saha, Mike Albright, Gordon Ebbitt, Mike Grimmer, Art Howle, Tom Reinhart
Fee $1995 3.6 CEUs

Vehicle Noise Engineering Academy: Vehicle Interior Noise Webinar Series

36 Hours
I.D.# WB1036

Note to Corporate Customers: This comprehensive Academy program can be delivered whole or in part as an instructor led, classroom event at your facility or as a series of webinar sessions. Contact SAE Corporate Learning Solutions for a no-obligation consultation at 1-724-772-8529 or corplearn@sae.org.

The Vehicle Noise Engineering Academy covers a variety of vehicle noise control engineering principles and practice. In a multi-session webinar format, there are two specialty tracks from which you can choose, based on your area of interest: either Vehicle Interior Noise Control or Powertrain Noise Control. The Vehicle Interior Noise track focuses on the understanding and application of acoustical materials to optimize NVH in the passenger or operator compartment of a vehicle. Throughout the series of 18 two-hour sessions, considerable attention is given to current measurement and instrumentation technologies and their effective use.

Learning Objectives

By connecting with this virtual academy, you will be able to:
- Define vehicle acoustics engineering terminology and principles
- Identify available acoustical materials and determine their optimum application
- Formulate a systematic approach to problem solving and measurement
- Conduct appropriate performance verification tests
- Analyze the contributing vehicle noise sources when devising noise solutions
- Produce valid measurements with noise instrumentation and accurately interpret results

Who Should Attend

This Vehicle Interior Noise Webinar Series, a track of the Vehicle Noise Engineering Academy, will be especially valuable for engineers who address vehicle interior noise in the following types of vehicles: passenger cars; heavy trucks; light trucks; off-highway vehicles; farm machinery; aircraft; personal watercraft; rail transit vehicles.

Topical Outline

Pre-Academy Assignment

Recorded module, readings, and exercises on noise fundamentals, delivered in advance of the start of the Academy through the online Learning Center

Session 1: Welcome and Introduction
- Pre-Academy Assignment: Review and Q&A
- Overview of the SAE Vehicle Noise Engineering Academy Powertrain Noise and Vehicle Interior Noise Tracks

Sessions 2-3: Fundamentals of Vehicle Sound Quality
- Review of Various Sound Quality and Noise Issues
- Human Hearing Mechanism
- Sound Quality Process
  - Listening evaluation
  - Recording
  - Objective measures
  - Relationship between listening evaluation and objective measures

Session 4: Vehicle Interior Noise
- Automotive Noise Problem
  - Automotive noise system
  - Uniqueness of acoustical treatment
- Different types of measurements

Sessions 5-6: Introduction to Numerical Acoustics
- Why CAE for Noise Prediction
- Review of Basic Acoustics Related to Noise Prediction
- Boundary Element Method (BEM)
- Finite Element Method (FEM)
- Statistical Energy Analysis (SEA)

Sessions 7-9: Instrumentation and Test Facilities Associated with the Vehicle Sound Package Development
- Sound and Vibration Transducers
  - Microphones, accelerometers, calibrators
  - Sound level meters
- Spectrum Analyzers
  - FFT analyzers
  - Laser vibrometers and sound intensity probes
- Test Facilities
  - Reverberation room, anechoic room, special testing equipment

Sessions 10-18: Sound Package Development for Vehicle Noise Control
- Source-Path-Receiver System and Vehicle Noise Sources
  - Various noise controls using acoustical materials
  - Acoustical materials and test methods
- Acoustical Materials, Test Methods, Case Examples of Absorbers, Barriers, Dampers
  - Application of the acoustical material
  - Primary function
  - How it works
  - How to improve performance
  - How one material differs from other materials
- Overview of Modal Analysis
  - Mode shapes and natural frequencies
  - How structures respond to localized forces and distributed pressures
  - Examples of the modal response of simple vibrators, beams, and panels
  - How panel modes affect low frequency sound transmission loss
- Isolators
  - Application
  - How it works
  - Case examples
- Different Measurement Techniques / Closing

Instructors: Pranab Saha, Alan D. Stuart, Gordon Ebbitt, Andrew Seybert

Fee $1995 3.6 CEUs

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Design of Experiments (DOE) for Engineers Webinar 114
Design of Experiments - Basic Simplified Taguchi 115
Simplified Taguchi/DOE Methods 116
Statistical Methods for Quality Engineering 117
Aerospace Product Support: Sustainment Throughout the Life Cycle 118
Weibull-Log Normal Analysis Workshop 118

Advanced Product Quality Planning (APQP) Workshop

4 Days
I.D.# C0111

This four-day workshop will provide you with fundamental knowledge and hands-on practice with the Advanced Product Quality Planning process and key tools. Topics addressed include the overview and application of the APQP process, Failure Mode and Effects Analysis, Control Plans, and Error Proofing. The program is designed for all levels of design and manufacturing personnel, as well as more experienced engineering and management personnel, especially for those involved in developing new products or processes. Why All Four Topics Together? APQP, FMEAs, Control Plans, and Error Proofing are all interrelated and build on each other. Training that focuses only on one of these subjects at a time cannot show how these tools work together to minimize effort, improve quality, and complete programs more quickly with less headaches before, during, and after launch. Participants apply these key tools together to bring an actual product from concept to production during this comprehensive, start-to-finish workshop.

Learning Objectives

By attending this seminar, attendees will learn:
- APQP phases, milestones, and deliverables
- The relationship between APQP, PPAP, FMEAs, and Control Plans, and Error Proofing
- Step-by-step instructions for completing Design and Process FMEAs
- How to avoid some of the most common FMEA pitfalls
- How to use FMEAs and other inputs to complete Control Plans easily and quickly
- Error proofing and mistake proofing concepts, applications, and opportunities throughout the APQP process.

Who Should Attend

This course is designed for individuals with minimal experience with the APQP process and its related key tools. However, many experienced individuals attend the course to refresh their knowledge, gain advanced strategies, and practice development and application of these tools with an experienced facilitator. Program managers, design-responsible engineers or managers, potential APQP or FMEA team members such as operators and technicians, quality personnel, and other product design and manufacturing personnel who are interested in continuous improvement strategies will all benefit.

Prerequisites

Attendees should have some previous experience with the APQP process and related tools.

Topical Outline

DAY 1
- Advanced Product Quality Planning
  - Pre-Assessment
  - Product Quality Planning Responsibility Matrix
  - Fundamentals of Product Quality Planning
  - Product Quality Planning Timing Chart
  - Plan and Define Program
  - Voice of the customer -- Market research; Historical warranty and quality information; Team Experience
  - Business plan/marketing strategy
  - Product/process benchmark data
  - Product/process assumptions
  - Product reliability studies
  - Customer inputs
  - Design goals
  - Reliability and quality goals
  - Preliminary bill of materials
  - Preliminary process flow chart
  - Preliminary listing of special product and process characteristics
  - Product assurance plan
  - Management support
- Product Design and Development
  - Design failure mode and effects analysis (DFMEA)
  - Design for manufacturability and assembly
  - Design verification
  - Design reviews
  - Prototype build -- control plan
  - Engineering drawings (including math data)
  - Engineering specifications
  - Material specifications
  - Drawing and specification changes
  - New equipment, tooling and facilities requirements
  - Special product and process characteristics
  - Gages/testing equipment requirements
  - Team feasibility commitment and management support
- Process Design and Development
  - Packaging standards
  - Product/process quality system review
  - Process flow chart
  - Floor plan layout
  - Characteristics matrix
  - Process failure mode and effects analysis (PFMEA)
  - Pre-launch control plan
  - Process instructions
  - Measurement systems analysis plan
  - Preliminary process capability study plan
  - Packaging specifications
  - Management support
- Product and Process Validation
  - Production trial run
  - Measurement systems evaluation
  - Preliminary process capability study
  - Production part approval

- Production validation testing
- Packaging evaluation
- Production control plan
- Quality planning sign-off and management support

- Feedback, Assessment and Corrective Action
  - Reduced variation
  - Customer Satisfaction
  - Delivery and service
  - Supplements
  - Post-Assessment

DAY TWO

- Failure Mode and Effects Analysis
  - Pre-assessment
  - Instructor-lead development of a sample FMEA
  - FMEA definition, questions, purpose, and benefits
  - Types of FMEAs, their focus, and their relationship with QS-9000
  - Timing of FMEA development and revisions
  - FMEA team composition and data inputs
- Design FMEA Development
  - DFMEA Candidates, Timing, and Inputs
  - Prepare the Form for Traceability
  - Item/Function, Failure Modes, and DFMEA Assumptions
  - Effects and Severity: Worst Case Scenarios
  - Causes and Occurrence: Warranty Data vs. Test Data
  - Current Design Controls and Detection: Ranking Criteria Weaknesses
  - Risk Priority Number: One of several indicators
  - Recommended Action Do's and Don't's
  - DFMEA group exercises
- Process FMEA Development
  - PFMEA Candidates, Timing, and Inputs
  - Process Requirements, Failure Modes, and PFMEA Assumptions
  - Effects and Severity: The Five Categories of Effects
  - Causes and Occurrence: The link with Cpk and the 5 Whys
  - Current Design Controls and Detection: The Case for Error Proofing
  - Risk Priority Number: Proper RPN Calculation
  - Recommended Action: What if there isn't one?
  - PFMEA group exercises
- FMEA Application Workshop
  - Participant-lead Review of Day 1 Content
  - Brainstorming, Selection, and Practice on a Sample FMEA Project
  - Guided Small Group FMEA Development
  - Small Group FMEA Presentations

DAY THREE

- FMEA and Control Plans
- FMEA Summary and Advanced Strategies
  - Characteristics of Good FMEAs
  - Concurrent Development of PFMEAs and DFMEAs: Benefits and Sources of Confusion
  - Data-Gathering Strategies and Related Quality Tools
  - Cost/Benefits Analysis and Cost of Changes
  - Potential Problems, Pitfalls, and Areas of Confusion: Beware of RPN Threshholds
  - FMEA Maintenance and Control Plan Links
  - Mining for Gold using FMEAs
  - Group Summary Exercises
  - Post-Assessment
- Control Plans
  - Pre-Assessment
  - What is a Control Plan?
  - How is a Control Plan Developed?
  - The Benefits of a Control Plan
  - Control Plans and the Product Life Cycle
  - Control Plan Inputs
  - The Control Plan Team (Process Team)
- Process Flow and Characteristics
  - Operation Flow
  - Characteristics
  - Control Methods
  - Determining Sources of Variation
  - Table of Controls
  - Evaluation Methods/Measurement Technique
  - Sample Size/Frequency
  - Reaction Plans
- Standardization and Continuous Improvement
  - Standardizing the Control Plan
  - Typical Instructions
  - Document Maintenance
  - Periodic Assessment
  - Process Review Flow Chart
  - Supplemental Information
  - Post-Assessment

DAY FOUR

- Error Proofing and Workshop Summary
  - Pre-assessment
  - The philosophy of process-focused quality
  - What is Error Proofing and Mistake Proofing?
  - Everyday examples of Error Proofing
  - Manufacturing examples of Error Proofing
  - Purpose and Benefits of Error Proofing
- The Key Elements of Error Proofing
  - Inspection Strategies
  - Feedback Categories
  - Intervention Levels
- Error Proofing Case Studies
  - Conduct the following steps on three manufacturing case studies: Analyze Process Data; Brainstorm Error Proofing Solutions; Conduct Cost/Benefits Analysis; Recommend Solutions; Peer Analysis
- Error Proofing, QS-9000, and the APQP process
  - QS-9000 Error Proofing requirements
  - Error Proofing strategies for each APQP phase
  - The role of Product Design Error Proofing
  - The link between Process FMEA and Error Proofing
  - Error Proofing at the Plant Level
- Error Proofing Case Study Workshop
  - Each team will be assigned a process and supporting data, and will work together to do the following: Create a process flow diagram; Conduct a root cause analysis and problem solving worksheet; Brainstorm Error Proofing Solutions; Conduct cost/benefits analysis; Complete an Error Proofing worksheet; Present the case before the group
- Error Proofing Summary and Advanced Strategies
  - Timing is everything: designing in Error Proofing
  - Choosing your Error Proofing battles
  - Resisting the temptation to inspect and rework
  - Data-Gathering Strategies and Related Quality Tools
  - Cost/Benefits Analysis Methods
  - Potential Problems, Pitfalls, and Lessons Learned
  - Additional Resources
  - Post-Assessment

Instructor: Daniel P. Bauer, Jr.

Fee $1655 2.6 CEUs

Global 8D - Ford Online Course

I.D.#PD111012ON (Online delivery)

Global 8D (G8D) is a disciplined process developed by Ford Motor Company to help product development and manufacturing engineers identify and solve problems. Solving problems results in efficient, as well as effective, resolution to 'root causes' of customer satisfaction issues, and helps reduce warranty costs. With this 12-hour online course, you will learn the methods and tools used to complete each step in the Ford Global 8D find-and-fix problem-solving process, including steps to define the problem, verify the root cause and escape point, and prevent occurrence.

Major topics include:

- Global 8D Overview
- Prepare for Global 8D and Establish the Team
- Describe the Problem and Find the Root Cause
- Choose and Implement a Permanent Corrective Action (PCA)
- Complete the Global 8D

Is this SAE/- Ford Online Course for you?

This course is geared toward quality, manufacturing, and product development engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

- Four months of online access to the 12 hour course
- Proof of Participation

Fee $395

Introduction to Advance Product Quality Planning (APQP) Fast Track

I.D.#PD230908ON (Online delivery)

To become a preferred supplier in the automotive industry, organizations must demonstrate high-level engineering and organizational capabilities that will meet customers' needs today and tomorrow. Because the outcome of a product development project may determine whether or not an organization procures a purchase order or contract from a global automotive customer, the *Introduction to Advanced Product Quality Planning Fast Track* will address an overview of the best practices / methodologies for planning and managing the successful launch of a new product.

Major topics include:

- What is APQP?
- What is the purpose of APQP?
- Understanding how APQP integrates into the automotive supply chain
- APQP - A master plan for new product development
- Summary of APQP benefits

Is this Fast Track for You?

Participants in the *Introduction to Advanced Product Quality Planning (APQP) Fast Track* will gain a 'common-sense' perspective for successful new product launches and what needs to be done to comply with automotive customer specific requirements. You will also understand how to apply the concepts of "front-end" planning (via the APQP process) that will result in continual improvement of products and services for both the customer and the supplying organization. This course is relevant to individuals with limited or general knowledge of the APQP process and some experience with introducing new products or new manufacturing processes.

What You Will Receive

- Three months of online access to the one hour presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructor: Larry Bissell
Fee $109

IAQG Sanctioned Aerospace Auditor Transition Training (AATT)

4 Days
I.D.# C1034

SAE International, the society dedicated to advancing mobility engineering worldwide, is pleased to be a recognized training provider of the classroom component of the IAQG-Sanctioned Aerospace Auditor Transition Training (AATT) . As an approved training provider, SAE is committed to providing the highest level of quality training using the most qualified instructors in the industry. This four-day course is the instructor-led classroom component of the AS9100 IAQG-Sanctioned training and includes how to audit to the AS9100 series standards using the process-based approach of AS9101D. Along with the training in this instructor-led component, there is a continual evaluation of each participant, paying particular attention to his/her active participation, role play, and case study exercises. The fourth day includes an online final examination and interview.

This course is certified by RABQSA International and meets the classroom training requirements of the IAQG Sanctioned Aerospace Auditor Transition Training for AS9100:2009. Successfully completing the AATT program and the awarding of the Certificate of Successful Completion satisfies the training requirements for auditors to update their AA, AEA and AIEA certification.

Required Training Elements:
There are three required elements to completing the Aerospace Auditor Transition Training and include the initial online exams and training module, the instructor-led AATT classroom course, and the final exam and interview.

Online Pre-Work:
- Prior to taking the classroom portion of this course, participants complete the Knowledge and the Application Initial Examinations (45 minutes each). Participants obtaining a score of 90% or better on both exams have the option of opting out of the online training module. Participants scoring less than the prerequisite 90% are then required to complete the Foundations: Understanding 9100 online training module. This module typically takes between eight and twenty hours to complete. Participants will receive a Certificate of Completion of the Online Training Module and must present this certificate to SAE to gain admittance to the classroom course.

Note: Registration for the online exams and training module must be done through Plexus Intl. It is recommended that everyone review the online training module prior to attending the AATT classroom course. Participants have access to this online module and associated online material for future reference.

Instructor-Led Classroom Training:
This course consists of three days of instructor-led training and one day of assessments. During the three days of classroom training attendees develop an audit package through various exercises. In addition, the instructors will evaluate the attendee's ongoing participation and learning achievement during the class. Class size is limited to twelve.

Final Exam:
On the fourth day attendees complete an online knowledge and application exam. The attendees will go through an interview with the instructors to review his/her audit package as well as an explanation of the instructors' conclusions. Based on the aggregate of the trainee's ongoing evaluation during the instructor-led course, the online knowledge and application exam, and the interview each participant will be issued a final grade. An aggregate score of at least 80% is required to pass.

Learning Objectives

By successfully completing this course, attendees will be able to fulfill the classroom requirement of the IAQG Sanctioned Aerospace Auditor Transition Training by demonstrating knowledge of audit planning; auditing top management; auditing process owners; auditing process trails; conclusions, reporting, and certification; surveillance and recertification; special audits.

Who Should Attend

For auditors seeking authentication to AS9100:2009, this certified course is intended to fulfill the instructor-led classroom training requirement of the Aeropace Auditor Transition Training (AATT). Additionally, aeronautics, space, and defense industry personnel responsible for establishing, implementing, and evaluating quality management systems will benefit from the information presented in this course.

Prerequisites

Registering for and completing the AS9100 online module through Plexus Intl. is the first step in meeting the IAQG AATT training requirements. Proof of satisfactory completion (copy of Certificate of Completion) required to gain admittance to the instructor-led course. The online component begins with the Knowledge and Application Initial Examinations followed by the Foundations: Understanding 9100 online training module. Participants achieving a score of 90% or better on the exams may opt out of taking the online training module. Upon completion, participants will be provided a Certificate of Completion of the Online Modules. In order to be admitted to the SAE instructor-led classroom course, must present to SAE the Certificate before the start of class or achieve a passing score of 90% on both Initial Examinations.

Topical Outline

DAY ONE
- Bridging the online modules and classroom training
- Pre-Audit Activities
- Stage 1 Audit Activities

DAY TWO
- Stage 2 Audit Planning
- Auditing Top Management
- Auditing Process Owners
- Auditing Process Trails

DAY THREE
- Audit Conclusions
- Audit Reporting
- Certification Requirements
- Surveillance, Recertification and Special Audits
- Use of the new AS9101D Audit Forms

DAY FOUR
- Final Online Knowledge and Application Exams
- Oral Interview Exam

FINAL DETERMINATION OF PASS/FAIL
- Final scores and the determination of Pass/Fail are provided by the IAQG and not the training provider.

Instructor:
Fee $2195 2.6 CEUs

Understanding AS9100C Quality Management System Standard

2 Days
I.D.# C0935

In a global economy, suppliers have the challenge of delivering products to multiple customers with varying quality requirements and expectations. To assure customer satisfaction, aviation, space and defense organizations must produce and constantly improve safe, reliable products that meet or exceed customer demand in addition to meeting statutory and regulatory requirements. This two-day seminar focuses on the changes to the newly revised AS9100, in Revision C to ensure solid application of the new specifics for the revision of this standard and its family of documents. AS9100 has been revised to incorporate the requirements of ISO 9001:2008. Included in the training will be a detailed review and intent of AS9100-C requirements and all changes made with an overview of the process used to update the standard, including the design specification. A discussion on the International Aerospace Quality Group (IAQG) and American Aerospace Quality Group (AAQG) will also be included. The original version of International Standard AS9100 specifies requirements for a quality management system. This standard specifies where an organization needs to demonstrate ability to consistently provide product that meets customer and applicable regulatory requirements, and aims to enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system and the assurance of conformity to customer and applicable regulatory requirements. While this course provides a comprehensive overview of the changes made to AS9100 in Revision C, additional training would be required for auditor certification.

Learning Objectives

By attending this seminar, you will be able to:
- Interpret the changes to AS9100 in revision C QMS standard including the intent of the requirement
- Articulate the details of AS9110 and AS9120 QMS standards including additional requirements imposed in those standards
- Understand the AS9101 QMS Auditing Standard ballot draft and the new process auditing requirements
- Breakdown the AS&D (Aviation, Space & Defense) certification process and discuss how training and auditors are approved
- Recognize the international process of generating QMS standards

Who Should Attend

This seminar will benefit any Aerospace or Defense industry professional or auditor who desires a detailed understanding of the AS9100 family of documents in order to implement or audit the standard.

Topical Outline

DAY ONE:
- AS&D Standards Overview
  - What is IAQG/AAQG?
  - What process is used for generating standards
- AS9100:2009, Rev C
  - Quality management system
  - Management responsibility and commitment to the development of quality consistency
  - Resource management to meet customer requirements
  - Planning product realization
  - Implementing the monitoring, measurement, analysis and improvement processed needed

DAY TWO:
- AS9110: 2009, Rev B
  - Additional requirements over AS9100
  - Discussion of the changes in Rev B
- AS9120: 2009, Rev B
  - Additional requirements over AS9100
  - Discussion of the changes in Rev B
- AS&D Certification Process
  - AS9101 - AS&D QMS Audit
  - AS9104 - AS&D Registration/accreditation process
  - AS9104/2 - AS&D Surveillance and oversight process
  - AS9104/3 - AS&D Auditor qualification and training process

Instructor: Buddy Cressionnie
Fee $1285 1.3 CEUs

Introduction to Weibull Engineering Fast Track

I.D.#PD230946ON (Online delivery)

The Weibull engineering technique is the starting point for solving most issues related to product reliability, maintainability, supportability, quality, safety, test planning, and cost control. Weibull Analysis is popular worldwide as the best method for predicting modeling variability and failure of designs, products, and systems. In this introductory short course, instructor Wes Fulton will provide a solid overview of Weibull Engineering capabilities. This Fast Track should be considered a prerequisite for participation in a Weibull project or for attending additional SAE training that covers advanced Weibull applications.

Major topics include:

- Introduction and Background
- Basic Weibull Plotting and Interpretation
- Case Studies of Successful Weibull Applications
- Overview of Weibull Extensions
- Course Summary

Is this Fast Track for You?

The *Introduction to Weibull Engineering Fast Track* is designed for the engineer - from automotive, aerospace, electrical, biomedical, and nuclear. This course does not require any pre-requisite, as the content will unfold from the basics, up to the more advanced features of this valuable analysis tool. The knowledge gained in this course can serve as a prerequisite to more advanced Weibull projects.

What You Will Receive

- Three months of online access to the 80 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructor: Wes Fulton
Fee $149

Understanding AS9100 Rev C Webinar

2 Hours
I.D.# WB0958

In a global economy, aviation, space and defense organizations are presented the challenge of producing and delivering safe and reliable products across a wide range of customer requirements and expectations. In doing so, these organizations must also meet various statutory and regulatory requirements. In an effort to address diverse quality requirements and expectations while also being able to reduce costs throughout the supply chain, AS9100 was developed by international aerospace industry representatives to standardize international aerospace quality management system requirements. Subject to periodic revisions, the latest revision to this standard was released in January 2009.

This two-hour webinar will provide participants with first-hand explanations and insight regarding the changes found in AS9100:2009 (Rev C). The instructor will begin with an explanation of the overall revision objectives followed by the design specification criteria that each change was required to meet in order to be considered. Because AS9100 incorporates the requirements of ISO 9001:2008, participants will also gain valuable insight into the ISO 9001:2008 amendment. The instructor will then guide participants through the implementation timeline so that each participant acquires understanding and insight into how AS9100 Rev C will impact their organization and their efforts to obtain certification.

Learning Objectives

By connecting with this webinar, you will be able to:
- Summarize the revision objectives for AS9100 Rev C
- Explain the AS9100 revision process and design specification requirements
- Identify the significant changes to AS9100 in Rev C
- Describe the AS9100 Rev C implementation timeline

Who Should Attend

This webinar will benefit any aerospace or defense industry professional or auditor who desires a detailed understanding of AS9100 Rev C in order to implement or audit to the standard.

Topical Outline

- AS9100 Rev C Objectives
  - Scope
  - Incorporating IAQG objectives

- AS9100 Revision Process and Design Specification
  - Understanding the design specification
  - Why changes were made
- AS9100 Rev C Review of Changes
- AS9100 Rev C Implementation Timeline
- AS9101 Rev D Implementation Timeline

Instructor: L.L. 'Buddy' Cressionnie
Fee $245 .2 CEUs

Principles of ISO 9000, ISO/TS 16949, and AS9100 Fast Track

I.D.#PD230824ON (Online delivery)

Understanding the purpose and intended use of standards, directives and requirements sets the foundation for developing a functional management system. This 25-minute, online short course is intended to present ISO 9000, ISO/TS 16949 and AS9100 as purpose driven management systems that are necessary for companies to survive in our fast-moving economy.

Major topics include:

- The history leading to the development of ISO/TS 16949 and AS9100
- The cost of poor quality
- Management system principles
- Plan-Do-Check-Act
- Process based quality system model
- Terms and Definitions
- ISO/TS 16949 and AS9100 Sections

Is this Fast Track for you?

In all three standards, paragraph 6.2.2 states the need for competence, awareness and training. Management and personnel in all departments from sales and marketing to engineering, purchasing, production, customer service, receiving, packaging, storage, shipping, and beyond will benefit from the purpose driven management systems that are necessary to deliver customer satisfaction and survive in the global economy. *This course is not intended for those already familiar with the purpose and benefits of the standards.*

What You Will Receive

- Three months of online access to the 25 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructor: Joseph Sorrentino
Fee $59

ANOVA for Design of Experiments

1 Day
I.D.# C0714

This seminar is suggested for product or process experts who have a need to utilize more detailed information concerning Design of Experiments analysis. It primarily addresses the subject of ANOVA, analysis of variance, which is a statistically based, objective decision-making tool. This is an advanced seminar that covers the fundamentals required to analyze orthogonal experiments, interpret, and recommend further action based on the analysis. Emphasis is placed on the analysis phase of the DOE process. The seminar covers DOE basic review, simple and complex ANOVA situations, process capability estimation, and a review of available computer software for experimental design and analysis.

Learning Objectives

By attending this seminar, you will be able to:
- perform ANOVA for DOE analysis
- interpret ANOVA results
- estimate process capability from ANOVA information

Who Should Attend

This seminar is designed for product and process design engineers, manufacturing engineers, quality engineers (control, assurance, or supplier), testing and development engineers, and technical managers who are interested in more comprehensive experimental analyses and information. Although, more statistical in nature, this seminar does not require a statistical education or background to comprehend the contents; only fundamental mathematical skills are necessary. This seminar is also very helpful in providing a statistical foundation for those seeking certification in quality engineering. It is strongly recommended that the registrant attend a Basic Design of Experiments course or have experience with fractional factorial experiments based on orthogonal arrays before attending the ANOVA for Design of Experiments course.

Topical Outline

- Training Objectives
- Design of Experiments Process Flowchart
- Planning and Conducting Phase Review
- Analyzing and Interpreting Results
  - observation method review
  - column effects method review
  - raw data ANOVA -- one-way; two-way; multi-way with orthogonal arrays
  - variation ANOVA
  - attribute data ANOVA
  - interpreting experimental results
  - plotting
  - prediction of mean and confidence interval
  - confirmation experiment
  - process capability estimates
- Software Review and Comparison

Instructor: Phillip J. Ross
Fee $725 .7 CEUs

Design of Experiments (DOE) for Engineers

2 Days
I.D.# C0406

Design of Experiments (DOE) is a methodology that can be effective for general problem-solving, as well as for improving or optimizing product design and manufacturing processes. Specific applications of DOE include identifying proper design dimensions and tolerances, achieving robust designs, generating predictive math models that describe physical system behavior, and determining ideal manufacturing settings. This seminar utilizes hands-on activities to help you learn the criteria for running a DOE, the requirements and pre-work necessary prior to DOE execution, and how to select the appropriate designed experiment type to run. You will experience setting up, running, and analyzing the results of simple-to-intermediate complexity, Full Factorial, Partial Factorial, and Response Surface experiments utilizing manual methods as well as a hands-on computer tool that facilitates experimental design and data analysis.

You will also receive an overview of Robust DOE, including the Taguchi DOE Method. Each attendee will receive a 30 day Minitab™ Product Demo for use in the class. While some computers will be available, attendees are encouraged to bring a laptop computer and/or a calculator to the seminar to provide additional hands-on time.

Learning Objectives

By attending this seminar, you will be able to:

- Decide whether to run a DOE to solve a problem or optimize a system
- Set-Up a Full Factorial DOE Test Matrix, in both Randomized and Blocked forms
- Analyze and Interpret Full Factorial DOE Results using ANOVA, (when relevant) Regression, and Graphical methods
- Set-Up a Fractional (Partial) Factorial DOE, using the Confounding Principle
- Analyze and Interpret the results of a Fractional Factorial DOE
- Recognize the main principles and benefits of Robust Design DOE
- Decide when a Response Surface DOE should be run
- Select the appropriate Response Surface Design (either Plackett-Burman, Box-Behnken, Central Composite, or D-Optimal)
- Interpret Response Surface Outputs
- Utilize the MiniTab ™ Software tool to analyze data

Who Should Attend

This seminar will benefit engineers, designers and quality professionals in research, design, development, testing and manufacturing who are interested or active in one or more of the applications listed above. Individuals should have an engineering degree or equivalent coursework in math, statistics and computers.

Topical Outline

- Icebreaker: Team Problem Solving Exercise Using Engineering Judgment
- What is DOE?
  - Types of Designed Experiments
  - Application Examples
  - Where DOE Fits in with Other Tools/Methods
- DOE Requirements: Before You Can Run an Experiment
  - Writing Problem and Objective Statements
  - Ensuring DOE is the Correct Tool
  - Selecting Response Variable(s) and Experimental Factors
  - Actual vs. Surrogate Responses
  - Attention to Experiment Logistics
  - Test Set-up and Data Collection Planning
  - Selecting and Evaluating a Gage
- Full Factorial Experiments
  - Introduction to Cube Plots for 3- or 4-factor 2-level Experiments
  - Experiment Set-Up
  - Factor Levels, Repetitions, and "Right-Sizing" the Experiment
  - Experiment Terms to Estimate (Main Effects and Interactions)
  - High-Level Significance Evaluation
- DOE Statistical Analysis
  - ANOVA Principles for Simple Full Factorial Experiments -- Statistics Basics; Significance Test Methods; Effect of Non-Random Experiments; Estimating Significance Test "Power"; Confidence Intervals; Estimating Random Error
  - Analysis Plots -- Normal and Half-Normal Plots; Main Effect and Interaction Plots
  - Regression Analysis of Simple Full Factorial Experiments
  - Using MiniTab ™ for Full Factorial DOE Experiments
- Fractional (Partial) Factorial Experiments
  - The Confounding Principle -- How it Works; What Information We Lose with Confounding (and why we might not care!)
  - Selecting and Using Generators (Identities) to Set Up Confounding Strings
  - Determining Which Factor Combinations to Run
  - Analyzing Fractional Factorial Experiment Data
  - Using MiniTab ™ for Fractional Factorial Experiments
- Robust Design Experiments (Overview)
  - What is Robustness?
  - Control and Noise Factors
  - Classical and Taguchi Robust DOE Set-Up
  - Robustness Metrics
  - Analytical and Graphical Output Interpretation
- Response Surface Modeling
  - What Response Surface Models do BEST
  - Available Response Surface DOEs (Plackett-Burman, Box-Behnken, etc.) -- Ideal Situation(s) to Use Each Response Surface DOE Type; Cube Plot Set-up of Each Response Surface DOE
  - Analyzing Response Surface Experiment Data
  - Methods for Finding Optimum Factor Values
  - Using MiniTab ™ for response Surface Experiments
- Miscellaneous Notes and Wrap-up

Instructor: Kevin Zielinski

Fee $1265 1.3 CEUs

Design of Experiments (DOE) for Engineers Webinar

12 Hours
I.D.# WB0932

Design of Experiments (DOE) is a methodology that can be effective for general problem-solving, as well as for improving or optimizing product design and manufacturing processes. Specific applications of DOE include, but are not limited to, identifying root causes to quality or production problems, identifying optimized design and process settings, achieving robust designs, and generating predictive math models that describe physical system behavior. This competency-based webinar utilizes a blend of reading, discussion and hands-on to help you learn the requirements and pre-work necessary prior to DOE execution, how to select the appropriate designed experiment to run, DOE execution, and analysis of DOE results. You will experience setting up, running, and analyzing simple-to-intermediate complexity

Full Factorial and Partial Factorial experiments both by hand and using computer software. You will also set-up and analyze Robust/Taguchi and Response Surface experiments utilizing computer software.

Each participant will receive a 30 day MiniTab ™ product trial copy for use in the webinar. Due to the nature of the webinar format, each participant will be expected to dedicate approximately one hour to complete "homework" and/or short reading assignments in preparation for each session.

Learning Objectives

By connecting with this webinar, you will be able to:
- Determine when DOE is the correct tool to solve a given problem or issue
- Select the appropriate DOE experiment type (DOE Goal) for a given application
- Set up simple Full Factorial DOEs by hand, using cube plots
- Set up and analyze any Full Factorial DOE using Minitab
- Identify appropriate partial factorial design(s) based on one's application
- Set-up and analyze Partial Factorial DOEs, simple Robust Design (Taguchi) DOEs, and simple Response Surface DOEs using Minitab
- Recognize the structured process steps recommended when executing a DOE project

Who Should Attend

This webinar will benefit engineers involved in product design and/or optimization; process design and/or optimization; quality improvement efforts such as defect elimination, warranty avoidance or similar initiatives; and technicians, analysts and managers who support engineers in these efforts. This course has no specific course prerequisites. However, participants are expected to have some math background, that includes elementary statistics. Since the course includes demonstration and hands-on use of Minitab, participants should have some familiarity with Windows-based personal computer applications.

Topical Outline

Session 1
- Introduction
- What is DOE (with Initial Data Collection Exercise)
- Full Factorial Experiments using Cube Plots
  - Identifying main effect and interaction terms
  - Determining effects for all terms
- Estimating How Much Experiment Data is Enough
- Assignment for Session 2: Review of Web-Based Demo of Minitab - Full Factorial DOE Set-up and Analysis; and Reading, Overview of DOE Statistics

Session 2
- Set up and Analysis of a Full Factorial Experiment using Minitab
- Minitab's DOE Results (High Level Overview of Minitab Outputs)
- Review of Methods for Determining 'Significance'
- ANOVA and Regression Overview
- Assignment for Session 3: Hands-on Exercise in the use of Minitab using Simulator to Generate Data, and Reading on the Structured DOE Process

Session 3
- Review of Exercise Assigned at the End of the Session 2
- Review and Additional Information on DOE Statistics and Interpretation of DOE Output
- Best Practice: The Problem Solving Process
- Best Practice: The Structured DOE Process
- Assignment for Session 4: Reading on Overview of Confounding and Partial Experiments

Session 4
- The Confounding Principle and Partial Factorial Experiments
- How Confounded Occurs in a DOE, including Identity Usage and Resolution
- Setting up Partial Factorial Experiments using Minitab
- Assignment for Session 5: Partial Factorial Exercise using Minitab and a Simulator to Generate Data for the DOE; Reading on Robust/Taguchi DOE

Session 5
- Review of Exercise Assigned at the End of the Session 4
- When Robust/Taguchi DOE is Appropriate
- How Robust/Taguchi DOE is Different
  - Two-Step Optimization Concept
  - Control vs. Noise
  - Importance of Control-by-Noise Interactions
  - Signal-to-Noise (S/N) and Loss Statistics
- Some Taguchi DOE Success Stories (incl. Set-up and Analysis in Minitab)
- Demonstration of Minitab for Setting Up a Taguchi DOE
- Assignment for Session 6: Robust/DOE Exercise using Minitab and a Simulator to Generate Data for the DOE, Reading on Overview of Response Surface Methodology

Session 6
- Review of Exercise Assigned at the End of the Session 5
- When Response Surface DOE is Appropriate
- How Response Surface DOE is Different
  - Box-Behnken Concepts (with Demonstration of Minitab Set-up)
  - Central-Composite Concepts (with Demonstration of Minitab Set-up)
- Class Exercise: Response Surface Set-up and Analysis
- High-level Overview of Other Designs/Application: Plackett-Burman and Mixture
- FAQ Review
- Summary

Instructor: Kevin Zielinski
Fee $915 1.2 CEUs

Design of Experiments - Basic Simplified Taguchi

2 Days
I.D.# C0231

Design of Experiments is a statistically based, structured approach to product or process improvement that will quickly yield significant increases in product quality and subsequent decreases in cost. Products and processes can be designed to function with less variation and with less sensitivity to environmental factors or customer usage. While still maintaining high quality from a customer's viewpoint, products and processes can utilize lower cost materials and methods. Specifications can be opened-up with wider tolerances while still maintaining high quality for customers. In summary, products and processes can be designed and developed in shorter times to reduce costs and become more competitive in the marketplace from a delivery and profit standpoint. This seminar covers the fundamentals required in planning, conducting, and analyzing orthogonal experiments, which are the major steps in the Design of Experiments (DOE) process. Emphasis is placed on the DOE process, which, if diligently followed will yield an effectively completed experiment. An introduction to parameter design is included. A short video

introduces the experimental approach; the end of the session allows practice with the new methods in a hands-on workshop. For more advanced study, attend C0714 ANOVA for Design of Experiments. It is strongly recommended that any registrant attend a Basic Design of Experiments course prior to taking the advanced course.

Learning Objectives

By attending this seminar, you will be able to:
- Choose appropriate factors and factor levels to effectively plan DOEs
- Define an appropriate set of tests to evaluate the chosen factors and levels
- Utilize appropriate randomization strategies and choose appropriate sample sizes for conducting tests for DOE
- Utilize basic analytical methods to identify influential & non-influential factors in analyzing and interpreting DOE results
- Set specification limits for all factors for effective performance and low cost

Who Should Attend

This seminar is designed for product and process design engineers, manufacturing engineers, quality engineers, testing and development engineers. Although it would be helpful, no statistical education or background is required for this course; only fundamental mathematical skills are necessary.

Topical Outline

- Training Objectives
- Design Of Experiments Background
  - DOE definition
  - DOE and Taguchi history
  - DOE in the product life cycle
  - implementation strategy
- Design Of Experiments Process
  - flowcharts
  - injection molding case study
  - water pump leak case study overview
- Planning Phase
  - state problem(s)
  - state objective(s)
  - determine measurement method(s)
  - quality characteristic(s)
  - select factors
  - identify control and noise factors
  - select levels of factors
  - select orthogonal array
  - assign factors
  - locate interactions
  - modification of standard orthogonal arrays
  - parameter design
- Conducting The Experiment
  - trial data sheets
  - testing logistics & assignments
  - identification of trial results
  - sample size per trial
  - randomization
  - good and bad data sets
- Analyzing And Interpreting Results
  - observation method
  - column effects method
  - plotting
  - ranking
  - analyzing variability
  - factor classification
  - attribute data
  - interpreting experimental results
  - confirmation experiment
- Experimental Workshop
  - popcorn experiment review
  - pendulum experiment

Instructor: Phillip J. Ross
Fee $1155 1.3 CEUs

Simplified Taguchi/DOE Methods

2 Days
I.D.# 96017

Companies realize that they need to do more with less which means we need to use the most efficient and effective methods. This seminar blends the philosophy of Taguchi with the simple graphical methods of Box, Hunter, & Hunter to give a powerful set of DOE tools. Wide use of Design of Experiments or DOE methods has been hindered by complications in planning a DOE to handle interactions and by analysis complexity of ANOVA. A Preferred Columns Method simplifies planning so engineers can assign factors to an array in minutes. Graphical methods allow quality professionals to distinguish large (active) factors from small terms and portray these findings to broad audiences. By simplifying DOE's, road blocks are removed so that more people can begin using these highly productive methods.

Learning Objectives

By attending this seminar, you will be able to:
- Explain Taguchi's Quality Philosophy of Closeness to Target
- Plan efficient factorial experiments using the Preferred Columns Method
- Compare data sets with dual or multiple stem and leaf plots
- Analyze the data using simple graphical methods such as dot plots and probability plots

Who Should Attend

This seminar will be most beneficial to engineers and quality professionals who work in product design, manufacturing, testing, reliability, quality, process, or development.

Prerequisites

Participants should have an undergraduate engineering degree or experience as a quality professional.

Topical Outline

- Taguchi Loss Function
- Comparison of Two Means
  - Dual stem & leaf plots
  - Exceedances test
  - Graphical T-test for differences
- One-Factor Experiments
  - Multiple stem & leaf plots
  - Graphical F-test for multiple comparisons
- Two-Factor Experiments
  - Response plots to see effects and interactions
  - Graphical F-tests to compare averages
- Full Factorials
  - Math model behind factorial experiments
  - Independent factors vs. interactions
  - Randomizing the runs
- Planning Fractional Factorials
  - Measurement system that uses continuous data

- How to select factors for a DOE
- Confounding patterns and resolution
- Preferred Columns Method to set up a fractional factorial
- Data sheets
- Customizing for a 4-level factor

- Analyzing Fractional Factorials
  - Column effects table
  - Quantifying the noise of repeats
  - Dot plots with error distributions
  - Interaction plots
  - Prediction model
  - Cube plot
  - Probability plot of column effects

Instructor: Jerry L. Roslund
Fee $1285 1.3 CEUs

Statistical Methods for Quality Engineering

3 Days
I.D.# C0554

Based on your test data or process data, do you ever wonder if:
- An improved product really performs better?
- A substitute material really processes the same?
- A cheaper material really performs satisfactorily?
- What confidence do you have in the final decision that you make? This seminar will help individuals responsible for product or process development and testing to statistically assess the variation of the product or process performance and make effective decisions with confidence. Technical personnel are consistently making changes to product and process designs and the resultant performance changes need a statistical basis for moving ahead to the cost assessment and release phases. Various continuous and discrete probability functions will be covered with the normal distribution receiving the most emphasis. Other distributions including Weibull, Exponential, Binomial, Poisson, Hypergeometric, and nonparametric comparisons will be covered. Various confidence intervals and tests of comparison, including Z test, Student's t tests, Chi-Square test, F test, and ANOVA for the normal distribution for these probability functions are covered.Attendees will work along with the instructor on many examples throughout the seminar and should bring a scientific or statistical calculator to class for the various activities.

Learning Objectives

By attending this seminar, you will be able to:
- Select the proper distribution model
- Determine valid sample sizes
- Design valid tests of comparison
- Make effective decisions at stated confidence levels

Who Should Attend

This course applies to anyone making product or process assessment or changes and will help them to make effective decisions concerning those situations. Product design managers and engineers, process design managers and engineers, and quality managers and engineers will particularly benefit from this course. Individuals seeking to attain the Certified Quality Engineering status within the American Society for Quality will find this course particularly helpful.

Prerequisites

Participants should have at least high school mathematics and graphing skills, a good technical understanding of products and processes in their work environment, and a good technical understanding of testing methods and protocols.

Topical Outline

DAY ONE
- Introduction
  - Training objectives
  - Statistical resources
- Concept of variation
  - Common development questions
  - Histograms
  - Descriptive statistics
- Distribution Models
  - Continuous
  - Discrete
  - Applications
- Model Selection
  - Empirical distribution functions
  - Cumulative distribution functions
  - Normal probability paper
  - Small sample sizes and median ranks
  - Tests for normality

DAY TWO
- Parametric Evaluations and Tests
  - Normal and log-normal data -- Z confidence intervals and tests; t confidence intervals and tests; Chi-Square confidence intervals and tests; K factor confidence intervals; F tests

DAY THREE
- Parametric Evaluations and Tests (continued) -- analysis of variance
  - Weibull distribution, confidence intervals and tests
  - Exponential distribution tests
  - Poission distribution applications
  - Binomial distribution applications
  - Hypergeometric applications
- Nonparametric Tests
  - Sign tests
  - Run tests
  - Rank tests

Instructor: Phillip J. Ross
Fee $1545 2.0 CEUs

Aerospace Product Support: Sustainment Throughout the Life Cycle

2 Days
I.D.# C0945

In today's aerospace industry, product life-cycles are often being extended far beyond a product's original design expectations. With fewer and fewer new aerospace products being introduced into the marketplace, there is a dramatic need for increased emphasis on supporting these products in the most efficient and effective manner possible throughout the entire product life-cycle. In addition to the initial product acquisition cost, customers are becoming more aware and sensitive to the product's total life-cycle cost. The long-term costs to operate, maintain, and otherwise sustain these products are often a determining factor in the initial product acquisition.

This two day seminar is intended to introduce participants to the various approaches, technologies, and tools available to support a product throughout the product's total life-cycle in the most efficient manner possible. Major topics presented and discussed during this seminar include The Elements of Logistics, Performance Based Logistics, Product Support Integration, and regulatory requirements. Collectively, the information presented in this seminar will equip attendees with the skills and techniques needed to help them comfortably and confidently develop the best tailored support package, satisfying the needs of both the customer and the provider.

Learning Objectives

By attending this seminar, you will be able to:
- Identify and apply basic concepts of Product Support, including Contractor Logistics Support, Total System Performance Requirements, Performance-Based Logistics, and Primary Support Integration
- Evaluate elements of cost associated with life-cycle support/ sustainment opportunities
- Compare and contrast the different approaches that may be taken to provide total life-cycle support in aerospace programs
- Assess relative risks to both the provider and the customer in the various approaches
- Determine how to best integrate sustainment activities within the OEM as well as after-market provider business plans

Who Should Attend

Technical professionals, as well as current and prospective Program/ Project managers, Product Support Managers, and Sustainment Specialists will benefit by attending this seminar. This seminar will also be of value to individuals in other disciplines, including marketing and general management, that require an understanding of the concepts and strategies of effective life-cycle sustainment programs.

Prerequisites

Basic knowledge or awareness of product support, logistic support, customer support, or sustainment will be beneficial but is not required.

Topical Outline

DAY ONE
- Introduction to Aerospace Product Support
  - Developing the class definition of product support -- Attributes; Shared experiences
  - Setting expectations
- Elements of Product Support Offerings
  - Characteristics of Product Support
  - Compare and Contrast -- Logistics Support; Product Support; Customer Support
  - "Bits and pieces" of product support
  - What constitutes success?
- Support Integration
  - How Support Integration works
  - Primary Support Integrator -- How PSI works
  - Third-Party Logistics Provider -- Definition; How 3PL works

DAY TWO
- Contractor Logistics Support
  - How CLS works
  - Customer and contractor roles
  - Constructing a CLS proposal -- Estimating costs
- Performance-Based Logistics
  - How PBL works
  - Customer and contractor roles
  - Constructing a PBL proposal -- Estimating costs
- Regulatory and Guidance Document Identification
  - Regulatory documents and reports
  - Development and use of metrics
  - Notification of problems and re-plans to stakeholders
- Seminar Review and Open Dialog

Instructor: Drex Rutledge
Fee $1225 1.3 CEUs

Weibull-Log Normal Analysis Workshop

3 Days
I.D.# 86034

RMS (Reliability-Maintainability-Safety-Supportability) engineering is emerging as the newest discipline in product development due to new credible, accurate, quantitative methods. Weibull Analysis is foremost among these new tools. New and advanced Weibull techniques are a significant improvement over the original Weibull approach. This workshop presents special methods developed for these data problems, such as Weibayes, with actual case studies in addition to the latest techniques in SuperSMITH® Weibull for risk forecasts with renewal and optimal component replacement. Class work is used to reinforce key concepts, lectures are based on actual case studies, and personal computers and hands-on experiments are used to analyze dozens of Weibull & Log Normal problems. Students will be fully capable of performing basic and advanced RMS Engineering analysis with their own software on completion of the workshop.

Attendees will receive the entire SuperSMITH® package - a complete self-study course and combined software package containing: SuperSMITH® Weibull, SuperSMITH® Visual, The New Weibull Handbook® 5th Edition and the PlayTIME™ Tutorial Booklet. A $960 value!

Optional Weibull Introduction
To accelerate your learning in this Workshop, you may want to complete the SAE Fast Track, *Introduction to Weibull Engineering*. This highly recommended overview of Weibull engineering can improve your retention prior to taking the workshop or provide a great review afterwards.

Learning Objectives

By attending this seminar, you will be able to:
- Analyze design, development, production, and service failures
- Model product lifetime and reliability
- Evaluate calibration and maintainability plans
- Analyze inspection data
- Reduce test substantiation, time and costs

Who Should Attend

An engineering undergraduate degree in any discipline would be beneficial. Engineers responsible for reliability, safety, supportability, maintainability, materials, warranties, life cycle cost, design, structures, instrumentation and logistics will find these Weibull techniques extremely useful.

Topical Outline

DAY ONE - Undergraduate Weibull Analysis
- Background, Development & Introduction - 23-Minute Video Short Course
- How to do Weibull Analysis
- Interpretation of Good Weibulls - 2 & 3 Parameter
- Are two Weibull datasets significantly different?
- Interpretation of Bad Weibulls
- Failure Predictions and Weibull Risk Analysis
- Case Studies, Failure Forecasting
- Weibull Experiments (Wire Rupture, Torsion, LCF, Accelerated Testing), Classwork Problems and Solutions

DAY TWO - Postgraduate Weibull Analysis
- Maximum Likelihood Weibull Theory and Application
- WeiBayes Analysis
- Dauser Shift, Warranty Analysis
- Rank Regression vs. Maximum Likelihood
- Extremely Small Samples Analysis
- Log Normal Analysis
- Predicting Future Failures With & Without Renewals
- One Failure Weibull Case Study
- An Introduction to SuperSMITH® Software, Features, Input, Analysis, Output
- Summary of Weibull Methods
- Class Work Problems
- Experimental Wire Data Distribution Analysis
- Optimal Replacement Intervals, Block Replacement
- Playtime With SuperSMITH® Tutorial
- Ph.D. Oral Examination

DAY THREE - Confidence Intervals and System Models
- Confidence Intervals, "The Good, The Bad and The Complicated"
- Comparing Designs
- The Binomial & Poisson, The Thorndike Chart
- Duane-AMSAA Reliability Growth Modeling - New Useful Technology for Tracking Development Testing
- The Exponential Related to the Poisson and the Weibull
- Kaplan-Meier Survival Analysis (Now Included in SuperSMITH® Weibull)
- Duane-AMSAA Employed for Analyzing Renewal-Repairable Systems
- System Models
- Classwork
- Complete Playtime With SuperSMITH®

Instructor: Wes Fulton
Fee $1935 2.0 CEUs

Catalog Key

Instructor-led programs | Online courses | ACTAR approved | Part of a Certificate Program Curriculum

Aircraft Cabin Safety and Interior Crashworthiness 120
Fundamentals of Motor Vehicle Fire Investigation 121
Injuries, Anatomy, Biomechanics & Federal Regulation 122
Side Impact Occupant Safety and CAE 122
Vehicle Accident Reconstruction Methods 123
Vehicle Frontal Crash Occupant Safety and CAE 124

Aircraft Cabin Safety and Interior Crashworthiness

2 Days
I.D.# C0926

The certification of transport category cabin interiors requires a thorough understanding of Part 25 Transport Category aircraft cabin interior safety and crashworthiness regulations and compliance requirements. Regardless of whether it is a simple modification, a specialized completion (VIP or VVIP) or airline passenger configuration, engineers, designers, and airworthiness personnel must understand and adhere to these requirements.

This two day seminar will begin with a discussion of Commercial off the Shelf (COTS) test requirements. The instructor will then guide participants through the various cabin interior emergency provisions and their requirements such as supplemental passenger oxygen, emergency equipment, seats, flammability, emergency exits, emergency lighting and escape path markings, and various other cabin interior systems. Additionally, DO-160 environmental, cooling and ventilation requirements will be discussed to provide participants a comprehensive introduction to cabin interior safety and crashworthiness requirements as specified in the CFR Part 25 Airworthiness Standards.

Learning Objectives

By attending this seminar, you will be able to:
- Identify key strategies to managing certification programs effectively
- Recognize cabin safety and design problems in a timely manner so they may be addressed in advance
- Communicate intelligently on the requirements and effectively negotiate with others involved in FAA certification programs
- Interpret and identify the reasoning behind cabin safety rules and regulations
- Demonstrate an understanding of cabin safety and crashworthiness regulations
- Examine and evaluate current cabin safety issues and their solutions through open discussions between instructor and attendees

Who Should Attend

This course is designed for engineering and certification managers, design engineers, airworthiness and certification engineers, program managers, consultants, Federal Aviation Administration designated engineering representatives (DER) interested in gaining interior arrangement authorization added to their delegated functions and authorized areas, and other technical and administrative personnel involved in FAA certification activities.

Prerequisites

None

Topical Outline

DAY ONE
- Introduction to Part 25 Airworthiness Standards Requirements
- Commercial Off The Shelf equipment (COTS) and Super COTS
- Galleys
  - Electrical disconnects
  - Water shut-offs
  - Latches
- Passenger Oxygen and Oxygen Masks
  - Reach (5th percentile female)
  - Quantity and duration requirements
- Emergency Equipment
  - Ditching requirements -- Life rafts; Life vests; Survival kits
  - First aid kits
  - Defibrillators
  - Fire extinguishers
  - Smoke detectors
  - Access
  - Placards
- Seats
  - Dynamic (C127a)
  - Static (C39b)
  - Divans
  - Seat belts and shoulder harness
  - Head strike
  - Oxygen mask requirements
  - Recline and rotations at exit rows
  - Exit access
  - Foot/leg rests
- Beds
- Latches and Secondary Latches
- Placards
  - Visibility
  - Contrast
  - Size
  - Locations
- Flammability
  - Bunsen Burner flammability tests and materials
  - Fire blocking on seat and back cushions and markings
  - Fire containment -- COTS; Lavatory and galley waste containers
  - Smoking and ash trays
- Smoke Detection and Penetration for Cabin Accessible Baggage Compartments

DAY TWO
- Emergency Exit Types and Requirements
  - Floor level
  - Window
  - Flight deck
- Exit Signs and Requirements
  - Size -- Equivalent safety
  - Visibility
  - Types and requirements -- Bulkhead; Locator; Marker
- Aisle Clearance Requirements
  - Cabin main aisles -- Cross aisles
  - Exit Passageways
  - Emergency Lighting Systems
  - Luminosity tests -- Cabin color contrast
  - Fuselage transverse separation
  - Emergency Escape Path Markings (EEPM) -- Luminous;

Incandescent; Visibility; Seat baggage bars
- Crew Areas
  - Crew assist space
  - Crew assist handle
  - Crew visibility
  - Crew rest area
  - Oxygen
  - Communication
- Flight Deck Door
- Cabin Doors and Curtain Dividers
- Ordinance Signs
  - Visibility
  - Legibility
  - Cross Aisle Visibility
  - Passenger Address (PA) System
  - Cabin Hand Sets and Egress Issues
  - Constant retention cord reels
  - Ratcheting
- EMI/RFI Tests
- DO-160 Environmental, Cooling and Ventilation Requirements
- Lithium Ion batteries
- Water systems

Instructor: Ken Farsi

Fee $1225 1.3 CEUs

Fundamentals of Motor Vehicle Fire Investigation

3 Days
I.D.# C0915

The manner in which a motor vehicle fire is initiated and subsequently spreads is dependent on a number of complex, interdependent, phenomena including combustion kinetics, heat transfer and fluid dynamics. Because the damage caused by a fire is coupled to these phenomena, damage patterns can sometimes be used to understand certain characteristics about the fire. In many cases, the goal is to determine the cause and origin of the fire. In this highly interactive, hands-on course, participants will acquire a working knowledge of fire science and be able to use this knowledge to assess possible ignition mechanisms, evaluate burn patterns, and analyze fire spread. This seminar will also explore the interpretation and limitations of the physical evidence from a fire scene. The approach to collecting and retaining important physical evidence, and laboratory techniques to examine this evidence, will also be described. As an in-class project, participants will have the opportunity to inspect several burned vehicles, predict cause and origin and compare findings to the actual cause and origin of the fire, as shown in burn test videos.

Learning Objectives

By attending this seminar, you will be able to:
- Apply fundamental combustion concepts to evaluate possible ignition mechanisms, burn patterns, and fire spread
- Recognize the value and limitations of burn patterns to determine the area of origin of a fire
- Describe the typical burning characteristics of motor vehicle fires
- Identify and retain important physical evidence during a structure or vehicle fire inspection
- Utilize laboratory techniques to evaluate physical evidence recovered from a fire scene

Who Should Attend

This seminar is designed for engineers, scientists, investigators and consultants involved in the investigation of vehicle fires.

Prerequisites

An engineering degree in any discipline would be beneficial.

Topical Outline

DAY ONE
- Combustion Fundamentals
  - Global and elemental combustion reactions
  - Heat release due to combustion
  - Combustion kinetics
  - General ignition mechanism
  - Flame structure
- Combustion Properties
  - Flammability limits
  - Flash point
  - Auto ignition
  - Piloted and unpiloted ignition of solids
- Ignition Mechanisms
  - Electrical sparks and arcs
  - Mechanical sparks
  - Resistive heating
  - Hot surfaces
  - Thermal radiation
- Vehicle Systems and Associated Ignition Mechanisms
  - Electrical system
  - Fuel system
  - Lubricant systems
  - Exhaust system
  - Brake system/overheated bearings
- Structures/garages and Associated Ignition Mechanisms
  - Electrical system
  - Power tools/equipment
  - Consumer electronics/extension cords
  - Heaters/cooking appliances
  - Oily rags/spontaneous combustion
  - Smoking materials

DAY TWO
- Fire Dynamics in Structures/garages
  - Fire growth rate and flame propagation
  - Effect of fuel load and ventilation
  - Flashover
  - Temperature versus time
- Fire Dynamics in Vehicles
  - Fire growth rate and flame propagation
  - Effect of fuel load and ventilation
  - Flashover
  - Temperature versus time
  - Time to untenable conditions
  - Effect of collision damage on flame spread
- Physical Evidence Interpretation
  - Burned/consumed combustible material
  - Melted metals
  - Oxidation of steel surfaces
  - Melted/beaded copper wires
  - Arcing-through-char
- Arcing-through Char Laboratory Demonstration
- Vehicle Fire Investigation Techniques
  - Information gathering
  - Interpretation of burn patterns
  - Evidence processing and preservation
  - Origin determination
  - Cause determination

- Structure/garage Fire Investigation Techniques
  - Information gathering
  - Interpretation of burn patterns
  - Scene processing and evidence preservation
  - Origin determination
  - Cause determination
- Laboratory Examination of Evidence

DAY THREE
- Introduction to Vehicle Inspection Class Project
  - Define circumstances prior to each vehicle fire
- Group Vehicle Inspections
  - Groups determine the cause and origin of each fire
- Group Discussion about Findings
- Review Video of Vehicle Burn Tests
- Discussion about Interpretation of Burn Patterns
- Summary

Instructor: Jeff Colwell
Fee $1545 2.0 CEUs

Injuries, Anatomy, Biomechanics & Federal Regulation

3 Days
I.D.# 85049

Safety continues to be one of the most important factors in motor vehicle design, manufacture and marketing. This seminar provides a comprehensive overview of these critical automotive safety considerations: injury and anatomy; human tolerance and biomechanics; occupant protection; testing; and federal legislation. The knowledge shared at this seminar will enable attendees to be more aware of safety considerations and to better understand and interact with safety experts.

Learning Objectives

By attending in this seminar, you will be able to:
- Recognize the significance of various injuries, how to rank order and quantitatively compare their severity, and how to access overall severity of multiple injuries.
- Assess the significance of various test results, know their basis and how to interpret them.
- Identify the biomechanical and legal basis of safety regulations and their changes (especially FMVSS 208 and 214).
- Describe the different measuring capabilities of various test dummies including Hybrid III test dummies.
- Contrast the difference between impact and deceleration injuries for various body regions and explain the "third collision," which takes place within the vehicle.

Who Should Attend

This seminar is designed for all professionals - technical or managerial - who are involved either directly or indirectly with vehicle safety performance. An engineering undergraduate degree in any discipline would be beneficial.

Topical Outline

- Introduction & Background
- Next Generation Restraint Systems
- Injury Scales -- Abbreviated Injury Scale (AIS); Injury Severity Score (ISS); Trauma Score; Harm; Injury Priority Rating (IPR), Functional Capacity Index (FCI)
- Diagnostic Images of Injuries -- Plain Film X-rays, CT, MRI
- The Role of Alcohol
- Anatomy, Injuries and Tolerance Parameters (By Body Region) -- Head & Neck; Spine; Chest; Abdomen; Pelvis and Lower Extremities
- Test Devices: Basic Differences and Measuring Capabilities for Front and Side Impact Tests
- FMVSS 201, 208, 214 and NCAP and LINCAP -- Current & Proposed Injury Criteria and their Biomechanical Basis
- Regulatory Process -- Federal Rulemaking Process and NHTSA -- Legal Authorizations and Restrictions
- Assessing Pre-existing Conditions and Previous Injury
- Older Drivers - Special Needs

Instructor: Jeffrey A. Pike
Fee $1545 2.0 CEUs
18 ACTAR CEUs

Side Impact Occupant Safety and CAE

2 Days
I.D.# C0717

Side impact crashes account for approximately twenty-four percent of all motor vehicle fatal crashes, second only to frontal crashes, according to a 2005 report by the National Highway Transportation and Safety Administration (NHTSA). While car companies and suppliers continue to develop new technologies that make vehicles safer, NHTSA is also updating safety regulations (FMVSS 214) based on new research studies, making vehicle safety design more and more complex. This seminar is designed to familiarize participants with the engineering principles behind vehicle and restraint designs for occupant safety. Students will learn the mechanics of side crashes and how vehicle structures, restraint systems, and interiors affect occupant safety. Students will also be exposed to system, subsystem and component level CAE and testing tools used in the simulation of side impacts. Accident crash statistics, biomechanics, government regulations and public domain frontal safety tests will also be covered. A combination of hands-on activities, including computer simulations, discussion, and lecture are used throughout the course.

Learning Objectives

By attending this seminar, you will be able to:
- Explain side impact and how the vehicle structure, door trim and side airbags affect occupant responses
- Describe different dummy types and what injury metrics are used to evaluate occupant injuries
- Interpret FMVSS 214 regulations and public domain safety evaluations such as LINCAP and IIHS safety rating systems
- Describe system, sub-system and component level CAE and testing tools that are used to assist in design decisions
- Evaluate the relative effect of door intrusion and restraint system characteristics

Who Should Attend

This course is designed for engineers who are new to the field of occupant protection in side impacts as well as those individuals who require knowledge regarding IIHS side impact ratings and the upcoming new FMVSS 214 regulation. This course will also be of interest to engineers who deal with side impact issues or are involved in designs of side impact related components, such as airbags, door

trim, side impact bolsters, door structures and body structures.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. Participants should have a basic working knowledge of Microsoft Excel.

Topical Outline

DAY ONE
- Vehicle Crash Safety Introduction
  - Crash injury and fatality data from the U.S.
  - Distribution of different crash types
  - Active safety and passive safety
  - Trend of crash safety ratings
- Vehicle Side Impact Test Modes
  - Moving deformable barrier impact
  - Pole impact
- Biomechanics
- Test Dummies and Injury Metrics
  - SID/HIII
  - SID IIs & SID IIs-FRG
  - ES-2 & ES-2re
  - BioSID & WorldSID
- U.S. Regulatory Requirements
  - FMVSS 214, 201, 301
- U.S. Public Domain Tests and Performance Ratings
  - LINCAP
  - IIHS
- European Regulatory Requirements
- Euro-NCAP and Performance Ratings in Other Markets
- Test Data Processing
  - Filtering and SAE J211 guidelines
  - HIC, TTI
  - Numerical integration, differentiation, occupant relative travel
  - Hands-on in computer lab: test data processing
- Hands-on Computer Exercises
  - Simulations Using Simplified Models
  - Crash Data Processing

DAY TWO
- Side Impact Mechanics
  - Vehicle structure
  - Door trim
  - Thoracic and pelvic bolsters
  - Inflatable devices for impact protection
- Restraint System for Side Impact
  - Thorax bag
  - Shoulder bag
  - Thorax-head combo bag
  - Thorax-pelvis combo bag
  - Seat mounted and door mounted side airbags
  - Inflatable curtain
  - Inflatable shoulder belt / lap belt
- Crash Sensors
  - G-based sensors
  - Pressure sensors
- Vehicle Crash Computer Modeling (CAE)
  - Vehicle CAE model
  - Occupant CAE model
  - Crash Barrier CAE models
- Component and Sub-system Crash Development Tools
  - Sled tests
  - Sub-system level FEA
  - Madymo for airbag development
- Vehicle Level Crash Development and Test Data Analysis
  - Barrier test
  - Crash vehicle re-build
  - Surrogate vehicle test
  - Full vehicle FEA analysis
  - Test data analysis
- Design Optimization and Robustness
  - DOE used in component test, HYGE sled and CAE
  - Optimization in CAE
  - Robust design using CAE
- Hands-on Project Using Miniature Test Kit
  - The effect of vehicle stiffness
  - The effect of door trim design, restraint system
- Summary

Instructor: Stephen Kang and Zhibing Deng

Fee $1315 — 1.3 CEUs, 12 ACTAR CEUs

Vehicle Accident Reconstruction Methods

2 Days
I.D.# C0416

Automotive accident reconstruction is a process carried out with the specific purpose of estimating in both a qualitative and quantitative manner how an accident occurred. Reconstructions are based on physical data and physical evidence gathered during an accident investigation. To some extent, testimonial evidence is also used. Whether a crash is between two vehicles, a vehicle and pedestrian or a vehicle and a barrier, specific accident components, classified as pre-impact, impact and post-impact motion often are studied separately. Each of the components is analyzed using established engineering, scientific and mathematical principles and based on the physical evidence. Not only must each method be well established, but it must be selected so its coverage corresponds to the conditions of the physical problem. Three main factors, human, vehicle and environment must also be taken into account during a reconstruction.

This seminar is devoted to the exposition, use and limitations of the engineering, scientific and mathematical principles and methods used to reconstruct vehicular accidents. The primary objective is to help the attendees achieve a high level of understanding of these methods. The course covers a wide range of topics including uncertainty, impact mechanics, tire mechanics, vehicle-pedestrian impacts and vehicle dynamics. Most of the calculations can be carried out using commonly available spreadsheet technology suitable for personal computer use.

Attendees will receive a copy of the instructors' book, *Vehicle Accident Analysis and Reconstruction Methods*, published by SAE International.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the basic mechanics of collisions, including the differences between normal and tangential contact/interaction effects, restitution, energy loss, ΔV, PDOF, common velocity conditions and other effects
- Articulate the differences between point mass and rigid body impact analysis and when each can be applied, not applied and misapplied
- Determine when conservation of momentum is and is not appropriate and see how it can be checked for consistency
- Recognize the assumptions and limitations of various methods that can be critical in carrying out an accurate reconstruction
- Describe the assumptions behind the methods and know when the methods should not be applied

- Use spreadsheet technology to turn an analysis into a reconstruction
- Formulate and solve impact problems that combine the use of Event Data Recorder data and crash analysis
- Combine accurate pedestrian motion analysis and vehicle motion to reconstruct pedestrian collisions without knowing the point of impact
- Determine unknown points and paths using a photograph and site measurements
- Describe tire forces and tire mechanics
- Determine the post-impact motion of a vehicle with one or two wheels locked due to damage and other free to rotate, including the effects of dynamic weight shift

Who Should Attend

This course is well suited for persons just beginning to work in the area of accident reconstruction as well as persons already in the field who want to establish a firm foundation in impact mechanics, tire mechanics and vehicle dynamics.

Prerequisites

Attendees should have a knowledge of mathematics, physics and mechanics at a level equivalent to a second-year of college.

Topical Outline

DAY ONE

- Uncertainty in Measurements and Calculations
  - Three methods of estimating uncertainty - upper and lower bounds, differential variations and statistics of related variables
- Straight-Line Motion
  - Position, speed and acceleration as functions of time, braking and stopping distance
- Analysis of Collisions, Impulse-Momentum Theory
  - Full and rigorous coverage of point mass impact theory, conservation of momentum and planar impact mechanics
- Crush Energy, ΔV and tangential energy loss
  - Estimation of crush energy using the CRASH3 algorithm and proper estimation of tangential energy loss
- Frontal Vehicle-Pedestrian Collisions
  - Mechanics of pedestrian and vehicle motion

DAY TWO

- Planar Photogrammetry
  - Transformation of points on a photograph to known and unknown points on a flat surface
- Mechanics and Modeling of Tire Forces
  - Equations of tire side force (cornering force), tire longitudinal force (braking or accelerating) and combined forces
- Critical Speed From Tire Yaw Marks
  - Use of the critical speed formula and experimental variations
- Vehicle Dynamics Simulation
  - Dynamics of a single vehicle or a tow vehicle and semi-trailer, sophisticated tire model, rigid suspension, specific vehicle physical characteristics, steering and lane-change maneuvers, locked-wheel braking or tabular steer inputs, dual friction flat surface
- Rollover
  - Presentation of vehicle and site examination as well as the analysis and reconstruction of pre-trip, trip and post-trip phases of rollover accidents
- Wrap-up Reconstruction
- A complete example of the reconstruction of vehicle speeds using:
  - crush measurements, energy loss and planar impact mechanics
  - post-impact travel and planar impact mechanics

Instructors: Raymond M. Brach and R. Matthew Brach

Fee $1345

1.3 CEUs
12 ACTAR CEUs

Vehicle Frontal Crash Occupant Safety and CAE

2 Days
I.D.# C0621

Car companies and suppliers continue to develop new technologies that make vehicles safer and regulatory agencies continue to update safety regulations based on new research studies, making vehicle safety design more and more complex. This seminar covers the mechanics of frontal crashes and how vehicle structures, vehicle restraint systems, and vehicle interiors affect occupant safety. It also describes details of how CAE tools work in the simulation of frontal crashes. The goal of the course is to familiarize participants with engineering principles behind vehicle and restraint designs for occupant safety. Accident crash statistics, biomechanics, government regulations and public domain frontal safety tests will be reviewed briefly. Students will also be exposed to Madymo, one of the major occupant CAE tools. The basic inner workings of the tool, such as rigid body dynamics, joints, contact, airbag and seatbelt modeling, and modeling techniques will be shared with the class. The class also offers participants opportunities to do hands-on computer analysis as well as simplified hands-on crash tests, where students can learn first-hand how vehicle pulses and restraint design affect occupant response.

Learning Objectives

By attending this seminar, you will be able to:

- Explain frontal crashes and how vehicle structure and restraint systems affect occupant responses
- Describe how restraint components function in crashes and protect occupants
- Carry out calculations of injury metrics using test or CAE results as input
- Describe the occupant CAE tool, Madymo, and how it works
- Explain assumptions and limitations of CAE models
- Evaluate the relative effect of crash pulse, and restraint system characteristics
- Analyze and evaluate crash pulses

Who Should Attend

This course is designed for engineers who are either new to the field of automotive safety or familiar with only certain aspects of automotive safety. It can help engineers, for example, who design a specific component in a vehicle to understand how it works in vehicle crashes, how its characteristics affect occupant response and how it relates to other components in the vehicle.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. Participants are expected to have a basic working knowledge of Microsoft Excel.

Topical Outline

DAY ONE

- Vehicle Crash Safety Introduction
  - U.S. crash injury and fatality data
  - Distribution of different crash types
  - Active and passive safety
- Vehicle Frontal Crash Modes
  - Frontal rigid, offset deformable and angular barriers
  - Out of position tests, driver and passenger
  - HYGE and Servo sled tests
  - Component tests
- Biomechanics - Human Anatomy and AIS Injury Scale

- Brief Overview of Frontal Test Dummies and Injury Metrics
- Frontal Crash Mechanics
  - Crash pulse, front loaded, rear loaded
  - Class Project using Excel: calculate vehicle velocity and crush from pulse; get maximum crush, time to zero velocity; pulse comparison, front-loaded and rear loaded pulses
  - Intrusions
  - Occupant to restraint gaps and restraint characteristics
  - Belted vs. unbelted occupant
  - Class project: determining occupant responses
  - Airbag quickness and stiffness
  - Belt slack, pretension, EMR o
  - Class project: Determining the best restraint characteristics
  - Driver vs. passenger
  - Typical crash event
  - Class project: determining the optimal pulse shape
  - 5th percentile female submarining
  - Crash Sensor - Airbag & Pretensioner Firing & Non-firing Conditions; Sensor Tests

DAY TWO
- Brief Review of U.S. and European Regulations and Public Domain Safety Ratings
- Numerical Data Processing
  - Filtering and SAE J211 guidelines
  - HIC, Nij, Cumdur, V*C calculations
  - Numerical integration, differentiation, occupant relative travel
- Vehicle Crash Computer Modeling (CAE)
  - Vehicle structure CAE, finite element method
  - Occupant CAE, rigid body dynamics
  - CAE assumptions and limitations
- DABLIT - Component Test for Driver Airbag
- DOE and Optimization
- Restraint System
  - Airbag, inflator, single & dual stage
  - Crash sensor, Restraint Control Module (RCM)
  - Seatbelt, D-rings
  - Retractors, torsion bars
  - Buckle and retractor pretensioners
  - Steering column stroke
  - Steering wheel lower and upper rims
  - Knee bolster
- Real World Crashes - Safety for the Aging Population; Crash Severity Distribution

Instructor: Stephen Kang

Fee $1265

1.3 CEUs
12 ACTAR CEUs

Catalog Key

Instructor-led programs | Online courses | ACTAR approved | Part of a Certificate Program Curriculum

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A Familiarization of Drivetrain Components

1 Day
I.D.# 98024

An efficient, robust, and quiet running drivetrain is as essential to customer satisfaction as styling and interior creature comforts. In this seminar, you will be exposed to various methods that can be used to accomplish this goal. Designed to help you visualize both individual components and the entire drivetrain system - without reference to complicated equations - this seminar focuses on the terms, functions, nomenclature, operating characteristics and effect on vehicle performance for each of the drivetrain components. Attendees will receive an introduction to the various components of the drivetrain, including the clutch or torque converter, manual or automatic transmission, driveshaft, axle, wheel ends, and brakes. The course also provides insight into: the structure and function of each component; vehicle integration; and related noise, vibration and harshness issues. You will be equipped to evaluate the space requirements, mounting needs, clearances required, and effect on vehicle response for each component.

The book, *Automotive Technology*, by M.J. Nunney is included in the course materials.

Learning Objectives

By attending this seminar, you will be able to:
- Discuss both practical and technical aspects of smoothing clutch operation by incorporating cushion and torsional dampers.
- Compare different types of transmission synchronizers, automatic transmission torque converters, hydraulic clutch operation and epicyclic gear trains.
- Describe the interaction of gear ratios and vehicle performance as related to engine horsepower and torque curves.
- Explain phasing and mounting of propeller shafts as related to torsional excitation and secondary couple loads
- Review different types of differentials.
- Compare common misconceptions of limited slip devices to their actual performance.
- Recognize four-wheel drive systems and the need for an inter-axle differential.
- Appraise electronic control of torque through braking and clutching devices.
- Evaluate the total drivetrain package as a system.

Who Should Attend

This seminar is intended for engineers now working with passenger car, sport utility, truck, bus, industrial, and off-highway vehicles who have had minimal prior experience with the total drivetrain.

Prerequisites

An engineering undergraduate degree in any discipline would be beneficial.

Topical Outline

CLUTCH (dry/wet)
- Pressure Plate (Cover)
  - Direct pressure
  - Indirect pressure
  - Belleville
  - Over center springs
- Disc

- Hub
- Facing support member
- Torsional damper -- damper springs; co-axial damper springs; damper friction devices
- Facings - Organic; Ceramic/metallic; cushion types

• Linkage
- Hydraulic
- Cable
- Mechanical

TRANSMISSION
• Automatic
- Hydraulically controlled
- Electronically controlled
- Planetary or epicyclical gearing
- Hydraulic multi-disc clutches
- Torque Converters
- Impeller
- Turbine
- Stator
- Lock-up clutch

• Manual
- Synchronized
- Non-Synchronized
- Electronically shifted
- Gear rattle

PROPSHAFT
• Cardan Joints
- Torsional excitation -- cancellation (two or more joints)
- Secondary couple

• Constant Velocity Joints
- Rzeppa type
- Others

AXLE
• Rigid -- Semi-float; Full-float; Carrier type; Banjo type
• Steering
• Independent
• Gearing -- Spiral bevel; Hypoid
• Differentials
- Two pinion
- Four pinion
- Limited slips
- Full locking
- Plate types -- spring loading of plates; springs between side gears and plates; springs between gears; gear loading of plates
- Cam loading of plates
- Viscous types
- Speed loaded types -- hydraulic pump; viscous pump

TRANSFER CASE
• Full Time
- The requirement for a differential -- bevel differential; planetary differential

• Part Time
- Two-wheel drive
- Locked four-wheel drive

WHEEL ENDS
• Independent
• Live vs. Dead Spindle
• Bearing architectures

BRAKES
• Disc
• Drum
• Hydraulics
- Master Cylinder, Proportioning valve

• Electronic Control of Brakes and Torque
• Anti-Lock Brake Systems

Instructor: Joseph Palazzolo
Fee $755 .7 CEUs

A Familiarization of Drivetrain Components e-Seminar

I.D.#PD130555ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this five and a quarter hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. This is divided into seven video modules and a coordinated handbook.

View the complete program brochure and demo at http://www.sae.org/e-seminars/drivetraincomponents.

What You Will Receive:

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf's, subject to DRM)
- The book, *Automotive Technology*, by M.J. Nunney
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Joseph Palazzolo
Fee $295 .6 CEUs
Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Automotive Lighting: Design and Technology

2 Days
I.D.# C0202

Since the invention of the automobile, lighting has been an important subsystem on all ground vehicles. Automotive lighting is vital to passenger safety, comfort and vehicle styling. The technology used in automotive lighting has rapidly expanded to make the lighting more value added, safer and pleasing to customers. This seminar provides broad information about automotive lighting systems with emphasis on lighting functions, effectiveness, and technologies. The intent is to assist attendees to gain sufficient knowledge about automotive lighting and its importance in overall vehicle design and development. Since only the exterior lighting devices on the ground vehicles are regulated by the federal and local governments, and standardized by the SAE Lighting Committee and the international communities, this course will only address automotive exterior lighting.

Learning Objectives

By attending this seminar, you will be able to:
- Describe various automotive lighting technologies
- Articulate the legal aspects and implications related to automotive lighting
- Examine safety measurements used with lighting functions and human factors costs
- Discuss the latest advancements in lighting technologies and trends in lighting styling

Who Should Attend

This seminar is of benefit to a wide audience, including: Automotive body engineers responsible for lighting and vehicle interface and integration; vehicle stylists who are interested in lighting effects on vehicle cosmetics; regulatory personnel involved with the legal specifications of automotive lighting; marketing specialists who are interested in customers' preferences based on the relationship of human vision and lighting; and newcomers in the automotive industry who need to obtain a general overview of lighting

Prerequisites

Participants should have an undergraduate engineering or related degree.

Topical Outline

DAY ONE
- Introduction
- Fundamentals of Automotive Lighting
  - Light -- What is light; Definition of light; Types of light; Visible light; Generation of light
  - Light Measurements -- Basic concept - photometry and radiometry; Color of light; Terms of photometry; Photometry units comparison; Photometry and radiometry unit conversion; Photometry and radiometry calculations
  - Lighting - Illumination Devices -- Functions of an illumination device; Types of illumination devices; Basic structure of illumination devices
  - Classification of Automotive Lighting -- Forward lighting and signal lighting; Headlamps; Fog lamps (front and rear); Daytime running lamps; Stop & tail lamps; Turn signal lamps (front and rear); Other lamps
  - Requirements for Automotive Lighting -- Regulations and industry standards; Performance; Testing
- Light Sources Used in Automotive Lighting
  - Basics of Light Source -- Incandescent; Discharge; Fluorescent; Solid-state; Electroluminescent; Light source comparison
  - Light Source Characteristics -- Light emitter geometry; Light output from a light source; Life; Light source operation and testing; Bulb accuracy levels
  - Types of Light Sources Used for Automotive Exterior Lighting -- Incandescent bulbs; Tungsten halogen bulbs; HID subsystem (burner, starter & ballast); Neon light source (emitter & ballast); LED source (LED package, circuit board & control device)
  - Major North America Automotive Light Source Suppliers -- Osram (OSI & OOS); Philips (including Lumileds); Others
- Automotive Lamp Photometry Design
  - Optical Design Principles -- Optics; Geometrical optics; Imaging optics; Non-imaging optics; Reflection; Refraction; Transmission; Dispersion
  - Light Control - Collections and Manipulations -- Light collectors - reflectors and lenses; Light manipulators (reflector optics, lens optics, diffusers, light guides and fiber optics, reflex); Etendue

DAY TWO
- Optical Design for Automotive Lamps -- Automotive lamp configurations; Optical design step 1 - feasibility study; Optical design step 2 - setup strategy; Optical design step 3 - design optics; Optical design step 4 - simulations; Other considerations; Light source selection; CAE for optical design and simulation
- Automotive Lamp System Configuration
  - Automotive Lamp System Design Overview -- System level specifications; Vehicle interface
  - Automotive Lamp Thermal Analysis -- Purpose; Heat transfer; Empirical database; CFD lamp thermal model
  - Automotive Lamp Venting Analysis -- Understanding moisture; Moisture and condensation in a lamp; Venting analysis; Vent design
  - Automotive Lamp System Analysis -- CAD tools used in automotive lamp design; Lamp thermal analysis; Lamp venting analysis; Lamp structural analysis; Lamp mold accuracy analysis; Lamp assembly analysis
  - Human Factor Considerations -- What are human factors; Headlamp safety - seeing distance; Glare; Headlamp aiming issue; Headlamp mounting height issue; Headlamp lens issue; Signal detection; Lamp design for human factor optimizations
- New Automotive Lighting Technologies
  - Advanced Optical Structures for Automotive Lamps -- Combination of projector & free-form reflectors (P&F) headlamps
- Improved projector modules
  - Dual-Function HID (Bi-Xenon) Lamps -- System; Reflector type dual-function HID lamp; Projector type dual-function HID lamp
  - Distributive Lighting System (DLS) - a Remote Lighting System Using Fiber Optics -- System; DLS headlamp application; Other DLS applications
  - Adaptive Forward-lighting System (AFS) - an Intelligent Lighting System -- System; Desired beam pattern variations; Driving and environment condition measurements; AFS design option I - add beam contributor(s); AFS design option II - rotate headlamps; AFS design option III - vary component(s) in the headlamp
  - Night Vision System -- System definition; Infrared and IR cameras; Types of night vision systems; Examples of night vision systems

Instructor: Jianzhong Jiao
Fee $1225 1.3 CEUs

Automotive Lighting: LED Applications

1 Day
I.D.# C0727

Lighting Emitting Diode (LED), a new generation semiconductor light source often referred to as Solid-State Lighting (SSL), has been broadly adopted in illumination, display, visualization, and other areas due to its higher efficacy and longer life. LEDs, first introduced for automotive interior applications such as indicators, expanded to exterior applications including center high mounted stop lamps and other automotive signal lighting devices. Today, LED technologies are being used for night vision, occupancy detection, and many other automotive application areas. This seminar is designed to provide the attendee with an overview of LEDs and their applications in automotive lighting and illumination.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the basic LED configurations, characteristics, and classifications
- Assess LED and SSL technologies used in automotive applications
- Identify technical challenges and limitations of LEDs

- Select appropriate equipment for measurement of various conditions
- Evaluate LEDs for conformance to SAE standards
- Establish a basic design strategy for specific applications including forward lighting devices
- Manage a design activity to deal with thermal management

Who Should Attend

This seminar can be of benefit to a wide audience including LED automotive body and system engineers responsible for lighting and vehicle interface and integration; vehicle stylists who are interested in lighting effects on vehicle cosmetics and lighting developers and manufacturers; marketing specialists who are interested in customers' preferences based on the relationship of human vision and lighting; and newcomers in the automotive industry who need to obtain a general overview of lighting.

Prerequisites

Participants should have an undergraduate engineering or related degree.

Topical Outline

- Introduction
- LED - Definitions and Classifications
  - Types of LEDs
  - Basic LED characteristics
  - LED efficiency
  - Life and lumen maintenance
- LED Measurements and Standardization
  - Photometric measurements -- Light output measurements; Color of the light source; Measurements of LED life and lumen maintenance
  - Thermal measurements -- Thermal resistance and de-rating
  - Measurement equipment -- Photometric measurement and thermal management equipment
  - LED binning -- Luminous flux, voltage, and color bin
  - LED automotive lighting standards -- Signal lighting and forward lighting standards; Human factors evaluations for white LEDs
  - LED component standards -- Definitions; Industry trends
- LED Automotive Exterior Lighting Applications
  - LED lamp design basics
  - Photometric design requirements -- Basic design procedure; Design flow and optimization process
  - LED lighting system thermal and electronic design -- Why thermal management?; Effects of LED junction temperature; Cooling systems; LED bin selection; Electronic design - dual level lamps
  - LED signal lighting design concepts and examples -- Direct lighting: with or without secondary optics; Indirect lighting: TIR - prism, light guide and light pipe
  - LED headlamp design concepts and examples -- Comparison of light sources used for headlamps; Design restrictions and strategies
  - LED Automotive Interior Applications -- Interior lighting basics (Types of interior lighting, Performance evaluations); LED applications (Backlight for display, Interior illumination, Occupancy detection)

Instructor: Jianzhong Jiao

Fee $725

.7 CEUs
6 ACTAR CEUs

Automotive Lighting: Testing and Requirements

1 Day
I.D.# C0618

It has not been commonly known that automotive exterior lights are safety devices and must comply with governmental regulations. Since the 1930s, the SAE Lighting Standards Committee has been actively working with the automotive industry OEMs, lamp makers, tier-two suppliers, and human factor experts to develop automotive lighting standards. These standards have been widely used or referenced by the U.S. federal or state governments in establishing and enforcing the lighting regulations. This seminar emphasizes the safety importance of automotive lighting devices and provides important information on lighting functions, standards or regulations, testing and evaluations.

Learning Objectives

By attending this seminar, you will be able to:

- Describe the legal aspects and implications related to automotive lighting
- Search for and use the lighting related standards for all exterior lighting devices
- Establish or assist with lighting tests and evaluations

Who Should Attend

Automotive engineers and product development personnel who are responsible for lighting design, manufacturing, quality assurance, installation, vehicle interface and integration will benefit from attending this seminar. Regulatory personnel who are involved with the legal specifications of automotive lighting and law enforcement agencies or individuals responsible for lighting regulations will find the information valuable and relevant as will testing engineers or technicians who are responsible for evaluating and verifying the compliance of lighting standards and regulations.

Prerequisites

Participants should have a technical background and some knowledge related to automotive lighting devices; an undergraduate engineering or related degree is preferred.

Topical Outline

- Introduction - SAE Lighting Standards Committee
  - Current organization
  - History
  - Duties, responsibilities and membership
- Definitions and Terminologies Used in Automotive Lighting
  - Illumination devices -- Functions; Types; Basic structure
  - Classification of automotive lighting - definitions and operations -- Forward lighting; Signal lighting; Auxiliary lamps
  - Automotive lighting terminology -- Terminology; Identification code; Inspection code
- Testing and Evaluations
  - General categories -- What needs to be tested?; Photometry tests; Environmental tests; Electrical tests; On-vehicle tests; Special tests for selective devices using HID, LED, neon and other light sources
  - Testing equipment -- Photometry test equipment; Environmental tests equipment; Electrical tests equipment
  - Test methods: lighting sources, subsystems, and devices -- Light source test; Special test for subsystems; Device test
  - Material tests -- Weatherability; High deformation temperature (HDT); Optical characteristic; Chemical and physical behavior
  - Human factor evaluations -- What are human factors?; Headlamp safety - seeing distance; Driver's comfort and glare; Signal detection

- Automotive Lighting Requirements
  - Industry standards and government regulations
  - SAE Requirements -- Classification; Component related requirements; Device related requirements
  - U.S. federal government requirements -- NHTSA; FVMSS 108; Petition and interpretation; Recalls
  - Comparison of SAE vs. U.S. federal regulations -- Light source and subsystem requirements; Photometry requirements for all lamps; General environmental requirements for all lighting devices; Additional environmental requirements for forward lighting devices; Additional environmental requirements for device functions - forward lighting and signal lighting devices; Technology specific requirements; Material requirements
  - International requirements -- Economic Commission for Europe (ECE); International Harmonization; Global Technology Regulations (GTR)

Instructor: Jianzhong Jiao
Fee $725 .7 CEUs
6 ACTAR CEUs

Automotive Powertrain and Battery Cooling Airflow Systems: A Vehicle Perspective

2 Days
I.D.# C0616

Designing more fuel efficient vehicles requires that considerations be given to the thermal management requirements of vehicle propulsion systems. Exterior appearance, vehicle function, and thermal limits all have a direct impact on the design of the cooling airflow system. For hybrid and all-electric vehicles, batteries and thermal management present unique integration challenges. To address these challenges, suppliers and vehicle manufacturers must work as partners in the selection and packaging of batteries and under-hood cooling components. Critical to a successful design effort is a thorough understanding of the vehicle-level trade-offs and cooling issues that affect system performance. This two-day seminar will provide attendees a vehicle-level perspective of powertrain and battery cooling airflow systems, including the unique challenges of hybrid and electric vehicles. Product design constraints related to front-end, batteries, and under-hood components will be discussed. Special emphasis will be placed on the numerous battery integration issues and thermal management characteristics. A lumped capacitance model will be used to pull together battery thermal analysis concepts and the trade-off with energy required for cooling. Attendees will also learn about cooling airflow (fan & ram), fan design parameters, grille openings, thermal recirculation, system resistance, cooling drag, powertrain heat rejection, and battery thermal characteristics and heat generation rate. The radiator heat transfer equation will be used to describe the influence of vehicle-level and subsystem requirements on powertrain cooling. Case studies will be used to reinforce concepts and attendees should bring a calculator for these in-class activities.

Learning Objectives

By attending this seminar you will be able to:
- List fundamental considerations of grille openings and underhood airflow systems
- List battery thermal management system options, requirements, and integration issues
- Describe the fundamental performance characteristics of cooling fans
- Use the fan/ram airflow map to track system design, operation, and performance
- List major factors and considerations in airflow system resistance and optimization
- Estimate installed-powertrain radiator heat rejection for system analysis
- Analyze a powertrain cooling system design proposal against thermal limits
- Draft alternatives for program management trade-off discussions on cooling system

Who Should Attend

This course is designed for OEM and supplier engineers, managers, and sales personnel involved with powertrain and/or battery thermal management systems or components or individuals that interface with program management on these issues. Engineering students and CAE analysts will find the product perspective beneficial.

Prerequisites

Participants should have an undergraduate engineering degree. Some exposure to thermal product development is helpful, but not required.

Topical Outline

DAY ONE
- OEM vehicle perspective
  - Powertrain cooling airflow system
  - Underhood package and cooling fan alternatives
  - Suppliers
  - System & sub-system requirements
  - Thermal recirculation
- HEV Battery Thermal Management
  - Battery thermal characteristics; a brief review
  - Heat generation rate
  - Lumped capacitance model
  - Thermal management system characteristics
  - Vehicle; BTMS integration, some examples
  - Current technology, challenges, future development
- Thermodynamics Review
  - First Law
  - Radiator heat transfer equation
  - SCFM
  - Total-pressure
- Powertrain Heat Rejection
  - Estimating radiator heat rejection; SAE Dynamometer engine test procedures
  - Engine mean effective pressure (MEP)
  - Engine specific heat rejection (SHR)
  - Engine oil temperature

DAY TWO
- Front-End Airflow
  - Airflow patterns; idle, ram, exit, underhood
  - Airflow restrictions; system resistance, underhood, grille opening
  - Sizing cooling openings; inlet total-pressure recovery
  - Ram airflow and cooling drag
  - Other airflow considerations
- Cooling Fans
  - Classification
  - Specific speed
  - Blade aerodynamics and design parameters
  - Air performance test chamber (AMCA airflow stand)
  - Characteristic curves and performance matching
  - Fan laws
  - Shrouds
  - Installation effects - tip clearance, obstructions, installed

performance
  - System airflow road map, fan and ram
- Radiators
  - Thermal classification
  - Calorimeters
  - Radiator heat transfer effectiveness and pressure drop
  - Thermal accumulation
- Powertrain Cooling System Case Study
  - Define a system to meet thermal & product requirements
  - Evaluate system alternatives
  - List and discuss options for program management trade-off discussions
- Wrap-Up Discussions

Instructor: Jack Williams
Fee $1305 1.3 CEUs

Brake Friction Materials: Testing, Quality and Selection

1 Day
I.D.# C1020

The choice of brake friction materials varies per application, but each must have the appropriate coefficient of friction and be able to disperse large amounts of heat without adversely effecting braking performance. This seminar will provide an introduction to brake lining raw materials and formulation, manufacturing, quality control and testing. The course covers the critical elements that must be reviewed before arriving at a lining selection decision. Different classes of friction material and their use will be defined.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the principles of friction
- Define the basic elements of friction material formulations
- Identify the difference between OE and after-market friction materials
- Identify appropriate tests to distinguish the differences between friction materials
- Interpret friction material test results

Who Should Attend

Engineers and technicians working for friction material manufacturers and suppliers to friction material industries will find this course valuable. Brake system designers, quality control auditors, product development engineers, application engineers, lab/bench/vehicle test technicians, managers/friction material sales and marketing will all gain valuable insight into this highly guarded industry.

Prerequisites

Individuals should have some knowledge of the brake industry.

Topical Outline

- Principles of Friction Materials
- Lining Coefficient of Friction
- Formulation/Compounding Friction Material
- Manufacturing Friction Material
- General Asbestos/Non-asbestos Friction Material Characteristics
- Friction Material Testing
- Edge Code
- Bench & Vehicle Tests
- Wheel Dust Test
- Government Regulations
- OE and After-market Friction Material Lining Selection
- Issues Facing Friction Material Industries
  - Copper in brake pads
  - CA intended regulations
- Workshop

Instructor: Mohammad Vakili
Fee $725 .65 CEUs

Brake Noise Problem Resolution

1 Day
I.D.# C0831

Brake noise is one of the highest ranked complaints of car owners. Grunts, groans, squeaks, and squeals are common descriptions of the annoying problem which brake engineers spend many hours trying to resolve. Consumer expectations and the high cost of warranty repairs are pushing the optimization of brake NVH performance. This course will provide you with an overview of the various damping mechanisms and tools for analyzing and reducing brake noise. A significant component of this course is the inclusion of case studies which will demonstrate how brake noise squeal issues have been successfully resolved.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the various brake shim damping mechanisms
- Compare the various brake shims available in the market place
- Describe the various tools available to reduce brake noise
- Utilize lessons learned in various brake noise problem case studies

Who Should Attend

The course is designed for a wide range of personnel from the brake test engineer who seeks to understand more about brake NVH to the experienced brake NVH/design engineer who wishes to know more about potential solutions. Anyone involved in the resolution of brake noise problems will find this course helpful.

Prerequisites

Participants should be familiar with brake hardware, basic terminology, and brake NVH measurement and testing. Previous attendance at SAE seminar ID# C0509, Hydraulic Brakes for Passenger Cars and Light Trucks and ID# C0802 Brake, NVH, Measurement, and Testing or equivalent experience and knowledge are highly recommended.

Topical Outline

- Brief Review of Brake Noise
  - Types of brake noises
  - Frequency range
  - Source/path/receiver
- Principles and Applications of Brake Shims
  - Damping
  - Role and purpose of brake shims
  - Different types of brake shims
  - Brake shims damping mechanisms
- Tools for Brake Noise Analysis/Reduction
  - Brake noise categorization

- Solution strategy
- Investigative tools -- Testing; Simulation
- Squeal
  - Brake pad design optimization
  - Pressure distribution optimization
  - Low frequency squeal
- Moan/Groan
  - After-stop noise program -- Problem identification; Transmission of the road to the lab; Measurement systems; Root cause analysis; Solution
- Questions and Answers Session

Instructor: Eric Denys
Fee $725 .7 CEUs

Commercial Vehicle Braking Systems

3 Days
I.D.# C0233

Increased public pressure to improve commercial truck safety and new stopping distance regulations have intensified the need to better understand the factors influencing heavy vehicle braking performance. To assist individuals and their organizations in preparing for these new truck braking standards, this seminar focuses attendees on understanding medium-duty hydraulic brake systems and heavy-duty air brake systems and how both systems' performance can be predicted, maintained and optimized. The function and application of the major brake system components will be explained and attendees will discover how brakes, tires and roadways interact as a system. Federal braking regulations for both hydraulic and air brake vehicles will also be covered.

Attendees will receive the text, *Commercial Vehicle Braking Systems: Air Brakes, ABS and Beyond*, written by Leonard C. Buckman.

Learning Objectives

By attending this seminar, you will be able to:
- Design safe and efficient braking systems
- Test and measure braking performance
- Maintain and troubleshoot braking systems
- Comply with state and federal regulations on brakes
- Describe the brake implications of accident investigation

Who Should Attend

This seminar is designed for engineers and technicians who are involved in the design, development and testing of heavy vehicle brakes. Fleet personnel involved with safety and brake system specification and maintenance, driver-trainers, and truck accident investigators will also find this course of value.

Topical Outline

DAY ONE
- Medium Truck Hydraulic Brake Actuation Systems
- Heavy Truck, Bus & Trailer Air Actuation Systems
- Brake Actuation Components - Function, Advantages/ disadvantages, Applications
- Foundation Brakes - Cam, Wedge, Air Disc, Hydraulic Disc

DAY TWO
- Braking Performance Fundamentals
- Maintenance and its Impact on Performance
- Brake Force Distribution
- Heavy Vehicle Dynamics and Tire Characteristics
- Thermal Considerations
- Tractor - Trailer Brake Compatibility
- Truck & Tractor Air Antilock Braking Systems

DAY THREE
- Trailer Air Antilock Braking Systems
- Hydraulic Antilock Braking Systems
- Electronic Data Communication
- Automatic Traction Control Systems (ATC)
- Electronically Controlled Braking Systems (ECBS or "Brake-by-Wire")
- Electronic Stability Control and Roll Stability Control - Extended Applications of Electronics in Braking
- Brake Testing Procedures
- NHTSA and FMCSA Commercial Vehicle Brake Regulations

Instructor: Paul Johnston
Fee $1545 2.0 CEUs
18 ACTAR CEUs

Commercial Vehicle Braking Systems e-Seminar

I.D.#PD130611ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this 18 hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course offers an overview and 17 modules on video, course exercises, and a coordinated handbook.

View the complete program brochure and demo at http://www.sae.org/e-seminars/cvbs.

What You Will Receive:

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf's, subject to DRM)
- The book, *Commercial Vehicle Braking Systems: Air Brakes, ABS and Beyond*, by Leonard C. Buckman
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Leonard C. Buckman
Fee $695 2.2 CEUs
18 ACTAR CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Compact Heat Exchangers for Automotive Applications

2 Days
I.D.# 97002

Rapid advances have been made in the range of available designs and operational parameters as well as in the fundamental understanding of compact heat exchangers (CHEs). Since the majority of modern heat exchangers used for heating and cooling systems for vehicular applications are CHEs, keeping up to date with these advances is essential. This seminar will help you understand and be able to apply comprehensive information about the intricacies of CHE design, performance, operating problems and state-of-the-art-technology for car and truck applications.

Learning Objectives

By attending this seminar, you will be able to:
- Describe current state-of-the-art vehicular heat exchangers and how they relate to the current heat exchanger technology of other industries
- Explain the interaction, feedback and importance of problem specifications, thermal-hydraulic design, mechanical design, manufacturing and cost considerations and trade-offs based on the component and system design approaches for vehicular heat exchanger design
- Assess in-depth -NTU, P-NTU and MTD methods of heat exchanger analysis and articulate advantages and limitations of each method
- Perform exchanger pressure drop analyses, taking into account pressure drop associated with the core (entrance, exit, friction, form drag and momentum effects) and flow distribution devices (manifolds, headers, tanks, bends, fittings, etc.)
- Explain theoretical solutions for developed and developing laminar and turbulent flows in heat exchangers
- Apply empirical correlations for various fin and surface geometry's used in vehicular heat exchangers
- Utilize theoretical solutions to extend the applicability range of empirical solutions
- Describe and implement detailed, step-by-step procedures for the design and performance of single-phase heat exchangers -- radiators, heaters, oil coolers and charge air-coolers
- Determine how to choose specific fin or surface geometry's for vehicular applications
- Optimize heat exchanger designs to work with a large number of variables associated with the design
- Computerize heat exchanger design and performance calculations
- Describe the engine cooling system from the radiator and heater design point of view
- Describe the components of the air-conditioning system and implications for the design of condensers and evaporators
- Utilize basic principles of vaporization and condensation for the design of condensers and evaporators
- Articulate design and rating procedures for condensers and evaporators
- Describe system design considerations for the design of engine cooling and air-conditioning heat exchangers
- Discuss future trends and technology developments of vehicular heat exchangers

Who Should Attend

This course is intended for product and design engineers and academicians seeking the latest developments in the field, and engineers involved in software development for heat exchanger design and heating and cooling systems.

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

DAY ONE
- Automotive Heat Exchangers - Functions and Types
- Heat Exchanger Design Logic/Procedure
- Single-Phase Heat Transfer and Pressure Drop Analysis
- Discussion
- Heat Transfer/Flow Friction Characteristics and Correlations
- Plate-Fin and Tube-Fin Rating and Sizing Procedures
- Vaporization and Condensation Principles
- Condenser and Evaporator Design
- Discussion Day Two
- Automotive Air-Conditioning System
- Engine Cooling System
- Cooling Airflow Determination
- Auto A/C Heat Exchangers Performance Testing
- Heat Exchanger Design from System Design Considerations
- State of the Technology and Future Trends in CHEs
- Discussion

Instructor: Ramesh K. Shah
Fee $1225 1.3 CEUs

Concurrent Engineering Practices Applied to the Design of Chassis Systems

3 Days
I.D.# 96016

This seminar explores the principles of concurrent engineering practices applied to the design of chassis systems. These principles include systems engineering, requirements setting processes, and actions to achieve a robust design. Special emphasis will be placed on selecting the appropriate design for meeting conflicting vehicle targets simultaneously.

Learning Objectives

By attending this seminar, you will learn the:
- Principles of concurrent engineering and systems engineering
- Customer wants and chassis design concepts
- Chassis system specifications to meet vehicle requirements
- Different types of suspensions
- Chassis designs meeting vehicle dynamics requirements
- Key parameters affecting noise, vibration and harshness isolation
- Chassis system effects on robustness
- Suspension alternatives for meeting conflicting targets

Who Should Attend

Engineers involved in chassis engineering, vehicle dynamics or vehicle development work will find this course especially valuable. This course will be most beneficial to those participants who have taken SAE seminars titled, "Chassis & Suspension Component Design for Passenger Cars and Light Trucks #95025"; "Vehicle Dynamics for Passenger Cars and Light Trucks #99020.

Prerequisites

Participants should have an undergraduate engineering degree and some exposure to chassis systems.

Topical Outline

DAY ONE
- Engineering Process "Experience Driven" to "CAE Driven" to "Process Driven"
- Concurrent Engineering Reducing Development Time
- Customer Ratings Relating to Engineering Requirements
  - Vehicle analysis
  - System analysis
  - Component analysis
- Interrelationship Between Vehicle Dynamics and NVH

DAY TWO
- Suspension Design - What's Important in the Big Picture
- Front and Rear Suspension Parameter Effects
- Importance of Rigid and Compliant Geometry
- Considerations for Transient Maneuvers
- Nibble, Roughness, Brake Pull
- Manufacturing Variations

DAY THREE
- Front Suspension Design Decisions
  - Steering gear location: front steer or rear steer
  - Mac Pherson - short or long spindle SLA suspension
- Rear Suspension Design Decisions - RWD Cars
  - Solid axle types
  - Semi trailing arm IRS, SLA-type, Multi-Link type
- Suspension Types and How to Select the Optimum Suspension
- Industry and Future Suspension Design Trends

Instructor: Manfred C. Rumpel

Fee $1545 2.0 CEUs

Laminated Glass: Design Considerations for Vehicle Door Systems Fast Track

I.D.#PD130810ON (Online delivery)

The evolution in glass technology creates both opportunities and challenges which must be understood by today's automotive designers and engineers for successful implementation. Because laminated glass has different structural properties than tempered glass, this 40 minute online short course will provide an overview of best practices for integration of the product into vehicle door systems based upon extensive testing and field experience.

Major topics include:

- Overview of Laminated Glazing
- Laminated Glazing Selection Criteria
- Automotive Glass Strength Characterization
- Static Stresses and Door Design Considerations
- Dynamic Stresses from Door Slam
- Laminated Glass Performance and Analysis Techniques
- Summary of Laminated Glazing Benefits

Is this Fast Track for you?

This online short course was developed for engineers and those in the automobile supply chain involved in all disciplines related to the design or development of glass. It is designed to provide a technology overview that is relevant to those who simply want an introduction to laminated glass, while providing sufficient technical detail on best practices to benefit seasoned glazing engineers.

What You Will Receive

- Three months of online access to the 40 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructors: Pete Dishart & DeWitt Lampman
Fee $79

Electronics Packaging: Thermal & Mechanical Design and Analysis

2 Days
I.D.# 97017

Reliability issues can be avoided if engineers from various fields can develop a mutual understanding of the technical issues facing the design of an electronics package. This seminar enables engineers specializing in one area - electronics, packaging (structural and thermal integrity), thermal, vibration - to better understand and communicate with other engineers in this area of discipline. The fields of thermal, vibration, and thermomechanical management are covered, with discussion on the relevance and applications of each field. Attendees will also receive a copy of the text "Practical Guide to the Packaging of Electronics", by the instructor, Ali Jamnia.

Learning Objectives

- By attending this seminar, you will be able to:
- Explain the fundamental engineering issues involved in electronics packaging
- Define guidelines for a system's design - when the design criteria and components are not fully known
- Identify reliability issues and concerns
- Conduct more complete analyses for the final designs
- Describe the delicate issues involved with electronics packaging and the interaction of various effects, and thus, fields of engineering

Who Should Attend

This course is intended for designers, mechanical and electrical engineers, project managers, engineering managers and/or Quality Assurance/Control managers who are, or will be, responsible for design or development of electronics systems. This workshop is developed from a system's point of view and is not intended to address the needs of a narrow and specialized field of engineering such as chip and encapsulation design or automotive microprocessor and harness packaging. An engineering undergraduate degree in any discipline would be beneficial.

Topical Outline

DAY ONE - Thermal Management
- Issues in the Design of Electronics Packaging
  - Electronic
  - Thermal
  - Mechanical
  - Reliability
- Basic Thermal Analysis and Heat Transfer Theory
  - Conduction, convection and radiation -- basic equations and concepts; navior stokes equations; table of nondimensional groups
- Conduction Cooling

- Thermal resistance
  - Comparison of some material properties
  - Contact interface resistance
  - Sample problem
- Convection Cooling
  - Free convection -- laminar and turbulent flows; effects of altitude
  - Forced convection -- pressure drop; fanning friction; effects of altitude
- Radiation Cooling
  - Emissivities
  - View factor calculations
- Putting It All Together
  - Specifying the design constraints
  - Sample problem
- Assignment
  - Specify the design constraints for a RF cabin
- Fans, Fan Laws and Fan-Selection
- Temperature and Reliability Issues

DAY TWO - Vibration Management
- Vibration and Reliability Issues
- Basics of Vibration
  - Oscillatory motion -- harmonic; periodic; vibration terminology
  - Free vibration -- Frequencies and mode shapes
  - Forced vibration
- Random Vibration
- Vibration Induced Stresses and Fatigue
  - Life expectancy calculations
- Numerical Methods
  - Finite Element Methods
- Assignment
  - Set up a simple vibration problem
  - Calculate the natural frequencies and mode shapes
  - Compare the results with analytical values
- Thermomechanical Management
- Thermal Cycling
- Basics of Thermal Stress Calculations
  - Basic engineering equations
  - Some tips - effects of temperature on properties
- Reliability Considerations
  - Fatigue and failure
- Some Design tips on Various Materials
  - Plastics
  - Materials with a range of properties
- Questions and Answers

Instructor: Ali Jamnia
Fee $1355 1.3 CEUs

Fundamentals of Automotive All-Wheel Drive Systems

1 Day
I.D.# C0305

This seminar provides an introduction to the fundamental concepts and evolution of passenger car and light truck 4x4/all-wheel drive (AWD) systems including the nomenclature utilized to describe these systems. Basic power transfer unit and transfer case design parameters, component application to system function, the future of AWD systems, and emerging technologies that may enable future systems are covered.

This course is an excellent follow-up to the *A Familiarization of Drivetrain Components* (ID#98024) seminar (which is designed for those who have limited experience with the total drivetrain).

Learning Objectives

By attending this seminar, you will be able to:
- Identify front wheel drive and rear wheel drive vehicle architectures
- Identify part time, full time, and on demand all-wheel drive systems
- Explain the benefits of all-wheel drive over two-wheel drive
- Quantify all wheel drive traction and mobility benefits
- Describe auxiliary axle disconnect systems
- Explain basic vehicle dynamics performance and the effect of AWD on performance
- Identify couplers vs. biasing devices and their basic function
- Describe the differences between mechanical and electrical implementation in AWD systems
- Describe basic control strategies and logic
- Discuss advanced propulsion concepts and systems

Who Should Attend

This seminar is designed for engineers (working with passenger cars, light trucks, and SUVs) who need to master AWD componentry, and the function and effect of those components. Engineers new to the 4WD/AWD field, as well as managers, marketing personnel, purchasing professionals and others interested in all-wheel drive fundamentals will benefit from this seminar.

Prerequisites

A technical background in any discipline is beneficial, although not required.

Topical Outline

- Front wheel drive and rear wheel drive vehicle architectures
  - Engine layout Â- Transverse vs. longitudinal
  - Transmission layout Â- Transaxle vs. longitudinal
  - Axle layout Â- Independent vs. beam
  - Powerflow Â- typical power transmission arrangements
- Part time, full time, and on demand all wheel drive systems
  - Modes of operation
  - Performance benefits
  - Usage profiles
  - Twin systems
- Benefits of all-wheel drive as compared to two-wheel drive
  - Performance
  - Weight
  - Packaging
- Quantifying all-wheel drive traction and mobility benefits
  - Vehicle dynamics
  - Stability Acceleration
- Auxiliary axle disconnect systems
  - Function
  - Design
- Basic vehicle dynamics performance and the effect of AWD on performance
  - Oversteer
  - Understeer
  - Neutralsteer
  - Traction Effects
  - Stability Effects
- Couplers vs. biasing devices
  - Functions of couplers
  - Functions of biasing devices
  - TypesÂ—mechanical, electrical, speed sensing, torque sensing
- Mechanical vs. electrical implementation in AWD systems
  - Active control
  - Passive control

- Effects of AWD driveline configuration on NVH and weight
  - Consequences of axle ratio selection
  - Halfshaft and propshaft options
- Basic control strategies and logic
- Advanced propulsion concepts and systems
  - Active differentials
  - Independent wheel control
  - Hybrid electric all-wheel drive

Instructor: Joseph Palazzolo
Fee $725 .7 CEUs

Fundamentals of Automotive All-Wheel Drive Systems e-Seminar

I.D.#PD130556ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this four and a half hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course is divided into eight video modules and is accompanied by a handbook.

View the complete program brochure and online demo at http://www.sae.org/e-seminars/awdsystems.

What You Will Receive:

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf's, subject to DRM)
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Joseph Palazzolo
Fee $265 .5 CEUs
Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Fundamentals of Continuously Variable Transmission Technology Webinar

4 Hours
I.D.# WB1002

The technology of continuously variable transmissions spans belts (both 'push' and 'pull'), 'disc-on-wheel', and toroidal. All common CVT technologies rely on friction, and typically require special fluids for optimum operation. CVT technology is one of a core of technologies commonly employed when smooth transition from one speed ratio to another is required and when powertrain system optimization relies on precise ratio control. This webinar will highlight the various mainstream CVT technologies as they apply to automotive applications - fundamental operational principals, the reliance on friction as the primary means to transmit power, and the specific characteristics of the common fluids used in these types of transmissions. This webinar will provide those with a basic understanding of automotive transmission operation and components the fundamentals of continuously variable transmission technology, its application to the automotive marketplace, and the significance of this technology as it applies to improvements in powertrain efficiency and affectivity.

You will also receive insights into the various types of CVT systems, review their relative differences from a 'theory of operation' point of view, and as a function of their core components. Further, Dr. McVea will explore the versatility and operator satisfaction that vehicles equipped with CVT systems can provide as well as some of the limitations to the core technology and limits on practical implementation.

Learning Objectives

By connecting with this webinar you will be able to:
- Identify, describe, and explain what continuously variable transmission (CVT) technology is, how it works, and what are the various types and underlying functional concepts of this transmission technology
- Explain the technical, operational, and financial benefits of CVT technology to the OEM, vehicle service personnel and owner/operators
- Compare and contrast the function of CVT-equipped vehicles versus vehicles with simple manual or automatic transmissions
- Describe all the various manifestations and configurations of CVT technology when applied to actual and/or conceptual transmission systems of today
- Compare and contrast system benefits, limitations and practical consideration of adopting CVT technology

Who Should Attend

This Webinar will benefit anyone involved in the design, analysis, development, service, customer support or sales of automotive transmission and/or powertrain components and systems. The material covered in this webinar should be considered a core adjunct to your current knowledgebase. The value of this webinar also extends to anyone involved in the vehicle powertrain design and/or application of the technology.

Prerequisites

A basic understanding of automotive transmission technology and a BS in mechanical engineering or a related field is recommended.

Topical Outline

Session 1
- Step-less Transmission Technology/Continuously Variable Transmissions
  - Theoretical framework of operation
  - The friction model
  - Fundamentals of power transmission based on friction
  - Developmental history
- Toroidal Drive Technology
  - Theory of operation
  - Main components
  - Benefits and limitation of the technology

Session 2
- Belt Driven Technology
  - 'Push' versus 'pull'
  - Theory of operation
  - Main components
  - Benefits and limitation of the technology
- CVT Technology as it Augments Hybrid Powertrain Models
- Control and Command

- Commercialization of a CVT
  - Optimum configuration
  - Performance
  - Vehicle fuel consumption
  - Cost/weight/packaging

Instructor: W. Mark McVea
Fee $395 .4 CEUs

Fundamentals of Modern Vehicle Transmissions e-Seminar

I.D.#PD130419ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this 14 hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course is divided into nine video modules, accompanied by a handbook.

View the complete program brochure and online demo at http://www.sae.org/e-seminars/fmvtrans.

What You Will Receive

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf's, subject to DRM)
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: William Mark McVea
Fee $695 1.5 CEUs
Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Fundamentals of Gear Design and Application

2 Days
I.D.# C0223

Through informative discussions and detailed explanations, this seminar will provide a solid and fundamental understanding of gear geometry, types and arrangements, and design principles. Starting with the basic definitions of gears, conjugate motion, and the Laws of Gearing, those attending will be given the tools needed to understand the inter-relation and coordinated motion operating within gear pairs and multi-gear trains. Basic gear system design process and gear measurement and inspection techniques will also be explained. In addition, the fundamentals of understanding the step-wise process of working through the iterative design process required to generate a gear pair will be reviewed, and attendees will also briefly discuss the steps and issues involved in design refinement and some manufacturing considerations. Also, an explanation of basic gear measurement techniques, how measurement equipment and test machines implement these techniques, and how to interpret the results from these basic measurements will be covered.

Learning Objectives

By attending this seminar, you will be able to:
- Describe the "Law of Gearing," conjugate action and specifically, involute profiles
- Review the various definitions and terms used in gearing
- Identify the function and operation of all gear arrangements
- Appraise preliminary design considerations and the gear system design process
- Explain practical gear measurement and inspection techniques, tools and equipment
- Recognize "Best Practices" in regards to gear system design
- Discuss some of the new and automated gear design systems

Who Should Attend

The intended audience for this seminar is powertrain engineers, engineering directors and managers, component suppliers, vehicle platform powertrain development specialists, and those involved in the design and application of geared systems and assemblies. This seminar will appeal to anyone who is interested in gears, gear systems, design development or measurement and inspection techniques. More specifically, anyone responsible for the following will benefit:
- Mechanical power transmission system design, development, durability assessment and application
- Application and development of geared systems technologies
- Management of transmission designers and manufacturers
- Supply of components and sub-systems to mechanical power transmission system manufacturers

Prerequisites

Attendees should have an undergraduate engineering degree to attend this program. This seminar is intended for powertrain engineers, engineering directors and managers, component suppliers, vehicle platform powertrain development specialists, and those involved in the design and application of geared systems and assemblies. Anyone who is interested in gears, gear systems, design development or measurement and inspection techniques should attend.

Topical Outline

DAY ONE
- Principles of Gears
  - Purpose of gears
  - Basic concepts -- Law of gearing; common tooth forms
  - Classification of gears
  - Definitions and terms used in gearing
  - Velocity ratio
  - Pitch surfaces
- Gear Tooth Action
  - Conjugacy
  - Profile curves
  - Surface of action
  - Profile sliding
- Gear Geometry and Nomenclature
  - Principle of planes
  - Tooth nomenclature
  - Blank nomenclature
- Gear Arrangements
  - Simple gear train
  - Compound gear train -- ratios
  - Epicyclic -- configurations (solar, planetary, star); ratios; tooth number selection and build requirements; application
- Preliminary Design Considerations
  - Gear type selection
  - Preliminary estimate of size
  - Stress formulations
  - Gear Drawing Data

DAY TWO
- Gear System Design Process
  - Calculation of gear tooth data
  - Gear rating practice
- Gear Design Process
  - Layout
  - Root geometry
  - Backlash
- Gear Measurement and Inspection
  - Dimension over pins
  - Pin diameter
  - Modify pin diameter and dimension over pins
  - Pin contact point
  - Charts - involute; lead; red liner
  - Dimension sheet
- Gear Design Systems and Best Practices
  - Common proportions
  - Interchangeability
  - Tooling considerations
  - Mounting considerations
  - Best practices
  - Application

Instructor: W. Mark McVea
Fee $1225 1.3 CEUs

Fundamentals of Modern Vehicle Transmissions

3 Days
I.D.# 99018

Starting with a look at the transmission's primary function -- to couple the engine to the driveline and provide torque ratios between the two -- this updated and expanded seminar covers the latest transmission systems designed to achieve the most efficient engine operation. Current designs, the components and sub-systems used, their functional modes, how they operate, and the inter-relationships will be discussed.A manual transmission display will be used to explain ratios and how they function within the driveline. Automatic transmission design will illustrate the concept of automatic control and hydro-mechanic decision theory and implementation. Attendees will have the opportunity to supplement these theoretical concepts with practical, "hands-on" experience using the various transmission models and components provided. Mechatronics, toroidal transmission functions, and the future of the automatic transmission will also be discussed. Continuously Variable Transmission (CVT) systems, which represent a fundamental shift in the way power is transmitted from the primary source to the remainder of the driveline will be the focus of in-depth coverage on the third day of this seminar.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the development, operational aspects and design principles of passenger vehicle and light truck transmission systems, their major components and sub-systems
- Describe the operational parameters and inter-relationships of each of the sub-systems
- Apply basic design synthesis and analysis techniques for each of the major components and sub-systems
- Compare and contrast 'stepless' to 'stepped' transmission technology
- Identify and describe the function and operation of all major components and sub-systems by participating in hands-on demonstrations
- Recognize the limitations, technological trends, and potential new products under consideration
- Summarize the direction of new passenger car transmission designs and systems

Who Should Attend

This seminar is intended for anyone not familiar with the operational theories or functional principles of modern vehicle transmission systems. As the material covered is targeted at a number of design and engineering disciplines, attendees should have a minimum of two years design experience in the automotive powertrain field, or preferably a B.S. in engineering or related field.

Topical Outline

DAY ONE
- Overview of Mechanical Power Transmission in a Passenger Vehicle and Light Truck -- Manual transmission; automatic transmission; continuously variable transmission (CVT)
- Theory, Function and Operation of Manual Transmission -- Design; main components; common configurations
- Vehicle Powertrain Requirements and Specifications Assessment
- Shift Strategy Analysis and Control System Implementation
- Components and Sub-systems -- Shifters, clutches, synchronizers, gears, shafts
- Basic Gear Theory and Application Development
- Powerflow Analysis
- Synchronizer Operation and Analysis
- Lubrication and Cooling Requirements Review

DAY TWO
- Development and Layout of the "Automatic" Transmission -- Front-wheel drive; rear-wheel drive; four-wheel drive
- Functionality -- Torque converter operation; gear systems; gear design considerations; type; layout; NVH (Noise, Vibration and Harshness); epicyclic powerflow
- Extension of Gear Theory to Epicyclic Gear-trains
- Design and Operation of Clutches and Bands
- Application of One-Way/Over-Riding Clutches
- Powerflow Analysis of Torque Converters, Epicyclic Gear Sets
- Review of Shift Strategy
- Implementation of Shift Strategy Through Hydro-Mechanical Control Systems
- Simple Shift Model Analysis
- Lubrication and Cooling Requirements Review

DAY THREE
- CVT Design and Operation -- Theory and function; typical layout; main components
- Technological Development of the CVT
- Basic Theory of Friction Drives
- Toroidal Drive Technology -- Theory of operation; main components; benefits and limitation of the technology
- Functionality and Characteristics of CVT Components, Sub-systems -- Gearbox housing; variators; forward clutch; converter housing; input shaft; selector shift valve; differential; output shaft; mechatronic control unit; belt/push chain
- CVT Power-Flow -- Torque converter; primary variator; secondary variator; output shaft
- Mechatronics -- Theory and operation; general implementation; CVT application
- CVT Manufacturing -- Considerations; major manufacturers; future CVT development
- Future Technologies -- "Manualized" automatics, automated manuals; DCT, SSCT, DSCT

Instructor: W. Mark McVea
Fee $1565 2.0 CEUs

Fundamentals of Steering Systems

2 Days
I.D.# C0716

Design and development of a modern steering system influences vehicle response, driver controllability, comfort, safety and fuel economy. In this interactive seminar, participants will analyze the steering system, from the steering wheel to the road wheel. The seminar will cover the anatomy and architecture of the lower steering system (wheel end suspension geometry, linkages and steering gear), its effect on vehicle response, and how a force at the contact patch is translated to a torque in the steering wheel. The anatomy and architecture of the upper steering system (steering column and intermediate shaft), including the topic of non-uniformity and the role of the upper steering in the occupant protection system will also be explored. Significant time will be devoted to the generation of power assist, either by way of a conventional hydraulic power steering (HPS) or electrically power assisted steering (EPAS). Topics include system anatomy/architecture as well as the effect of the system on fuel economy. The seminar will finish with a discussion of common steering objective tests and how the kinematics, compliances, friction and power assist affect steering response and torque feedback. Students will have the opportunity to participate in exercises throughout the seminar, culminating in a final project where they will calculate an assist curve for both a HPS and an EPAS system.

Learning Objectives

By attending this seminar, you will be able to:
- Identify common steering and suspension system architectures
- Compare and contrast different types of steering gears
- Describe the function of the steering column and intermediate shaft subsystem
- Describe the influence of system tuning on steering response and torque feedback
- Compare and contrast different types of power assist systems
- Describe the effect of power steering on fuel economy
- Calculate important parameters that affect steering response and torque feedback

Who Should Attend

This seminar is designed for automotive engineers in the vehicle dynamics, chassis, suspension, steering and chassis controls fields who work in product design, development, testing, simulation or research.

Prerequisites

Participants must have a working knowledge of the fundamentals of vehicle dynamics acquired through sufficient work experience or by participating in seminars such as SAE's Vehicle Dynamics for Passenger Cars and Light Trucks (ID# 99020), Chassis and Suspension Component Design for Passenger Cars and Light Trucks (ID# 95025) or Concurrent Engineering Practices Applied to the Design of Chassis Systems (ID# 96016).

Topical Outline

DAY ONE
- Introduction
  - Elements of the steering system
  - Coordinate systems
- The Lower Steering System
  - Kingpin axis -- Front versus rear steer; Caster angle and kingpin inclination; Caster trail and scrub radius; Steer arm
  - Class exercise - Calculate moment about the kingpin axis for cornering and parking loadcases
  - Linkages/steering geometry -- Rack and pinion; Haltenberger; Parallel linkage
  - Steering gear anatomy and architecture -- Rack and pinion; Recirculating ball
  - Friction and compliances
  - Class exercise - Calculate pinion torque for cornering and parking loadcases
- The Upper Steering System (steering column & intermediate shaft)
  - Anatomy and architecture
  - Non-uniformity
  - Sources of friction and torsional compliance
  - Role of the upper steering system in the occupant protection system

DAY TWO
- Power Assist Systems
  - Conventional hydraulic power assist
  - Electro-hydraulic assist
  - Electric power assisted steering
  - Speed sensitive steering
- Vehicle Level Considerations
  - Steering response -- Effect of steering ratio on response gain
  - Steering feel/torque feedback -- Common steering tests and metrics; Effect of friction, compliances, and steering column non-uniformity
  - Class exercise - Calculate a power steering assist curve for hydraulic or electric power assisted steering system
  - Error states (nibble/wheelfight, pull/drift)
  - Power steering system effect on fuel consumption

Instructor: Timothy Drotar
Fee $1225

1.3 CEUs
12 ACTAR CEUs

Fundamentals of Truck and Off-Highway Transmission Systems

2 Days
I.D.# C0024

This course will develop a basic understanding of the fundamentals of operation and explain the current state-of-the-art design of the modern transmission designs. Transmission systems in current production will be used as a practical example throughout the seminar. Two basic product areas of truck and off-highway transmission systems will be reviewed: Planetary Automatic Transmissions, and Power-Shifted Transmissions.

The functional requirements of the "current" market and the operational needs of its drivers will drive the course. Course material will be presented in the chronological order in which it was introduced into the marketplace. This order is shown through the requirements of " new" functionality by the marketplace at the time it was introduced. The design advances that satisfied these requirements will be discussed and used to show design progression through to the current state of design.

This "current state-of-the-art" design schematic will then be used to show the driving forces behind the next evolutionary step in the development of future designs of transmission systems. All aspects of current designs will be reviewed in depth; the components used, how they operate and the interrelation of all components. All functional modes of the major components and sub-systems will be discussed

and explained to the audience. Based on this working knowledge of transmission components and systems, attendees will work through design specifications, functional modes and considerations of reliability and life for each major sub-system in a transmission system.

The seminar will conclude with a brief discussion of the future of transmission systems and what functional requirements are likely to be expected by the users of the next generation vehicles within this market.

Learning Objectives

By attending this seminar, you will be able to:
- Identify the major components and system functions in a modern truck or off-highway transmission system
- Compute powerflow, relative rotational speeds of various components, and the functional relationships that exists between these components
- Specify the size of a truck or off-highway transmission, select the numbers of speed ranges and ratios for each, and assess system efficiency
- Explain the operational aspects and design principles of each of the major components and sub-systems of a transmission
- Describe the operational parameters and inter-relationships of each of the sub-systems within the truck transmission
- Summarize basic design synthesis and analysis techniques for each of the major components and sub-systems of a transmission
- Discuss the direction of new truck and off-highway equipment transmission designs

Who Should Attend

The intended audience for this seminar is powertrain design engineers, designers, engineering directors and managers, component suppliers, platform powertrain test and development specialists, and those involved in the application, design and discussion of engines. The seminar will appeal to anyone who is interested in truck or off-highway vehicle operation and design.

Prerequisites

Participants should have an undergraduate engineering degree.

Topical Outline

- Theory of Operation of a Basic Transmission
  - Basic transmission layout
  - Main components
  - Common configurations/transmission types
- Development of the "Automatic" Transmission
- Major Components of a Modern Automatic Transmission
  - Torque converter
  - Planetary gearsets
  - Clutch packs and bands
  - Powerflow
- Functionality
  - Torque converter operation
  - Gear systems
  - Gear design considerations
- Type
- Layout
- NVH (Noise, Vibration and Harshness)
- Planetary powerflow
  - Common gear arrangements and standard design configurations
- Clutches and bands
  - One-way/over-riding clutches
- Comparisons to Power-Shift transmissions
- Operational characteristics of power-shift transmissions
- Components and typical layouts
- Clutch packs
- Shift systems
- Application and duty cycle consideration
- Design considerations for Over-The-Road Transmissions
- Process to select the number of speed ranges
- Select approximate gear ratios for each speed range
- Calculate losses and efficiencies
- Power-flow optimization
- Duty cycle considerations
- Design for reliability and life
- Design considerations for Off-Highway transmissions
- Process to select the number of speed ranges
- Select approximate gear ratios for each speed range
- Calculate losses and efficiencies
- Design information content of engine curves
- Duty cycle considerations
- Design for service, repair and "rebuildability"
- Future direction of technologies

Instructor: William Mark McVea
Fee $1245 1.3 CEUs

Heavy Vehicle Ride Comfort Engineering

1 Day
I.D.# C0948

Ride comfort engineering is an essential element in the design of heavy vehicles and has a direct impact on operator performance, market differentiation, and overall customer satisfaction. Practitioners in the commercial vehicle industry must be able to assess the effects of noise and vibration on operator comfort and performance. This one-day seminar provides a comprehensive evaluation of heavy vehicle ride comfort engineering, balancing fundamental concepts with contemporary issues. This seminar begins with the fundamentals of ride comfort engineering, covering the elements that impact operator comfort and fatigue in heavy vehicles, particularly heavy trucks. This will include vehicle components that influence vibrations being transmitted to the operator such as cab and seat suspensions, cab layout, and sleeper arrangement. Additionally, this seminar includes an evaluation of the impact vibrations have on the human body and motor skills as they pertain to vehicle operation. This seminar concludes with two case studies that highlight some of the new technologies that can assist the attendee in evaluating and improving truck ride dynamics.

Please note: Individuals that have attended the Fundamentals of Heavy Truck Dynamics seminar should be aware there is considerable overlap in the content presented in this seminar.

Learning Objectives

By attending this seminar, you will be able to:
- Describe heavy vehicle ride engineering and the factors that influence it, both in theory and in practice
- Identify the vehicle components effecting vibrations in heavy vehicles
- Evaluate cab and seat suspension dynamics
- Identify the impact vibrations have on human comfort and fatigue
- Predict how various sub-systems interact with each other to influence truck dynamics
- Evaluate some of the contemporary issues in heavy truck dynamics

Who Should Attend

This seminar will benefit design, manufacturing, and customer support engineers in the heavy truck industry, most notably the original equipment manufacturers and their suppliers. Managers and marketing staff, as well as individuals in government agencies and educators in academic institutions that have a need for understanding heavy vehicle ride dynamics will also benefit from attending this seminar.

Prerequisites

A basic knowledge of college-level statics, dynamics, and vibrations will help the attendees to more easily follow the course material. Practical knowledge and common sense can replace the academic training in statics and dynamics.

Topical Outline

- Course Outline
- Course Introduction
  - What is ride engineering
  - Importance of ride engineering in heavy vehicles
- Elements of Ride Engineering in Heavy Vehicles
- Vibration Sources
  - Road roughness
  - Tire and wheel assembly
  - Engine and transmission
  - Driveline excitation
  - Truck frame dynamics
  - Cab suspension dynamics
- Vehicle Dynamic Elements
  - Suspension dynamics
  - Nonlinearities in suspension
  - Resonance of axle hop
  - Bounce and pitch of rigid body
  - Roll response
  - Frame bending
  - Cab mounting system
  - Position of fifth wheel
  - Driver's seat
  - Loading
  - Trailer effects
- Human Aspect of Ride Engineering
  - Biodynamics
  - Perception of ride
  - Human body response to vehicle vibrations
- Case Study 1: Effect of Seat Suspension on Heavy Truck Ride Engineering
- Case Study 2: Effect of Cab Suspensions on Heavy Truck Ride Measurements
- Seminar Evaluation and Conclusion

Instructor: Mehdi Ahmadian
Fee $725 .7 CEUs

High-Performance Brake Systems

2 Days
I.D.# C0718

While most passenger car brake systems are quite robust and reliable under typical operating conditions, high-performance driving and/or racetrack operation generally require alternative design solutions to optimize consistency and longevity. Whether it is brake fluid fade, cracked rotor discs, chronic knockback, or insufficient brake pad life, the stresses of motorsports can pose unique challenges to even the very best brake system designs. Consequently, ceramic rotors, six-piston calipers, adjustable balance bars, and titanium backing plates have all made their way onto the high-performance brake system scene, but what is the right answer for your application?This seminar has been designed to assist you in answering that very question. The day begins with a concise yet thorough analysis of brake system design factors relevant to all types and categories of high-performance vehicles. The principles of energy conversion, gain, balance, and deceleration are discussed and supported with straightforward mathematical models, allowing attendees to realize the compromises that must be considered when designing from a system perspective.

From selecting an appropriate brake pedal ratio through the calculation of caliper effective piston area, the second portion of the seminar dives into the details of brake system component design. Based upon the principles learned earlier in the day, attendees will quickly realize that just as with proper system design, brake system component design is an exercise in managing engineering trade-offs. As a result, the material presented will not disclose what components to choose as much as how to choose them.

Day two of the seminar concludes with a design exercise that will allow attendees to put into practice several of the key concepts learned throughout the seminar. Detailed course notes and illustrations are provided along with a copy of *High-Performance Brake Systems: Design, Selection, and Installation* for on-the-job reference.

Learning Objectives

By attending this seminar, you will be able to:
- Estimate brake system energy capacity
- Approximate brake system gain requirements
- Calculate vehicle deceleration
- Establish brake proportioning for ideal balance
- Determine pedal ratios, booster output, and hydraulic system gain
- Discuss the differences between brake fluid chemistries
- Specify brake caliper components
- Differentiate between brake pad friction materials
- Select rotor technologies for application-specific needs

Who Should Attend

This course has been developed for individuals involved in the specification, design, installation, maintenance, and performance of brake systems and their associated components in high-performance and/or racing applications; however, the fundamental principles and design considerations presented apply to all facets of brake system engineering. In addition to individuals involved directly in brake system design, this course can be valuable to those responsible for chassis design, suspension tuning, tire optimization, and overall vehicle dynamics in high-performance applications.

Prerequisites

An undergraduate engineering degree or a strong automotive technical background is highly recommended. A basic knowledge of college algebra, college physics, and a familiarity with vehicle hydraulic brake system functionality is required to participate in the final seminar design exercise.

Topical Outline

DAY ONE
Module 1: Energy Conversion
- The Conservation of Energy
- Types of Energy
- Energy Transformation
- Calculating Brake System Temperatures

Module 2: Tires
- Brake Forces & Tire Slip

- The Mu-Slip Curve
- Calculating Maximum Deceleration

Module 3: Gain
- Gain & Force Distribution
- Brake Component Gain
- Brake System Gain
- Calculating Stopping Distance
- Compliance

Module 4: Brake Balance
- Brake Force and Corner Weight
- Static and Dynamic Weight Distribution
- Ideal Brake Balance
- Why Ideal Brake Balance Matters

Module 5: Apply System
- Brake Pedal Design & Function
- Brake Booster Design & Function
- Master Cylinder Design & Function
- Balance Bar Design & Function
- Proportioning Valve Design & Function

Module 6: Brake Fluid & Hoses
- Boiling Points and Water Adsorption
- DOT Ratings
- Hydraulic Circuit Design
- Brake Hose Design & Function

DAY TWO

Module 7: Calipers
- Caliper Design & Function
- Taper Wear and Piston Count
- Caliper Mounting
- Caliper Body Design
- Knockback

Module 8: Brake Pads
- Brake Pad Design & Function
- Brake Pad Fade
- Friction Material Categories & Chemistries
- Friction Mechanisms

Module 9: Rotors
- Rotor Design & Function
- Rotor Cooling
- Solid & Vented Rotors
- One-Piece & Two-Piece Rotors
- Cross-Drilled Rotors & Slotted Rotors

Module 10: Design Exercise
- Brake Force Analysis
- Deceleration Analysis
- Weight Transfer Analysis
- Brake Balance Analysis

Instructor: James Walker, Jr.
Fee $1255 1.3 CEUs

Hydraulic & Pneumatic Fluid Power Seals

1.5 Days
I.D.# 91002

This seminar presents the findings of several seal research and development programs, focusing on the "lessons learned" from - and innovative solutions to - seal problems. Attendees will gain insights from numerous R&D programs, including: a large rod scraper evaluation study; experiments evaluating different types of cap seals; and the military's research on 8,000 psi hydraulic systems (the findings of which are equally applicable to lower pressure components). Seal design recommendations applicable to actuators will also be presented. A software program for seal squeeze and gland volume fill (with most adverse tolerances) will be demonstrated and provided to each attendee.

Who Should Attend

This seminar is designed for those responsible for the design of hydraulic or pneumatic components, the selection of fluid power systems, or the sales of hydraulic or pneumatic seals.

Prerequisites

Attendees should have previous experience with seals or basic knowledge of the subject.

Topical Outline

DAY ONE
- Calculating Seal Squeeze and Gland Volume Fill
  - Demonstration of AS 4727 procedures
- Sealing Surface Finishes
- Rod Bushing Design
  - Choice of bushing material
  - Preferred axial location of O-ring grooves
- Backup Rings
  - Cross-sections that have been effective anti-extrusion devices
- Seal Elastomers
- Rod Scrapers
- Cap Seals
- Two-Stage Rod Seals
  - History of un-vented rod seals in the U.S.
  - Design of cylinders that do not leak
- Seal Friction
  - Low-friction design recommendations
- Pneumatic Seals
- Spiral Failures
  - Conditions leading to spiral failures
  - Configurations that are immune to spiral failures
- Static Face Seals and Static Radial Seals
  - Eliminating leakage
  - Design standards

DAY TWO (ends at 12:00 noon)
- Guide Rings
- High-Pressure Seals
- Rotary Seals
  - Demonstration of the Joule effect
- Lessons Learned
- System Design to Prevent Leakage
  - Responsibility of component designer and system designer

Instructor: Kelley Fling
Fee $1155 1.0 CEUs

Hydraulic Brake Systems for Passenger Cars and Light Trucks

3 Days
I.D.# C0509

Hydraulic brake systems, one of the most important safety features on many road vehicles today, must meet manufacturer and customer requirements in addition to Federal Motor Vehicle Safety Standards. This course will analyze automotive braking from a system's perspective, emphasizing legal requirements as well as performance expectations such as pedal feel, stopping distance, fade and thermal management. Calculations necessary to predict brake balance and key system sizing variables that contribute to performance will be discussed. Major components of a brake system, including calipers, boosters, master cylinders, drum brakes, and park brakes will be presented in detail highlighting the many design variations. An overview of the chassis control components and operating principles will be presented with an emphasis on ABS, traction control and stability control.

Learning Objectives

By attending this seminar, you will be able to:
- Design a brake system in compliance with Federal Motor Vehicle Safety Standards
- Calculate the ideal brake balance for a vehicle under any loading condition
- Calculate the actual brake balance and brake output for a selected set of brake components and evaluate the effects of changing component parameters
- Determine the effects of variation in component parameters on the system performance
- Describe the basic function of major brake components
- Describe various chassis control systems and their role in vehicle safety
- Determine the appropriate design variation for a particular application

Who Should Attend

This course is designed for engineers interested or responsible for the specification, prediction and validation of braking system performance. It will also benefit engineers responsible for brake component design by providing insight into the interaction of components and the contribution to system level performance metrics.

Prerequisites

A basic understanding of vehicle dynamics and familiarity with hydraulic principles would be helpful, but is not required.

Topical Outline

DAY ONE
- System Level Requirements
  - Emphasis on FMVSS 135 and ECE 13 -- Effects of requirements on design; Tradeoffs with other system requirements; Partial system considerations; Loading conditions
  - Stopping Distance -- Actual vs. magazine; Contributions of subsytems; Effects of driver
  - Thermal management -- Conservation of energy; Abuse schedules; Mountain descents; Design for max speed vs. high use
  - NVH & pedal feel -- Metrics and criteria; Objective techniques
- Brake Balance and System Output Calculations
  - Ideal brake force derivation
  - Actual brake output
  - Effects of variation, planned and unplanned

DAY TWO
- Workshop - The student will design a brake system for a vehicle of their choice and predict the performance to key system level targets
- Component Functional Review
  - Brake pedal assembly -- Variable ratio; Adjustable; Composite
  - Brake booster options -- Vacuum; Hydroboost; Active
  - Master cylinder
  - Fluid, pipes, and hoses
  - Proportioning and metering valves
  - Disc brakes -- Fixed; Floating; Multi-piston; Vented; 2-piece

DAY THREE
Component Functional Review (continued)
- Drum brakes -- Leading-trailing; Duo-servo; Self-adjusting; Static Brake
- Parking Brakes -- Foot vs. hand; Cables and tensioning; Drum-in-hat; Caliper mechanisms
- Workshop - The student will determine the effects of component variation on their design from Day 2
- Anti-lock Braking Systems
  - Mechanization
  - Performance
  - Dynamic rear proportioning/electronic brake force distribution
- Advanced Concepts and Technology
  - Panic brake assist
  - Hybrid/regenerative braking
  - Brake-by-wire
  - Electric parking brake

Instructor: Thomas J. Hall
Fee $1545

2.0 CEUs
18 ACTAR CEUs

Introduction to Brake Control Systems: ABS, TCS, and ESC

2 Days
I.D.# C0315

Once reserved for high-end luxury vehicles, electronic brake control systems are quickly becoming standard equipment on even the most inexpensive cars and trucks. Today, nearly every new vehicle benefits from the optimized braking, enhanced acceleration, or improved stability that these systems provide. This comprehensive seminar introduces participants to the system-level design considerations, vehicle interface requirements, and inevitable performance compromises that must be addressed when implementing these technologies.

The seminar begins by defining the tire-road interface and analyzing fundamental vehicle dynamics. Following an in-depth study of system electronics, hydraulic hardware, and sensor requirements, the participants learn about the control strategies employed by anti-lock brakes (ABS), dynamic rear proportioning (DRP), traction control (TCS), and electronic stability control (ESC) with strong emphasis placed on vehicle dynamic response. The seminar concludes with a study of unique applications, a look forward to advanced brake control system integration, and an overview of Federal Motor Vehicle Safety Standard 126. Over 500 pages of detailed course notes and illustrations are provided for on-the-job reference.

Learning Objectives

By attending this seminar, you will be able to:
- Analyze brake system design parameters and their vehicle

performance effects
- Evaluate the compromises between stability, steerability, and stopping distance
- Discern the discrete mechanical components required for ABS
- Specify fundamental ABS performance attributes
- Estimate dynamic brake balance and explain the benefits of DRP
- Reconcile TCS performance expectations vs. method of implementation
- Interpret ESC metrics and ultimate dynamic limitations
- Discuss opportunities for advanced brake control system integration
- Comprehend federal requirements for the performance of ESC

Who Should Attend

This course has been developed for engineers involved in all fields related to the design or development of vehicle dynamics, vehicle braking systems, powertrain systems, chassis systems, or suspension systems. In addition, this course can be valuable to those with component design responsibilities in brake, chassis, suspension, or tire disciplines. Individuals new to the field of brake control systems will benefit most from the material; this introductory course is not intended for individuals with significant experience with brake control systems. In addition, please note that because of proprietary considerations this class does not provide details of algorithm design, algorithm performance, or algorithm application. Instead, the course places strong emphasis on vehicle dynamic responses.

Prerequisites

An undergraduate engineering degree or a strong technical background is highly recommended. A basic knowledge of college algebra, college physics, and a familiarity with vehicle brake and suspension systems is required.

Topical Outline

DAY ONE
- Tire-Road Interface Characteristics
  - Defining slip
  - Longitudinal mu-slip relationship
  - Longitudinal vs. lateral slip capacity
  - The friction circle
- Hydraulic Brake System Overview
  - What do braking systems do?
  - How does each component contribute?
  - What are the underlying fundamental relationships?
  - How does this apply to brake control systems?
- Stability, Steerability, Stopping Distance
  - Define stability, steerability, stopping distance
  - Illustrate with mu-slip curves
  - Illustrate with friction circle
- Mechanization of ABS
  - ECU functions and components
  - HCU functions and components
  - ABS hold, release, and apply functions
  - Diagnostics and warning lamp considerations
- ABS Sensor Overview
  - The role of sensors
  - Wheel speed sensors
  - Brake apply state sensors
  - Longitudinal accelerometers
- ABS Performance
  - ABS objectives and strategies
  - Basics of ABS wheel control
  - ABS performance on homogeneous surfaces
  - ABS performance under other conditions

DAY TWO
- DRP Performance
  - Weight transfer and brake proportioning
  - Proportioning valve design and performance
  - DRP strategies, wheel control, and performance
  - DRP benefits, design compromises, and limitations
- Mechanization of TCS and ESC
  - Additional ECU functions and components
  - Additional HCU functions and components
  - Pressure build sequence
- TCS and ESC Sensor Requirements
  - The role of sensors
  - Steering angle sensors
  - Brake pressure sensors
  - Lateral accelerometers and yaw rate sensors
- TCS Performance
  - TCS objectives and strategies
  - Basics of TCS wheel control
  - TCS performance under various conditions
  - Driveline architecture interactions
- ESC Performance
  - The physics of turning
  - ESC objectives and strategies
  - Basics of ESC wheel control
  - ESC performance
  - Driveline architecture
- Special Conditions and Considerations
  - 4x4 and off-road considerations
  - Racing and high-performance considerations
  - Impact of vehicle modifications
- Advanced Integration (handout only - no presentation)
  - Adaptive cruise control (ACC)
  - Panic brake assist (PBA)
  - Brake-by-wire (BBW)
- Federal Motor Vehicle Safety Standard 126
  - ESC definitional requirements
  - ESC dynamic performance test
  - Stability and responsiveness requirements
  - Industry rollout requirements
  - Federal Register preamble requirements
- Learning Assessment

Instructor: James Walker, Jr.
Fee $1225 1.3 CEUs
13 ACTAR CEUs

Introduction to Brake Control Systems e-Seminar


I.D.#PD130501ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this nine and a half hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. The course is divided into 13 video modules, accompanied by a handbook.

View the complete program brochure and online demo at http://www.sae.org/e-seminars/brakecontrolsystems.

What You Will Receive:

- 365 Day access through MyLearn.sae.org
  - Links to streaming video modules
  - Course Handbook (downloadable .pdf's, subject to DRM)
- Online Pre-test (self-test, immediate results)
  - Online Post-test (submit to SAE)
  - CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: James Walker, Jr.
Fee $525 1.0 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Introduction to Commercial and Off-Road Vehicle Cooling Airflow Systems

2 Days
I.D.# C0738

Vehicle functional requirements, emission regulations, and thermal limits all have a direct impact on the design of a powertrain cooling airflow system. Given the expected increase in emission-related heat rejection, suppliers and vehicle manufacturers must work together as partners in the design, selection, and packaging of cooling system components. An understanding and appreciation of airflow integration issues and vehicle-level trade-offs that effect system performance are important to the team effort. The severe duty cycles, minimal ram air, and sometimes unconventional package layouts present unique challenges.The goal of this two-day seminar is to introduce engineers and managers to the basic principles of cooling airflow systems for commercial and off-road vehicles. Participants will learn about vehicle/product constraints, integration issues, cooling airflow, system resistance, fans, shrouds, radiators, coolers, estimating heat rejection, thermal accumulation, air recirculation, system performance, and underhood airflow. Basic concepts will be reinforced with in-class discussion of case studies.

Learning Objectives

By attending this seminar, you will be able to:

- List fundamental factors and constraints of commercial and off-road vehicle cooling airflow systems
- List vehicle requirements and system integration issues
- Describe system resistance, fan, shroud, installation effects, and radiator characteristics
- List fan/shroud aerodynamic design considerations and installation effects
- Estimate heat rejection and thermal accumulation for system analysis
- Analyze performance of diesel cooling airflow system
- List alternatives for program management trade-off discussions on cooling airflow systems

Who Should Attend

OEM and supplier engineers and managers who are involved with vehicle cooling systems, or who interface with vehicle program management on these issues, will benefit from this seminar. Graduate-level students interested in cooling systems will also find it instructive.

Prerequisites

Participants should have an undergraduate engineering degree. Exposure to thermal product development is helpful, but not required.

Topical Outline

DAY ONE

- Vehicle Overview
  - Cooling airflow system
  - A classification
  - Industrial air-cooled heat exchanger assemblies
  - System and sub-system requirements
  - Thermal recirculation
  - Challenges
- Thermodynamics Review
  - First law
  - Radiator heat transfer equation
  - Bernoulli's equation
  - SCFM
- Key Concepts
  - Thermal road map
  - Fan airflow map
  - Flow energy balance equation
- Fan Airflow (and system airflow road map)
  - Fan classification
  - Specific speed
  - Fan characteristic curve and matching
  - Fan static pressure
  - Air performance test chamber (AMCA)
  - Pusher and puller fans

DAY TWO

- Fan Airflow (and system airflow road map) cont'd
  - Vehicle installation effects-fan position, tip clearance, obstructions, installed performarmance
  - Fan laws
  - System airflow road map
  - Basic principles of mechanical fan systems
- Vehicle Airflow Restrictions-Energy Losses
  - Loss mechanisims-expansion and contraction loss, grilles, heat exchangers and underhood
  - Front-end and underhood flow patterns
  - Ram pressure recovery
  - Locating fan operating point
- Compact Heat Exchangers (and system heat transfer equation)
  - Thermal classification
  - Compact heat exchangers
  - Calorimeters
  - Radiator effectiveness and pressure drop
  - Fouling considerations, air-side
  - Thermal accumulation
- Estimating Powertrain Heat Rejection
  - Heat rejection to coolant -- Mean effective pressure; SAE dynamometer test procedures
  - Specific Heat Rejection (SHR) characteristic curve
  - Vehicle installation considerations
- Diesel Cooling Airflow System - Case Studies and Exercises
- Underhood Airflow
  - Thermal considerations, airflow pattern, and air temperature distribution
  - Flow visualization video (using water)

Instructor: Jack Williams
Fee $1305 1.3 CEUs

Introduction to Gears

1 Day
I.D.# C0822

This seminar is designed to provide gear novices with a general understanding of gear nomenclature, geometry, and arrangements. Starting with the basic definition of gears, conjugate motion and the "Laws of Gearing", you will gain a solid understanding of gearing and the fundamentals of rotary motion transfer through gear-trains. Gear classifications, tooth forms and geometry, and very high-level application considerations, manufacturing processes, and inspection techniques will be covered.

Attendees will receive a copy of the book, *Gear Design Simplified*, by Franklin D. Jones & Henry H. Ryffel.

Learning Objectives

By attending this seminar you will be able to:
- Describe the "Law of Gearing", conjugate action and involute profiles
- Identify the various gear types and configurations
- Articulate the various definitions and terms used in gearing
- Identify the function and operation of all gear arrangements
- Articulate basic design considerations, nomenclature and inter-relationship of gear forms and motions
- Describe the various manufacturing processes and inspection techniques commonly used in industry today

Who Should Attend

This seminar is designed for individuals with little or no previous experience in gear systems. Engineers new to the field of gearing, sales and marketing people responsible for interacting with gear engineers, component suppliers, and vehicle platform powertrain development specialists who have not been previously involved in gear system specification or design will benefit from this course.

Topical Outline

- Principles and Purpose of Gears
- Basic Concepts
  - Law of Gearing
  - Common Tooth Forms
- Classification of Gears
- Definitions and Terms Used in Gearing
- Gear Tooth Action
- Conjugacy
- Gear Geometry and Nomenclature
  - Tooth and blank nomenclature
- Gear Arrangements
  - Simple and compound gear train
- Ratios: What They Mean and How to Calculate
- Epicyclic
  - Configurations (Solar, Planetary, Star)
  - Ratios
- Gear Measurement and Inspection
- Charts - Involute, Lead, and Red Liner
- Dimension Sheet

Instructor: William Mark McVea
Fee $755 .7 CEUs

Powertrain Control Unit/ Transmission Control Unit Technology Webinar

4 Hours
I.D.# WB1001

Powertrain and Transmission Control Units are among the core technologies commonly employed in the mobility industry when designing and developing new transmissions. This webinar will focus on the basic functionality and configurations, high-level architecture, and block diagram type logic of modern automatic transmission powertrain control systems for enhanced vehicle operation, improved powertrain efficiency/reduced vehicle emissions, smooth transition from one speed ratio to another, and when powertrain system optimization relies on precise ratio selection. The course will also present a high-level description of the connectivity between the various control units, their architecture and the powertrain configurations with which they are matched. This connectivity will serve as the basis for a functional development of the shift strategy analysis and implementation requirements used by the system architecture. For each of the main powertrain configurations, the participant will be presented with an operational summary for that particular hardware and then shown how the PCU/TCU must be modeled to optimize function. This is not intended as a deep-dive into the various aspects of programming and/or network communication.

Learning Objectives

By connecting with this webinar you will be able to:
- Identify, describe, and explain what powertrain and transmission control units are and how they are used in modern vehicle transmission systems
- Explain the similarities and differences between PCUs and TCUs
- Discuss how PCUs/TCUs work as a standalone unit and as part of the larger vehicle control system
- Compare and contrast the various underlying functional concepts of PCU/TCU technology
- Explain the technical, operational, and functional benefits of incorporating (compared to discrete non-systemic control architecture) PCU/TCU to the OEM
- Describe all the various manifestations and configurations of PCU/TCU technology as applied to actual and/or conceptual transmission systems of today

Who Should Attend

This Webinar will benefit anyone involved in the design, analysis, development, service, customer support or sales of automotive transmission and/or powertrain components and systems should consider this as a core adjunct to their current knowledgebase. The value of this webinar also extends to anyone involved in the vehicle powertrain design and/or application of the technology.

Prerequisites

A basic understanding of automotive transmission technology and a BS in mechanical engineering or a related field is recommended.

Topical Outline

Session 1
- Fundamental Explanation of Powertrain Control Units (PCU) and Transmission Control Units (TCU)
- Core Technology Development as it Applies to Designing and Developing New Transmissions to:
  - Provide enhanced vehicle operation

- Improve powertrain efficiency/reduce vehicle emissions
- Generate and control smooth transition from one speed ratio to another
- Optimize powertrain system performance
- Review All the Various Inputs to and Outputs from Common PCU/TCU Technologies

Session 2
- High-Level System Architecture
- Powertrain Layout
- Overlay PCU/TCU on Transmission Architecture
- Applicability to Hybrid Transmission Control

Instructor: W. Mark McVea
Fee $395 .4 CEUs

Powertrain Controls (PTC) - Ford Online Course

I.D.#PD111013ON (Online delivery)

The Ford Powertrain Controls (PTC) online course introduces the critical role the powertrain controls system plays in providing excellent vehicle performance, fuel economy, driveability, and emissions. The course describes the powertrain controls system components, including sensors and actuators. The information is presented from a functional, interface diagram, and p-diagram perspective, to enable reliable and robust powertrain operation. In addition, the course emphasizes powertrain controls interactions with internal and external interfaces.

This 6-hour online course is intended to stimulate systems interaction thinking by emphasizing powertrain controls interactions with internal and external interfaces and to help you understand powertrain control systems, prevent late design changes, reduce warranty costs, and improve customer satisfaction.

Major topics include:

- Powertrain Controls Overview
- Powertrain Controls Hardware
- Powertrain Controls Software/Calibration and Diagnostics
- Powertrain Controls Reliability and Robustness
- Powertrain Controls Interfaces
- Sensors and Actuators
- Powertrain Controls Modes of Operation

Is this SAE/- Ford Online Course for you?

This course is geared toward powertrain, product development, quality, and manufacturing engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

- Three months of online access to the six hour course
- Proof of Participation

Fee $215

Powertrain As-Installed Driveline Subsystems (PAIDS) - Ford Online Course

I.D.#PD111014ON (Online delivery)

Powertrain as-installed subsystems have a common fundamental function to perform in harmony, enabling the engine to power the vehicle and/or accessories. There is a need to avoid issues such as idle roughness and to realize these are system interaction issues. For example, modal alignment affects idle roughness, and improving idle roughness can affect fuel economy.
This 8-hour - Ford Online Course describes the function and major interfaces of powertrain as-installed driveline subsystems. It also discusses Design Verification System (DVS) metrics/performance requirements for each subsystem and how each subsystem affects other subsystems.

Major topics include:

- Introduction to Driveline
- Drive Axles
- Driveshafts/Halfshafts
- Transfer Case/PTU/Coupling/RDU

Is this SAE/- Ford Online Course for you?

This course is geared toward quality, manufacturing, and product development engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

- Three months of online access to the six hour course
- Proof of Participation

Fee $275

Powertrain As-Installed Stationary Subsystems (PAISS) - Ford Online Course

I.D.#PD111015ON (Online delivery)

Powertrain as-installed subsystems have a common fundamental function to perform in harmony, enabling the engine to power the vehicle and/or accessories. There is a need to avoid issues such as idle roughness and to realize these are system interaction issues. For example, modal alignment affects idle roughness, and improving idle roughness can affect fuel economy.
This 12-hour - Ford Online Course discusses hardware design, function, and major interfaces of powertrain as-installed stationary subsystems. It also discusses Design Verification System (DVS) metrics/performance requirements for each subsystem and how each subsystem affects other subsystems.

Major topics include:

- Accelerator Controls
- Air Induction
- Engine and Transmission Cooling

- Exhaust
- Fuel
- Powerplant Mounts

Is this SAE/- Ford Online Course for you

This course is geared toward quality, manufacturing, and product development engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

- Four months of online access to the six hour course
- Proof of Participation

Fee $395

Powertrain Driveability - Ford Online Course

I.D.#PD111016ON (Online delivery)

Driveability is the result of a system's interaction between the powertrain, the vehicle, and the customer. Driveability concerns can arise in any mode of operation and have a common factor that all are the result of a change in engine/torque speed. Driveability is a key customer-driven Powertrain attribute. Improving Driveability is critical to improving customer satisfaction and competitiveness of vehicles.

All Powertrain Product Development engineers must know how their area of subsystem responsibility could affect vehicle Driveability. This 3-hour - Ford Online Course will provide knowledge of Driveability fundamentals. With this knowledge, you can better determine actions to improve the customer's perception of Driveability.

Major topics include:

- The Customer's Perspective
- Systems and Interfaces that Impact Driveability
- Evaluating a Vehicle's Driveability Performance

Is this SAE/- Ford Online Course for you?

This course is geared toward quality, manufacturing, and product tdevelopment engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

- Three months of online access to the six hour course
- Proof of Participation

Fee $115

Powertrain Performance Feel - Ford Online Course

I.D.#PD111017ON (Online delivery)

In addition to NVH, Driveability, and Shift Quality, Performance Feel is among the four Powertrain attributes that directly influence customer satisfaction. It is defined in terms of the availability of power to the end customer and is the customer perception of performance that includes the effects of vehicle acceleration, accelerator control characteristics, shift character, and sound quality.

This 3.5-hour - Ford Online Course is intended to increase the awareness of vehicle Performance Feel issues, target setting process, and the interactions and controls that affect Performance Feel.

Major topics include:

- Performance Feel from the Customer's Perspective
- Performance Feel from an Engineering Perspective
- Metrics and Targets of Performance Feel
- Performance Feel Design Considerations

Is this SAE/- Ford Online Course for you?

This course is geared toward powertrain, product development, quality, and manufacturing engineers. It is recommended that you have an engineering degree and experience in the automotive engineering field.

What You Will Receive

- Three months of online access to the six hour course
- Proof of Participation

Fee $125

Review of AMT and DCT Technology Applied to Automotive Powertrain Webinar

6 Hours
I.D.# WB1003

In this webinar, you will receive thorough coverage of the various and common AMT systems, their basic functionality, unique components, configurations, and the underlying theory of operation. It is designed to also place dual-clutch technology within the proper context of automotive powertrain designs and products. You will receive insight into the various limitations of current technology, the impact on vehicle operation and efficiencies of each, and the means employed to correct and enhance AMT operation. The course will also review the fundamentals of dual-clutch technology, its application, and the significance of this technology as it applies to improvements in all facets of an automotive powertrain. It will explore the versatility and operator satisfaction that vehicles equipped with dual-clutch systems can provide. It will conclude with a review of the combined effect of each of these advanced technologies on the overall operator satisfaction with all measures of vehicle performance.

This webinar is not intended to be a deep-dive into the various aspects of the design and analysis parameters and considerations

of each of these systems and/or components. Automated manual transmission (AMT) technology is commonly employed when designing and developing new transmissions to provide for enhanced vehicle operation, improved powertrain efficiency/reduced vehicle emissions, smooth transition from one speed ratio to another, and when powertrain system optimization relies on precise ratio selection. Dual-clutch technology is an extension of manual transmission technology and rovides a means to capitalize on the installed manufacturing and service base of current production transmissions; and does not require the OEM, the supplier, or the service technician to learn a new technology and tool-up for either the manufacture or service of a new product. The newly combined functions allow for many improvements over the efficiency of a manual, to the effortless operation of an automatic, to the seamless function of a CVT.

Learning Objectives

By connecting with this webinar you will be able to:
- Identify, describe, and explain how an automated manual transmission operates and the added functional benefit it provides to the vehicle powertrain
- Classify the common AMT systems by their proper designations and defined functionality
- Assess the merits and limitations of each of the major AMT systems and configurations common in the mobility industry
- Appreciate the differences and application focus of the various clutch engagement and shift action designs currently available
- Describe and explain what dual-clutch technology is, how it works, and what it has in common with modern manual transmission technology
- Explain the technical, operational, and financial benefits of dual-clutch technology to the OEM, vehicle service personnel and owner/operators
- Compare and contrast the function of DCT-equipped vehicles versus vehicles with simple manual and automatic transmissions

Who Should Attend

This webinar will benefit anyone involved in the design, analysis, development, service, customer support or sales of automotive transmission and/or powertrain components and systems. The material covered in this webinar should be considered a core adjunct to your current knowledgebase. The value of this webinar also extends to anyone involved in the vehicle powertrain design and/or application of the technology.

Prerequisites

A basic understanding of automotive transmission technology and a BS in mechanical engineering or a related field is recommended.

Topical Outline

Session 1
- Manual Transmission Operation Review
- Functions and Limitations of Current Clutch Engagement Systems
- Functions and limitations of Current Shift Systems
- Review of Driveline Response to Transmission Input
- Theoretical Development of Optimize Driveline Response

Session 2
- Explanation of the Benefits of Theoretical Automated Manual Transmission (AMT)
- Development of AMT Theory
  - Clutch actuation and control
  - Shift system operation and integration
- Review of Common Automated Clutch Actuation Mechanisms and Configurations
- Review of Common Automated Shift Implementation Mechanisms and Configurations

Session 3
- DCT: Clutch Technology
  - Types, operation, benefits and limitations
- DCT: Shift Mechanism/Technology
  - Actuation types, operation, benefits and limitations
- DCT: Pros/Cons of Dual-Clutch Transmission
  - System benefits
  - Operational Changes to vehicle powertrain control
- Commercialization of the Dual-Clutch Transmission
  - Performance/vehicle fuel consumption
  - Cost/weight/packaging

Instructor: W. Mark McVea
Fee $515 .6 CEUs

Safe Handling of High Voltage Battery Systems

1 Day
I.D.# C1019

Electric and hybrid vehicles are becoming more visible on today's roadways and the automotive companies are working hard to make these vehicles as transparent as possible to enhance consumer acceptance. The battery system forms a key part of any of these vehicles and is probably the least understood. With practically no moving parts the battery systems show no visible or audible warning of any latent dangers. This seminar will introduce participants to the risks encountered in handling high voltage battery systems and their component parts. With the understanding of these risks, the seminar will then address how to raise risk awareness and then methods of dealing with those risks. The outcome of this seminar should be improved avoidance of personal injury, reduced risk of reputation loss and product liability actions and reduced risk of loss of property and time.

Students will have an opportunity to participate in a real world battery handling case study scenario in which they will identify solutions for potential risk situations.

Learning Objectives

By attending this seminar, you will be able to:
- Identify the handling risks of the battery system
- Respect the risks and work with them
- Develop a safety program to manage the risks

Who Should Attend

This seminar is primarily intended for vehicle and battery engineers, battery system integration engineers, battery testing engineers, safety systems engineers, electrical engineers and thermal management engineers recently assigned to their roles or returning to hybrid or electric vehicle programs. It will also be beneficial to those involved in the specification, design, development, testing and planning of hybrid vehicle programs. Prototype shop staff will find the safety protocol aspects helpful.

Prerequisites

SAE course C0626, Introduction to Hybrid and Electric Vehicle Battery Systems, is recommended as a prerequisite. Material presented will be practical in nature and is based on selected fundamentals of chemistry, materials science, electrical and mechanical engineering. An undergraduate degree in electrical, mechanical or chemical engineering will assist in gaining maximum benefit from the material

presented. Experience or training in battery electrochemistry is helpful, but not essential.

Topical Outline

- High Voltage Batteries
  - Electrochemical energy
  - Construction aspects and controls
  - DC vs AC
  - Lithium Ion aspects
- Risks of HV Batteries
  - Team exercise: identifying the risks
  - Risk drivers
  - Hazards classifications
  - Cell vs pack level
- Risk Management
  - Abuse prevention
  - Best practices, design measures, error proofing
  - Prevention & warnings
  - Claims vs. test data
  - Housekeeping
  - Containment
- High Voltage Issues in Engineering and Manufacturing Environments
  - Avoidance of internal dangers from handling
  - What can go wrong in different environments
  - MSDS
  - Special tools
  - Handling of 'failed' batteries or cells
  - Dealing with an incident - team exercise

Instructor: Erik J. Spek
Fee $725 7 CEUs

The Tire as a Vehicle Component

1 Day
I.D.# C0101

The principal functions of the pneumatic tire are to generate driving, braking, and cornering forces while safely carrying the vehicle load and providing adequate levels of ride comfort. This seminar explains how tire forces and moments are generated under different operating and service conditions and, in turn, demonstrates how these forces and moments influence various vehicle responses such as braking, handling, ride, and high-speed performance. The content focuses on the fundamentals of tire behavior in automobiles, trucks, and farm tractors, but also includes experimental and empirical results, when necessary.

The Pneumatic Tire, a 700-page E-book on CD, edited by Joseph Walter and Alan Gent is included in the course material.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the force and moment generating behavior of tires as related to construction, materials, and operating conditions
- Predict vehicle response based on tire characteristics using basic laws of mechanics supplemented by experimental results as necessary

Who Should Attend

This course is designed principally for technical professionals in the automobile, tire, and wheel industries and their suppliers. In addition, some case studies and examples involve truck, agriculture, and aircraft tires.

Prerequisites

- An undergraduate degree in a technical field or commensurate experience is desirable.

Topical Outline

- Introduction
  - Brief history of tires and wheels
  - Types of tires
  - Tire construction features
- Longitudinal Tire Properties
  - Braking and driving forces
  - Rolling resistance
- Lateral Tire Properties
  - Cornering force
  - Camber thrust
  - Ply steer and conicity forces
- Combined Longitudinal and Lateral Forces
  - Friction ellipse
  - Load transfer in cornering
- The Tire as a Spring
  - Linear vs. non-linear springs
  - Rolling vs. non-rolling behavior
  - Tire frequency response
- Tire and Wheel Non-Uniformities
  - Force and moment variations
  - Low speed/high speed effects
  - Tire manufacturing issues
- Influences of Tire Properties on Vehicle Response
  - Vehicle stopping distance
  - Vehicle ride
  - Vehicle handling
  - Vehicle high speed performance
  - European vs. North American requirements
- Future Technological Developments
  - Run-flat tires
  - Cordless cast tires
  - Intelligent tires

Instructor: Joseph D. Walter
Fee $725 .7 CEUs
7 ACTAR CEUs

Threaded Fasteners and the Bolted Joint

2 Days
I.D.# 95030

This seminar introduces participants to all aspects of threaded fasteners including nomenclature, geometric considerations, metallurgy, material properties, applied stresses, and considerations for fatigue, corrosion, brittle fracture and temperature. Methods are developed for the analysis and design of bolted joints under axial and shear loads. Other topics include assembly practice and methods to control preload.

Learning Objectives

By attending this seminar, you will be able to:
- List the characteristics of threaded fasteners - their geometry, materials and standards
- Describe how fasteners fail and failure prevention methods
- Identify the methods and key variables involved in the analysis and design of a bolted joint
- Define assembly practice and methods to control preload

Who Should Attend

This seminar is intended for design, analysis, test or production engineers who deal with threaded fasteners. Although the seminar content was developed for engineers, the material would also be useful to others who deal with threaded fasteners including designers, technicians, production and maintenance supervisors and managers.

Prerequisites

The attendee needs little if any previous experience with threaded fasteners. The attendee should have completed the standard undergraduate courses in stress analysis and material science.

Topical Outline

PART 1 - Geometry, Materials and Standards
- Introduction
  - Bolts, rivets and pins
  - Are you breaking fasteners?
  - Do you have a happy joint?
- Geometry
  - Threaded fastener -- Head, threads
  - Nuts
  - Washers and other elements
- Materials and Manufacturing
  - Material Properties & Fastener Testing
  - Fastener Grades and Classes
  - Nut Grades and Classes
  - Selection Nut & Fastener
  - Forming Method
  - Coatings and Finishes
  - Other Fastener Material

PART 2 - Behavior of the Bolted Joint
- Joint Diagram
  - Introduction
  - Behavior - Axial Loading
  - Preload and Clamp Load
  - Joint Constant
  - Separation
  - Joint Diagram
  - Hard vs. Soft Joint
  - Application of Joint Diagram
  - Application of external load
  - Determination of separation load
  - Axial and shear loading
  - Non-linear member behavior
  - Non-linear fastener behavior
  - Loss of preload due to embedment
  - Joint Analysis
- Joint Preload
  - Overall Strategy
  - Considerations in Selection of Preload
  - Selection of Preload

PART 3 - Loads and Environment
- Fatigue and Fracture
  - Ductile vs. Brittle Fracture
  - Fatigue
  - Methods to Improve Fatigue Performance
  - Relative Importance of Sources
  - Hydrogen Embrittlement
  - Stress Corrosion Cracking
- Loading of the Fastener
  - Applications of Fasteners
  - Loading of the Joint - Axial, shear, torsion, thermal
  - Loading of the Member -- Contact stress; creep and stress relaxation; thread loading
- Corrosion
  - General Corrosion
  - Performance of Coatings
  - Galvanic Corrosion
  - Crevice Corrosion

PART 4 - Preload and Assembly
- Loss of Preload
  - Basic Behavior
  - Sources of Loss of Preload -- Self loosening; preload relaxation; differential thermal contraction
  - Methods to Prevent Loss of Preload -- Self loosening; preload relaxation
- Methods to Control Preload
  - Tools
  - Potential Assembly Problems
  - Control of Preload
  - Torque Control
  - Stretch Control
  - Tension Control
  - Turn Control
  - Torque-Turn Control
  - Yield Control

Instructor: Jess J. Comer
Fee $1265 1.3 CEUs

Tire and Wheel Safety Issues

1 Day
I.D.# C0102

One of the most important safety critical components on cars, trucks, and aircraft is the pneumatic tire. Vehicle tires primarily control stopping distances on wet and dry roads or runways and strongly influence over-steer/under-steer behavior in handling maneuvers of cars and trucks. The inflated tire-wheel assembly also acts as a pressure vessel that releases a large amount of energy when catastrophically deflated. The tire can also serve as a fulcrum, both directly and indirectly, in contributing to vehicle rollover. This seminar covers these facets of tire safety phenomena. Engineering fundamentals are discussed and illustrated with numerous practical examples and case studies of current public interest.

The Pneumatic Tire, a 700-page E-book on CD, edited by Joseph Walter and Alan Gent is included in the course material.

Learning Objectives

After completing this seminar attendees will be able to:
- Describe the most important performance parameters and operating conditions of pneumatic tires related to safety.
- Use fundamental equations of engineering science to predict and/or explain tire-vehicle interactions related to safety.

Who Should Attend

This course is designed principally for technical professionals in the automobile, tire, and wheel industries and their suppliers. In addition, some case studies and examples involve truck, agriculture, and aircraft tires.

Prerequisites

An undergraduate degree in a technical field or commensurate experience is desirable.

Topical Outline

- Introduction
  - Vehicle accident statistics
  - The role of the tire in accident prevention/causation
  - Tire construction features
  - Tire failure modes
- Tire Grip and Related Phenomena
  - Tire-road friction characteristics
  - Tire braking forces
  - Factors influencing vehicle stopping distance
  - Combined braking and cornering
  - Hydroplaning
  - High speed behavior and standing waves
- Brake Performance
  - Front wheel/rear wheel lock-up
  - Braking efficiency
  - Anti-lock braking and other systems
- The Tire as a Pressure Vessel
  - Burst pressure
  - Energy release in punctured tires
  - Wheel issues
  - Tire and/or wheel case studies
- Over-steering Vehicles
  - Meaning of under-steer coefficient
  - The contribution of the tire
- Vehicle Rollover Analysis
  - History of rollover
  - Rollover threshold
  - Tripping mechanisms
- Tire effects
- Operating conditions
- Public policy issues

Instructor: Joseph D. Walter
Fee $725

.7 CEUs
7 ACTAR CEUs

Vehicle Braking Performance: Stopping Distance Fast Track

I.D.#PD230826ON (Online delivery)

Stopping Distance is one of the most common metrics of a vehicle's braking performance and one of the most critical attributes of accident prevention and minimization. The measurements are used within the development of the vehicle and are a critical aspect of accident prevention, accident reconstruction, and overall occupant and pedestrian safety management. While the results of this metric are published in a variety of sources, the factors that differentiate vehicle performance, vehicle dynamics, and calculation of the braking performance required to achieve desired performance are not widely available.

Major topics include:

- Calculation of Stopping Distance
- Common Procedures Used to Assess Stopping Distance
- Performance Metrics Compared to Target Avoidance
- Determination and Generation of Forces Necessary to Stop a Vehicle
- Contributions and Limitations

Is this Fast Track for you?

The *Vehicle Braking Performance: Stopping Distance Fast Track* would be of value to anyone involved in the validation of a braking system, either in the development of the validation plan or the execution of the validation plan. Those involved in accident reconstruction and accident prevention would benefit from an understanding of the techniques, principles, contributing factors and limitations of stopping performance to improved vehicle and road system design. This course would also be of value to those involved in vehicle marketing -- a detailed understanding of the metric's generation and contributing effects will insure that promotion and comparison is done in a qualified manner.

What You Will Receive

- Three months of online access to the 60 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructor: Thomas J. Hall
Fee $109

Vehicle Braking Performance: Braking Confidence and Pedal Feel Fast Track

I.D.#PD230912ON (Online delivery)

Braking confidence and pedal feel are important braking performance attributes that should be optimized to achieve customer satisfaction with a vehicle's braking system. The relationship between the input force and travel provided by the driver to achieve the desired vehicle deceleration is as core to the vehicle personality or DNA as ride, handling, or driveability. This Fast Track will cover the main concepts and methods needed for tuning brake systems to desired pedal force and travel characteristics.

Major topics include:

- Introduction to Braking Confidence
- Input Force to Vehicle Deceleration Relationship
- Input Travel to Vehicle Deceleration Relationship
- Parametric Analysis
- Environmental Effects
- Emerging Trends Affecting Braking Confidence

Is this Fast Track for you?

The *Vehicle Braking Performance: Braking Confidence and Pedal Feel Fast Track* would be of value to anyone involved in the validation of a braking system, either in the development of the validation plan or the execution of the validation plan. This course would also be of value to those involved in vehicle marketing -- a detailed understanding of the metric's generation and contributing effects will insure that promotion and comparison is done in a qualified manner.

What You Will Receive

- Three months of online access to the 70 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructor: Thomas J. Hall
Fee $109

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Accelerated Test Methods for Ground and Aerospace Vehicle Development

2 Days
I.D.# C0316

Engineers and managers involved with product development are constantly challenged to reduce time to market, minimize warranty costs, and increase product quality. With less and less time for testing, the need for effective accelerated test procedures has never been greater. This course covers the benefits, limitations, processes, and applications of several proven accelerated test methods including accelerated reliability, step stress, FSLT (Full System Life Test), FMVTÂ® (Failure Mode Verification Testing), HALT (Highly Accelerated Life Testing), and HASS (Highly Accelerated Stress Screening). A combination of hands-on exercises, team activities, discussion, and lecture are used throughout the course.

Participants will also receive a copy of the instructor's book, *Accelerated Testing and Validation Management*, which includes numerous hands-on exercises and a CD with analytical spreadsheets.

Attendees are requested to bring a calculator to the seminar.

Learning Objectives

By attending this seminar, you will be able to:
- Choose the accelerated test method for a given application
- Analyze accelerated testing results
- Explain how to accelerate one's current test methods
- Explain how to accelerate one's validation program
- Adjust accelerated test programs for business situations
- Describe how product development cycles can be reduced from 18 to 6 months

Who Should Attend

This seminar is designed for anyone involved in product design, life testing, reliability testing and validation for passenger cars, light trucks, heavy duty, off-highway or aerospace vehicles, including reliability engineers, validation engineers, design engineers and their managers. Individuals who need to achieve shorter time to market or higher quality through custom test plans will find this course to be especially valuable. Purchasers or users of testing or engineering services will also find this course to be valuable. There are no prerequisites for this course although a technical background is helpful.

Topical Outline

- Statistical model for reliability testing
  - Fundamentals of a statistical reliability test
  - Effects of automotive supply chain on sample size and duration
  - Common pitfalls
  - Examine and solve two or three real life statistical data set problems
- Key Accelerated Tests, Terms, and Methods
  - Definitions: Information Goal, Basic Method, Limitations
  - Full System Life Test (FSLT)
  - Step Stress
  - Accelerated Reliability Highly Accelerated Life Test (HALT)
  - Failure Mode Verification Test (FMVT) -- Development; Warranty; Life Prediction
- Test Acceleration vs. Program Acceleration
  - Advantages of accelerating a full validation program compared to an individual test
  - Examples of time/cost saved on individual test acceleration
  - Examples of time/cost saved on program acceleration
- Hybrid Acceleration Methods
  - Using information goals of individual test methods to combine and leverage tests
  - Hands-on team exercise: combine test methods to solve a particular information need
- Decision and selection process
  - How to choose which method
  - Considering position in supply chain
  - Considering business model and product type
  - Considering development phase
  - Considering component, subsystem, and system level testing
  - Hands on team exercise: selecting optimal testing solution for several scenarios

Instructor: Alexander (Alex) J. Porter
Fee $1295 1.3 CEUs

Accelerated Test Methods for Ground and Aerospace Vehicle Development e-Seminar

I.D.#PD130624ON (Online delivery)

This course offers more than 10 hours of instruction divided into fourteen modules; a coordinated handbook; and a copy of the instructor's book, *Accelerated Testing and Validation Management*, which includes numerous hands-on exercises and a CD with analytical spreadsheets. Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), the e-seminar program options offer new and alternative ways to receive the same instruction as the live classroom learning without the expense of travel and time away from the workplace.

View the complete program brochure and online demo at http://www.sae.org/e-seminars/atm.

What You Will Receive:

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf's, subject to DRM)

- The book, *Accelerated Testing and Validation Management*, by Alexander J. Porter (hardback)
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Alexander J. Porter
Fee $565 1.0 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Practical NVH Signal Processing Methods

2 Days
I.D.# C0431

Signal processing has become a critical tool in optimizing vehicle noise. This seminar will help you to understand the foundation common to all NVH data acquisition equipment including digitizing, windows, aliasing, averaging techniques, and common analysis functions such as the power spectrum, transfer function and coherence. Fundamental concepts such as filtering, modulation, convolution, and correlation, as well as specialized techniques used in rotating machinery such as adaptive re-sampling and order tracking, will be covered. The seminar will also cover multi-input multi-output (MIMO) signal processing, array based solutions for force identification, source and path characterization and data visualization. Brief introductions to emerging concepts will also be explored and computer demonstrations, physical experiments and case studies will be used to illustrate applied, real-world problems.

Learning Objectives

By attending this seminar, you will be able to:
- Explain the fundamental controls typical in modern spectrum analysis tools
- Interpret NVH data and judge its relevance to physical phenomena
- Extract new types of useful information from NVH data
- Implement new signal processing techniques

Who Should Attend

NVH technicians, engineers and managers who want to understand how NVH data is produced and interpreted will find this seminar valuable. The material is presented at a level suitable for beginners, but offers the more experienced practitioners new insight into the concepts presented through the illustrations and demonstrations that are included.

Prerequisites

The majority of the course material is presented through qualitative descriptions, practical examples, illustrations and demonstrations, which require only basic mathematical skills. However, some familiarity with time and frequency domain measurements, linear algebra and statistics will enhance overall understanding of the material.

Topical Outline

- Properties of the FFT
  - Sampling and digitizing
  - Aliasing and filters
  - Leakage and windows
  - Averaging techniques
  - Autopower, crosspower and coherence
  - Transmissibility and isolation
  - Measuring and interpreting the transfer function
- Rotating Machinery Basics
  - What is an order?
  - Rotation synchronous data acquisition methods
  - AM and FM modulation effects
  - FIR, IIR and re-sampling filters
  - Up-sampling down-sampling and adaptive re-sampling
- Time Frequency Methods
  - Short time Fourier transform
  - Gabor expansion and Gabor transform
  - Orthogonality, invertability and the dual function relationship
  - Gabor order tracking
  - Introduction to wavelets
- Fundamentals of Multi-Input-Multi-Output (MIMO) System Analysis
  - Review of Single-Input-Single-Output (SISO) systems
  - Introduction to Single-Input-Multiple-Output (SIMO) systems
  - Partial correlation concepts
  - Coherent output power
  - Statistical errors in basic estimates
  - Conditioned spectral analysis
- Forces and Sources in MIMO Systems
  - Least squares solution techniques
  - Force estimation technique Conditioned Source Analysis (CSA)
  - Case history: transfer path analysis
  - Case history: model correlation and updating
- Introduction to Data Classification and Pattern Recognition
  - Techniques for building and analyzing feature vectors
  - Recognition engines: neural networks and hidden Markov models
  - Applications: machine noise recognition, vision based gear mesh quality

Instructor: Michael F. Albright
Fee $1225 1.3 CEUs

Practical Race Car Data Acquisition: RPM and Speed Analysis Fast Track

I.D.#PD230834ON (Online delivery)

Two of the most important and commonly used components in racing data acquisition today are engine RPM and speed analysis. These two channels of data give race teams and engineers critical information that can be used every day to help quantify changes in both the driver and the race vehicle. This 80-minute, online short course focuses on race car data acquisition, highlighting cornering speeds, engine acceleration rates, gear selection, engine RPM curves, shift times, throttle on/off, engine acceleration, wheel spin, brake lock, cornering speed, ignition cutout and much more. Whether you are a weekend racer or a professional data acquisition engineer, you will find the components of this course fundamental to successful data analysis in the real world. From hardware installation to software interpretation, this course will give you confidence and additional insight into these key pieces of data analysis.

Major topics include:

- Introduction

- Set-up for Acquiring Engine RPM Data
- Acquiring and Analyzing Engine RPM Data
- Interpreting RPM Results
- Set-up for Acquiring Speed/MPH Data
- Interpreting Speed/MPH Results
- Alternative Analysis Strategies

Is this Fast Track for you?

The *Practical Race Car Data Acquisition: RPM and Speed Analysis Fast Track* is designed for the racer - from the professional road racer to the weekend racer - or the engineer who is incorporating data acquisition into their race team strategy and want to maximize the abilities of their system as quickly as possible. This course does not require any pre-requisite, as the content will unfold from the basics, up to the more advanced features of these important data acquisition sensors. The knowledge gained in this course can be applied the next day at any level of racing without any additional training or experience.

What You Will Receive

- Three months of online access to the 80 minute presentation
- Integrated knowledge checks to reinforce key concepts
- Proof of Participation

Instructor: Dave Scaler
Fee $149

Advanced Vehicle Dynamics for Passenger Cars and Light Trucks 156
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Advanced Vehicle Dynamics for Passenger Cars and Light Trucks

3 Days
I.D.# C0415

This interactive seminar will take you beyond the basics of passenger car and light truck vehicle dynamics by applying advanced theory, physical tests and CAE to the assessment of ride, braking, steering and handling performance. Governing state-space equations with transfer functions for primary ride and open loop handling will be developed & analyzed. Building on the analysis of the state space equations, common physical tests and their corresponding CAE solutions for steady state and transient vehicle events will be presented. The "state-of-the-art" of vehicle dynamics CAE will be discussed. Common lab and vehicle tests and corresponding metrics used to assess chassis system and vehicle performance will be discussed in great detail. Hands-on workshops using CARSIM™ vehicle dynamics simulation software will help reinforce the material. Significant time will also be dedicated to the use of design of experiments (DOE) as a tool to assist in the analysis and optimization of chassis systems for multiple vehicle responses.

Participants should bring a scientific calculator to participate in the classroom workshops.

Learning Objectives

By attending this seminar, you will be able to:
- Apply vehicle dynamics theory to practical evaluation and measurement
- Use governing state space equations and transfer functions to determine the effect of key parameters on primary ride and open loop handling
- Describe the current "state-of-the-art" of vehicle dynamics CAE
- Articulate various types of vehicle dynamics models
- Recognize kinematics and compliance (K&C) lab tests commonly used to quantify chassis system performance
- Identify and evaluate important K&C metrics used in vehicle dynamics development
- Identify and utilize important vehicle tests commonly used in industry to evaluate ride, steering and handling performance
- Relate chassis system characteristics to vehicle dynamic performance
- Utilize vehicle dynamics CAE software for the simulation of common physical lab and vehicle tests
- Apply design-of-experiments (DOE) to vehicle dynamics development

Who Should Attend

This seminar is designed for automotive engineers in the vehicle dynamics, chassis, suspension, steering and braking fields who work in product design, development, testing, simulation or research.

Prerequisites

Participants must have a working knowledge of the fundamentals of vehicle dynamics acquired through sufficient work experience or by participating in seminars such as SAE's Vehicle Dynamics for Passenger Cars and Light Trucks (ID# 99020) or Concurrent Engineering Practices Applied to the Design of Chassis Systems (ID# 96016).

Topical Outline

DAY ONE
- Modeling Primary Ride Dynamics
  - 4-degree of freedom (DOF) primary ride model
  - 2-DOF primary ride model
- Modeling Vehicle Handling Dynamics
  - Developing the cornering compliance model
  - Developing the transfer function
- Introduction to Vehicle Dynamics CAE
  - Types of models
  - Strengths/Limitations
  - Commercial software packages
- Measurement and Simulation of Suspension Kinematics and Compliance (K&C)
  - Objectives of the K&C test
  - Definitions
  - Measurement equipment
  - Common tests
  - Simulation of the K&C test
- Measurement and Simulation of Primary Ride
  - Primary vs. Secondary Ride
  - Physical measurements
  - Common primary ride metrics
  - Olley Criteria for primary ride
  - Primary ride simulation
- CARSIM™ Exercise - Primary Ride Simulation

DAY TWO
- Measurement and Simulation of Acceleration and Braking
  - Steady state acceleration test and metrics
  - Steady state braking test and metrics
  - Simulation of steady state acceleration and braking
- Measurement and Simulation of Steering
  - On-center steering test and metrics
  - Low-g swept steer test and metrics
  - Simulation of steering tests
- CARSIM™ Exercise - Steering
- Measurement and Simulation of Open Loop Handling
  - Definition of open loop
  - Steady state open loop tests -- High-g swept steer
  - Transient open loop tests -- Step steer; Brake/throttle release in a turn; Fishhook; Sine with dwell
  - Simulation of open loop handling tests
- CARSIM™ Exercise - Open Loop Handling

DAY THREE
- Measurement and Simulation of Closed Loop Handling
  - Definition of closed loop
  - Steady state closed loop tests -- Constant radius
  - Transient closed loop tests -- Lane change; Slalom
  - Simulation of closed loop handling tests
- CARSIM™ Exercise - Closed Loop Handling
- Design of Experiments (DOE) Applied to Vehicle Dynamics

Development
- What is DOE
- Why use DOE
- Terminology
- Types of DOE's
- Example - Screening DOE for primary ride
- Example - Response Surface Method (RSM) DOE for Transient Handling
- Vehicle Dynamics Summary

Instructors: Richard Lundstrom and Timothy Drotar

Fee $1595 2.0 CEUs
18 ACTAR CEUs

Applied Vehicle Dynamics

3 Days
I.D.# C0414

While a variety of new engineering tools are becoming available to assist in creating optimal vehicle designs, subjective evaluation of vehicle behavior is still a vital tool to ensure desired braking, handling, and other dynamic response characteristics. In order to better prepare today's engineer for this task, this course offers twelve modules devoted to the key fundamental principles associated with longitudinal and lateral vehicle dynamics. Each focused classroom session is paired with an on-track exercise to immediately reinforce these concepts with a dedicated behind-the-wheel driving session, effectively illustrating these principles in the real world.

Note that unlike most driving schools, this course is not designed to train performance drivers. Rather, the exercises on days one and two build the bridge between vehicle dynamics theory and practical application by providing a rich academic underpinning and then reinforcing it with highly focused and relevant driving experiences. Significant technical skill-building is provided on day three, with increased instructor supervised track time to further absorb the principles learned on days one and two. If your job description does require performance driving skills, the dynamic exercises on day three will lay a solid foundation on which you can independently refine your own skills.

This course is offered at the BMW Performance Center in Greer, South Carolina (near Greenville). Driving exercises are conducted on a closed circuit and skidpad using primarily BMW 3-series sedans and other BMW vehicles for comparison exercises. Vehicles are also equipped with Escort G-Timer devices for basic data acquisition.

Learning Objectives

By attending this seminar, you will be able to:
- Explain tire-road friction limits and compose the friction circle for a given vehicle system
- Compute fundamental braking response attributes
- Illustrate the physics of turning and calculate lateral weight transfer
- Estimate brake system balance and brake proportioning
- Measure and graph a vehicle's understeer gradient
- Analyze basic anti-lock brake system (ABS) operation
- Discuss the effectiveness and limitations of electronic stability control (ESC) systems
- Demonstrate the interactions of brake, steering, suspension, and powertrain systems
- Calculate the most efficient path for a vehicle to negotiate a given test maneuver
- Comprehend the subtle effects that vehicle positioning has on vehicle speed
- Predict what response characteristics can be influenced by vehicle state
- Define those vehicle dynamic attributes which can be impacted through vehicle selection

Who Should Attend

This course has been developed for engineers and technical personnel involved in all fields related to the design or development of vehicle dynamics, vehicle braking systems, powertrain systems, chassis systems, or suspension systems. In addition, this course can be valuable to those with component design responsibilities in brake, chassis, suspension, or tire disciplines who desire a fundamental background in vehicle dynamics with a practical driving linkage.

Prerequisites

You should have an undergraduate engineering degree or a strong technical background. As a minimum, a basic knowledge of college algebra, college physics, and a familiarity with vehicle brake and suspension systems is required.

Topical Outline

DAY ONE
- Longitudinal Slip and Weight Transfer
  - Defining longitudinal slip
  - Longitudinal mu-slip relationship
  - Principles of longitudinal weight transfer
  - Friction circle concept
  - Driving exercise - orientation
- Fundamentals of Straight-Line Braking
  - What do braking systems do?
  - How does each of the components contribute?
  - What are the underlying fundamental relationships?
  - Driving exercise - limit braking
- Slip Angle and Transient Response
  - Slip angle and cornering stiffness
  - High-speed steering and transient response
  - Lateral weight transfer
  - Driving exercise - slalom
- Braking Stability
  - Rear brake proportioning fundamentals
  - Braking stability
  - Rear brake proportioning in practice
  - Driving exercise - brake in a turn

DAY TWO
- Steady-State Cornering
  - The understeer gradient
  - Components of the USG
  - Neutral steer, understeer, and oversteer
  - Driving exercise - skidpad
- Combining Lateral and Longitudinal Slip
  - Braking in a turn, turning while braking
  - Drive-off in a turn, turning during drive-off
  - Driving exercise - avoidance
- Anti-Lock Brake Systems
  - Stability, steerability, and stopping distance
  - Objectives and strategies of ABS
  - ABS performance
  - Driving exercise - avoidance
- Electronic Stability Control
  - Objectives and limitations of ESC
  - ESC detection and countermeasures
  - ESC performance
  - Driving exercise - wet skidpad

DAY THREE
- Test Procedure Selection
  - Defining terms and concepts
  - Test circuit overview
  - Driving exercise - path selection
- Test Procedure Sensitivity
  - Defining the apex
  - Driving the friction circle
  - Driving exercise - path variation
- Test Vehicle Sensitivity
  - Brief USG review
  - Impact of tire pressure adjustments
  - Driving exercise - low pressure
- Comparison Vehicle Evaluation
  - Comparison vehicle overview
  - Driving exercise - lapping
- Learning Assessment

Instructor: James Walker, Jr.
Fee $2295 2.4 CEUs
24 ACTAR CEUs

Vehicle Dynamics for Passenger Cars and Light Trucks e-Seminar

I.D.#PD130702ON (Online delivery)

Convenient, portable, and with core content from the instructor-led seminar (content and description immediately preceding), this four and a half hour e-seminar option offers an alternative way to receive the same instruction without the expense of travel and time away from the workplace. This course offers more than fourteen hours of instruction and simulations divided into nineteen video modules; The Automotive Chassis: Engineering Principles by Reimpell, Stoll and Betzler; a coordinated handbook that includes a resource guide and SAE papers and paper collections.

View the complete program brochure and demo at http://www.sae.org/e-seminars/vehicledynamics.

What You Will Receive:

- 365 Day access through MyLearn.sae.org
- Links to streaming video modules
- Course Handbook (downloadable .pdf's, subject to DRM)
- The *Bosch Automotive Handbook* (hardback)
- The book, *The Automotive Chassis: Engineering Principles* by Reimpell, Stoll and Betzler (hardback)
- The SAE Papers (bound, paperback):
  - 970091
  - SP-355
  - 760713
  - 760710
- Online Pre-test (self-test, immediate results)
- Online Post-test (submit to SAE)
- CEUs/Certificate of Achievement (with satisfactory post-test score)

Instructor: Richard Lundstrom
Fee $695 1.6 CEUs

Quantity discounts and Site License options are available – call SAE Corporate Learning Solutions hotline at 724-772-8529 for a quote.

Fundamentals of Heavy Truck Dynamics

3 Days
I.D.# C0837

Understanding vehicle dynamics is one of the critical issues in the design of all vehicles, including heavy trucks. This seminar provides a comprehensive introduction to the fundamentals of heavy truck dynamics. It covers all of the critical subsystems that must be considered by designers and decision makers in determining the effect of various components on heavy truck dynamics. This seminar begins where the tires meet the ground, progressing up through the various components and bringing together the theory and practice of heavy truck dynamics. A series of case studies related to truck ride engineering will provide an opportunity for attendees to demonstrate their knowledge gained and introduces them to some of the newer technologies related to evaluating and improving heavy truck ride dynamics.

Learning Objectives

By attending this seminar, you will be able to:
- Acquire an overall understanding of heavy truck dynamics, both its theory and practice
- Acquire and demonstrate knowledge of heavy truck ride engineering and the factors that affect it
- Define the dynamics of various truck sub-systems and components that include tires, steering system, and truck suspensions
- Identify how sub-systems or components interact with other sub-systems to effect truck dynamics
- Describe some of the contemporary issues in heavy truck dynamics
- Assess and evaluate selected research topics you may want to consider for the sub-systems and components that you work with

Who Should Attend

This seminar will benefit design, manufacturing, and customer support engineers in the heavy truck industry, most notably the original equipment manufacturers and their suppliers. Managers and marketing staff, as well as individuals in government agencies and educators in academic institutions that have a need for understanding heavy truck dynamics will also benefit from attending this seminar.

Prerequisites

A basic knowledge of college-level statics, dynamics, and vibrations will help the attendees to more easily follow the course material. Practical knowledge and common sense can replace the academic training in statics and dynamics.

Topical Outline

DAY ONE
- Course Introduction
  - What is Vehicle Dynamics
  - Course Outline
- Tire Dynamics
  - Tire Mechanics
  - Tire Dynamics
  - Tire Operating Conditions
- Steering System
  - Steering Mechanism
  - Forces and Moments
  - Steering Vibrations
  - Steering Effects
  - Maneuverability

DAY TWO
- Suspension Dynamics and Kinematics
  - Introduction to Suspension Systems
  - Spring Elements
  - Damper Elements
  - Advanced Suspensions
- Heavy Truck Dynamics
  - Dynamics Basics
  - Center of Gravity (CG) Calculations
  - Roll Dynamics
  - Load Transfer
  - Aerodynamics Loads
  - Frame Dynamics

DAY THREE
- Vibration Sources
  - Road Roughness
  - Tire and Wheel Assembly
  - Engine & Transmission
  - Drive line Excitation
  - Truck Frame Dynamics
  - Cab Suspension Dynamics
- Vehicle Dynamic Elements
  - Suspension Dynamics
  - Nonlinearities in Suspension
  - Resonance of Axle Hop
  - Bounce and Pitch of Rigid Body
  - Roll Response
  - Frame Bending
  - Cab Mounting System
  - Position of Fifth Wheel
  - Driver's Seat
  - Loading
  - Trailer Effects
- Perception of Ride
- Human Body Response to Vehicle Vibrations
- Case Studies: Contemporary Topics in Heavy Truck Dynamics
  - CASE 1: Practical Evaluation of Truck Suspension Kinematics and Dynamics
  - CASE 2: Dynamic Influence of Frame Stiffness on Heavy Truck Ride
  - CASE 3: Effect of Panhard Rod Cab Suspensions on Heavy Truck Ride Measurements
  - CASE 4: Simulation Analysis of Suspension and Driveline Dynamic Coupling and their effect on Truck Ride
- Seminar Evaluation and Conclusion

Instructor: Mehdi Ahmadian

Fee $1545

2.0 CEUs
15 ACTAR CEUs

Vehicle Dynamics for Passenger Cars and Light Trucks

3 Days
I.D.# 99020

This seminar will present an introduction to Vehicle Dynamics from a vehicle system perspective. The theory and applications are associated with the interaction and performance balance between the powertrain, brakes, steering, suspensions and wheel and tire vehicle subsystems. The role that vehicle dynamics can and should play in effective automotive chassis development and the information and technology flow from vehicle system to subsystem to piece-part is integrated into the presentation. Governing equations of motion are developed and solved for both steady and transient conditions. Manual and computer techniques for analysis and evaluation are presented. Vehicle system dynamic performance in the areas of drive-off, braking, directional control and rollover is emphasized. The dynamics of the powertrain, brakes, steering, suspension and wheel and tire subsystems and their interactions are examined along with the important role of structure and structural parameters related to vehicle dynamics. Physical experiments, applicable to vehicle dynamics are also introduced.

Attendees will receive the *Bosch Automotive Handbook* and *The Automotive Chassis: Engineering Principles* by Reimpell, Stoll and Betzler.

Learning Objectives

By attending this seminar, you will be able to:
- Summarize how vehicle dynamics is related to the voice of the customer
- Identify important vehicle system parameters useful for effective application of vehicle dynamics to chassis development
- List and explain parameters that effect vehicle performance relative to drive-off, braking, directional control and rollover
- Identify physical measurements needed to effectively apply vehicle dynamics to passenger cars and light trucks
- Define the value of vehicle dynamics simulation in the development and evaluation of vehicles
- Explain the balance required between ride, directional control and rollover and the essential process for this balance to be obtained for marketplace vehicles

Who Should Attend

Automotive engineers and quality professionals who work in product design, testing, quality, process or development will benefit from attending.

Prerequisites

Participants should have an undergraduate engineering degree and some exposure to vehicle dynamics.

Topical Outline

DAY ONE
- The Role of Vehicle Dynamics in Passenger Car and Light Truck Product Development
- Vehicle Dynamics and the Voice of the Customer
  - Use of QFD to manage vehicle dynamics performance in drive-off, braking, ride and handling
  - Thinking systemically about automotive chassis design and development through the logic of vehicle dynamics
- Effective Metrics for Vehicle Dynamics
  - Vehicle system, subsystem and piece-part metrics used to link vehicle dynamics to vehicle system design and development: bounce frequencies, lateral acceleration gain, understeer gradient, roll gradient, roll stiffness, etc.
- Tire Fundamentals: Tire Wheel System Anatomy and Architecture, Tire Axis System, Parameters and Characteristics
- Elementary Tire Patch Forces and Moments: Forces and Moments at the Tire Contact Patch During Steady Braking, Steady Cornering and Steady Drive-Off Maneuvers
- Acceleration (Drive-Off) Performance
- Basic powertrain system anatomy and architecture
- Power limited and traction limited drive-off including powertrain system dynamics required to produce vehicle motive force at the tire patch
- Road load considerations: aerodynamic resistance, rolling resistance, grade resistance
- Performance prediction in acceleration and fuel economy

DAY TWO
- Braking Performance
  - Basic brake system anatomy and architecture

- Braking dynamics: braking forces, weight transfer, center of weight, brake force distribution, stability
- Pedal force gain, brake proportioning, braking efficiency, anti-lock braking systems
- Tire - road limitations
- Federal requirements for braking performance
- Brake system performance prediction
- Ride Fundamentals
  - Input excitation signals: road roughness, vehicle sources (tire/wheel system, driveline and engine)
  - Vehicle response properties: suspension isolation, tire vertical stiffness, spring rate ratio, suspension stiffness, ride rate, suspension damping, pitch and bounce frequencies
  - Quarter vehicle and pitch plane ride simulations
  - Ride performance prediction based on flat ride criteria

DAY THREE
- Cornering Fundamentals
  - Low speed turning
  - High speed cornering: tire forces, Bundorf bicycle model, understeer gradient, characteristic speed, lateral acceleration gain, yaw velocity gain, side-slip
  - Suspension effects on cornering: tire cornering stiffness, camber thrust, roll steer, lateral force compliance steer, aligning torque, lateral load transfer, steering system
  - Experimental methods for vehicle handling development
- Suspension Systems
  - Suspension system anatomy and suspension system performance requirements relative to drive-off, braking, ride and handling
  - Solid live axles, twist beam suspensions and independent suspensions
  - Side view pitch poles and pitch axis considerations: anti-squat and anti-dive suspension geometry, wheel travel and caster geometry
  - Role axis considerations: roll center location, roll axis geometry and location, wheel travel and toe geometry, wheel travel and camber geometry
- Steering Systems
  - Steering system anatomy, architecture and performance requirements
  - Steering geometry, wheel geometry, steering system forces and moments, steering ratio, steering compliance
  - Experimental methods for steering system performance evaluation and development
- Roll-Over Fundamentals
  - Vehicle system roll-over prevention requirements
  - Elementary and suspended vehicle simulations
  - Suspension system and steering system considerations
- Introduction to CAE Applications for Vehicle Dynamics: CARSIM™ and sSNAP and Manual Analysis Methods.

Instructor: Richard Lundstrom

Fee $1665 2.0 CEUs

Chassis & Suspension Component Design for Passenger Cars & Light Trucks

3 Days
I.D.# 95025

Just as the chassis and suspension system provides an ideal framework for the automobile, this popular SAE seminar provides an informative framework for those involved in the design of these important systems. Emphasizing the fundamental principles that underlie rational development and design of suspension components and structures, this course covers the concepts, theories, designs and applications of automotive suspension systems.

Learning Objectives

By attending this seminar, you will be able to:
- Identify the types of suspensions and structures and their design differences from concept to prototype, theory to application; static and dynamic load conditions; and suspension modeling
- Describe the chassis design process and various suspension system interactions through demonstrations, video and audio devices and computer simulation
- Illustrate how an algorithm for a complete design cycle of the chassis works
- Explain the various chassis suspension analyses and designs that need to be performed and verified during development
- Recognize Magic Numbers in suspension design and the Suspension Design Factors (SDF)
- Analyze, predict, and evaluate the design parameters and performance characteristics for ride and handling quality control behavior of ground motor vehicles as a result of suspension design
- Reference a unique set of lecture notes related to suspension design

Who Should Attend

This seminar is designed primarily for engineers involved in vehicle ride, handling, chassis design, suspension, steering and brake design for passenger cars and light trucks.

Topical Outline

DAY ONE
- Survey
- General Overview
- Tires and Wheels
- Ride and Ride Design Criteria
- Handling and Handling Design Criteria
- Vehicle Dynamics Terminology

DAY TWO
- Roll Rates, Roll Motion
- Dynamic Transfer During Cornering
- Understeer Coefficient
- The Design of Springs, Stabilizer Bars, Shock Absorbers, Bushings, Control Arms
- Links, Semi-Active Damper, and Control Links
- Static Analysis and Design of Suspensions
- Suspension Terminology

DAY THREE
- Fore/Aft Dynamic Load Transfer Analysis
- Dive, Lift and Squat
- Steering Systems
- Active and Semi-Active Suspension
- CAD/Static, Dynamic and Proving Ground Testing
- Suspension Design Cycle
- Magic Number in Suspension Design
- Concluding Remarks

Instructor: Pinhas Barak

Fee $1545 2.0 CEUs

Mehdi Ahmadian
Mehdi Ahmadian, Ph.D. is a Professor of Mechanical Engineering at Virginia Tech, where he is also the Director of the Center for Vehicle Systems and Safety (CVeSS) and the Railway Technologies Laboratory (RTL). He is the founding director of CVeSS, RTL, Virginia Institute for Performance Engineering and Research, and the Advanced Vehicle Dynamics Laboratory. Dr. Ahmadian has authored more than 200 technical publications and has made more than 130 technical presentations in topics related to advanced technologies for ground vehicles. He holds six U.S. patents and has edited four technical volumes. He currently serves as editor for the International Journal of Vehicle Systems Dynamics, co-editor for Advances in Mechanical Engineering, and associate editor for the journal Shock Vibration. Dr. Ahmadian is a member of SAE and is the recipient of the 2008 Forest R. McFarland Award for outstanding contributions to the SAE Engineering Meetings Board. He is also a Fellow of ASME and a Senior Member of AIAA.

In the past, he has served as associate editor for the ASME Journal of Vibration and Acoustics and associate editor for the AIAA Journal. Dr. Ahmadian's research interests include vehicle dynamics and control, advanced suspensions, biodynamics, ride engineering, tire dynamics, advanced materials for improving vehicle performance, and vehicle noise and vibration assessment. Dr. Ahmadian has over 25 years of industrial and academic experience, working in research, development, and engineering of various systems for ground vehicles, air vehicles, and water vessels for both civilian and military applications.

Michael F. Albright
Michael F. Albright is co-founder and General Manager of Signal.X Technologies, LLC, a firm specializing in NVH engineering and custom test and measurement application development. He brings over 20 years of NVH experience to the SAE Noise Academies team. His past positions include Business Development Manager for the NVH consulting group of LMS North America, Management and Project engineering positions at the Roush Anatrol Division of Rousch Industries, Inc. and Civilian engineering for the U.S. Navy. With experience predominantly in the automotive industry, Mr. Albright has addressed a very diverse range of noise and vibration control issues including Powertrain NVH, Vehicle NVH, Brake noise, Engine accessory noise, Driveline NVH, Test procedure and facility development, Test/CAE Hybrid simulation methods, as well as a host of manufacturing quality issues. Mr. Albright's degrees include a BSME from University of Cincinnati and MSME from Purdue University.

Farid M.L. Amirouche
Dr. Farid M.L. Amirouche has been with the Univ. of Illinois at Chicago for over 13 years where he serves as Professor in Mechanical and Bioengineering and the Director of the Dynamics and Vibration Laboratory and the Biomechanics Research Laboratory. In addition, he has contributed over 100 publications in the area of dynamics, vibration, and control of mechanical systems and human body modeling. Dr. Amirouche's primary interest is in the dynamics and vibration of multibody systems with emphasis on vehicles and their interaction with the human operator, as well as modeling techniques in human body vibration. His focus has been in the development of new technologies, combing neural networks, continuum mechanics, and vibration to advance the state of the art of the dynamic analysis and simulation of interconnected rigid and flexible multi-body systems. Dr. Amirouche is the recipient of the SAE Ralph R. Teetor Educational Award (1994), the 1995 NATO project on human body vibration control, and the G-7 Summit Fellowship among others. He has also published two textbooks in the field of computer aided design and multi-body dynamic analysis.

Michael A. Anleitner
Michael A. Anleitner is President of Livonia Technical Services Company, a consulting and training firm that provides technical and managerial expertise to companies engaged in manufacturing and assembly of commercial, industrial, and consumer products. His activities at LTS include quality and productivity improvement, product development, process improvement, total quality system implementation, and technical engineering support. Mr. Anleitner has over 30 years of diversified experience in manufacturing and engineering. He was co-founder, and for seven years, CEO of HydraMechanica Corporation, which produced brakes, clutches, torque-limiting devices, friction materials, and other special friction products for a variety of applications. Prior to that, he was the Director of Engineering for a Tier I automotive supplier. His experience includes positions at Ford Motor Company in both materials and design engineering.

Mr. Anleitner has co-authored several papers published by the American Society for Quality and regularly speaks at Automotive Division meetings of ASQ. He is also a contributor to the SAE International Technical Paper Series, has had three papers selected for SAE's Transactions, and has been honored with SAE's Award for Excellence in Oral Presentation. Mr. Anleitner received a B.A. in technical communications from Michigan Technological University, a B.S. in engineering from Wayne State University, and an M.B.A. from the University of Michigan.

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Dr. Baghdachi serves as the President of Innovative Technical Systems Corporation and is a Professor/Program Director at Eastern Michigan University, Coatings Research Institute. He has been actively involved in adhesive bonding and coatings technologies, their applications and the science of adhesion for the past 25 years. An active consultant for the industry, he has been conducting workshops on adhesive bonding, coatings and paint, corrosion, and plastics for the past 20 years. He is the author of two technical books, has published 152 technical papers and holds 41 patents in the above areas. He is a frequent speaker for professional organizations including SAE, ASM, SME and ESD. Prior to his current positions, Dr. Baghdachi was on the technical staff of BASF Corporation and ARCO Chemicals. He received his B.S. and M.S. in Chemistry from the University of Tennessee and a Ph.D. in Chemistry from the University of Mississippi and worked as a post-doctoral fellow at the University of Massachusetts.

Pinhas Barak
A professor of mechanical engineering, Dr. Pinhas Barak specializes in vehicle systems dynamics and suspension design, active and semi-active suspension systems, chassis and vehicle design systems, mechanical control systems, and vibrations. He recently established the Vehicular Dynamics Design Center at Kettering University. Dr. Barak is a member of SAE, ASME, ASEE and SIAM, with more than 25 years of industrial experience in automotive engineering. He also received the SAE Outstanding Faculty Advisor Award in 1993. Dr. Barak received both a B.S.C. and an M.S.C. in mechanical engineering from the Technion Israel Institute of Technology and his Ph.D. in mechanical engineering from Wayne State University.

Ewa Bardasz
Dr. Ewa Bardasz is a Fellow at The Lubrizol Corporation, where she is currently responsible for overseeing activities related to lubricating novel combustion hardware, aftertreatment systems and emissions. She is experienced in the areas of lubrication, corrosion inhibition, engine testing and exhaust emission control. Before joining Lubrizol, Dr. Bardasz worked for Exxon Research & Engineering, where she was a member of the team responsible for formulating new generations of fuel efficient passenger car crankcase lubricants. She holds 21 U.S. patents in lubrication, corrosion inhibition, and emission control. Dr. Bardasz has published multiple technical and scientific papers and is a frequent invited speaker at conferences throughout the U.S. and

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Simon J. Baseley is the Director of Engineering Strategy and Program Management within the Intelligent Hydraulic Drive Group at Bosch Rexroth Corporation. Mr. Baseley was also the Director of the Intelligent Hydraulic Drive Products for the Dana Corporation, where he worked to develop and promote applications for hydraulic drive systems for vehicles. Prior to that, he was the Director of Advanced Engineering for Hobourn Automotive Ltd. where he formulated and executed new hydraulic pump applications and directed the applied research initiatives in fluid flow and noise suppression. Mr. Baseley also has extensive experience within the aerospace industry, previously serving as Chief Design Engineer for Rolls-Royce Ltd. An active member of SAE, Mr. Baseley has written several papers on noise related research and hydraulic hybrid systems. He holds six patents related to hydraulic pumps and hybrid systems. Mr. Baseley, formally educated in the U.K., received a B.S. in Mechanical Engineering from the University of Nottingham and a M.S. in Aircraft Propulsion from Cranfield University.

Daniel P. Bauer, Jr.
Mr. Bauer, an ASME Certified Senior GD&T Professional who holds a Master of Science in Industrial Operations and is fluent in Spanish, serves as president and principal consultant with ITR. With experience supporting over 20 automotive component and vehicle programs in the past 10 years in the U.S., Europe, and China, he specializes in providing training and engineering services in the areas of design engineering, quality, performance improvement, and productivity. In the early '90s Mr. Bauer spent three years designing and implementing training and quality programs for six Ford Motor Company launches. Programs included electrical, fuel handling, and powertrain components, including the 60oV6 Vortec Launch. Over the past three years he has worked to develop a comprehensive error proofing system for Chrysler Corp. He has worked with Chrysler to implement the system on several vehicle programs: the 1998 Dodge Durango, the 1999 Jeep Grand Cherokee, the 2000 Dakota Quad Cab, the 2001 Minivan, and the 2002 Ram Pickup. Most recently Mr. Bauer served as a visiting professor at Shanghai Jiao Tong Univ. where he conducted a certification program in Geometric Dimensioning and Tolerancing and Reading Engineering Drawings. The train-the-trainer program certified university professors and GM engineers who support the GM China training curriculum in both Shanghai and Beijing. He serves as an adjunct instructor and consultant for the Society of Manufacturing Engineers, DaimlerChrysler Quality Institute, General Motors Univ., General Physics Training Institute, and other post secondary institutions. He provides training and consulting services on topics including Failure Mode and Effects Analysis (FMEA), Control Plan Development, Problem Solving, Statistical Process Control (SPC), Capability Analysis, Blueprint Reading, Geometric Dimensioning and Tolerancing (GD&T), Project Management, and Error Proofing.

Mr. Bauer has authored publications on Geometric Dimensioning and Tolerancing, Tolerance Stackup Analysis, Product Design Error Proofing, Failure Mode and Effects Analysis, Lean Plant Layout, Standardized Work, Blueprint Reading, Program Management, Advance Product Quality Planning, Control Plan Development, and Team Building. He has additionally worked with General Motors Distance Learning to pilot a series of interactive television broadcasts on Project Management. Mr. Bauer holds a B.A. from Eastern Michigan Univ. and an M.S. in Industrial Operations with distinction from Lawrence Technological Univ.

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John-Paul Belanger is president of Geometric Learning Systems, a consulting firm specializing in geometric dimensioning and tolerancing (G D & T). For over ten years, he has trained people throughout North America and Europe in the proper interpretation and application of G D & T per the Y14.5 standard by using practical examples. Mr. Belanger is certified by the American Society of Mechanical Engineers as a Senior G D & T Professional, and has worked with a wide range of companies in the automotive, aerospace, electronic, and other industries to apply tolerances and perform stack calculations. He holds a B.S. in aerospace engineering from the University of Michigan specializing in aircraft design and safety.

Mark Beranek
Mark Beranek has 20 years combined experience at Boeing and Naval Air Systems Command (NAVAIR) working in the aerospace fiber optics and photonics research and engineering field. His program experiences span commercial aircraft, military aircraft, and space vehicle fiber optics development and acquisition, and government and corporate-sponsored fiber optics and photonics science and technology programs. Mr. Beranek's early aerospace career focused on development of optoelectronic device and package design and assembly technology for digital fiber optic transceiver applications including the Boeing 777, NASA Earth Observer One, and Boeing X-32 Joint Strike Fighter. More recently, Mr. Beranek has been working on military aircraft fiber optics acquisition and science & technology programs in the areas of advanced component design, qualification, standardization, supportability, maintainability and manufacturing technology development. Mr. Beranek has held fiber optics committee chairmanship positions for the IEEE Components, Packaging and Manufacturing Technology Society, IEEE Lasers and Electro-Optics Society and IEEE Photonics Society, and the SAE Avionics Systems Division. Mr. Beranek holds a B.S. in Technology and Management from the University of Maryland, University College, a B.S. in Chemistry from Northern Illinois University, and an A.S. Certificate in Electronics from Harper College.

Paul Berry
Paul Berry is currently the Powertrain Core Competency Project Manager at Ford Motor Company. During his tenure with Ford, Mr. Berry has been a Powertrain Systems Engineering Technical Specialist responsible for defining processes, methods, tools and training for implementing the systems engineering approach within the powertrain community. He implemented a common set of vehicle attributes, attribute cascade diagrams, trade-off studies, and interface diagrams. Mr. Berry authored the Ford Product Development System (FPDS) Targets Balancing and Cascading course, which was delivered both in North America and Europe. He is a co-author of the Ford Systems Engineering Fundamentals course, and has received two Quality Awards.

Mr. Berry has also led systems engineering projects for aerospace, highway, rail and water-borne vehicles, as well as for consumer electronic systems. He is a Certified Six Sigma Black Belt and teaches systems engineering subjects as well as both executive and technical-level Design for Six Sigma classes. Mr. Berry has taught courses at Boston University, Rensselaer Polytechnic Institute and has lectured at the University of Detroit-Mercy and the Massachusetts Institute of Technology. A member of SAE and INCOSE, Mr. Berry holds a B.S. and M.S. in Aeronautical Engineering from Rensselaer Polytechnic Institute.

Larry Bissell
Larry Bissell is a renowned and well respected international trainer, consultant, and auditor specializing in automotive supply chain management, supplier development, business management systems, business excellence, and continual improvement for all size automotive companies. Mr. Bissell is recognized as an authority on global supply chain requirements and global supplier

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André Boehman
André Boehman is a Professor of Fuel Science and Materials Science and Engineering in the Department of Energy & Geo-Environmental Engineering in the College of Earth and Mineral Sciences at the Pennsylvania State University, where he has taught courses on Energy, Fuels, Combustion and the Environment since 1994. At the Penn State Energy Institute, Prof. Boehman manages the Diesel Combustion and Emissions Laboratory. Professor Boehman's research interests are in alternative and reformulated fuels, combustion and pollution control. His present research activities are focused on alternative diesel fuels, diesel combustion and diesel exhaust aftertreatment. He is presently on the Editorial Board of Fuel Processing Technology and holds executive positions with the American Chemical Society Division of Fuel Chemistry and with the International DME Association. He has received the 1999 Alumni Achievement Award from the University of Dayton School of Engineering, the 1999 Matthew and Anne Wilson Award for Outstanding Teaching from the Penn State College of Earth and Mineral Sciences and the Philip L. Walker Jr. Faculty Fellowship in Materials Science and Engineering, from 1995-97. He also received the 1986 Charles T. Main Bronze Medal from the American Society of Mechanical Engineers. He has supervised seventeen M.S. theses and five doctoral theses at Penn State, and he has published more than 36 refereed papers and book chapters. He holds a B.S. in Mechanical Engineering from the University of Dayton (1986) and an M.S. (1987) and Ph.D. (1993) in Mechanical Engineering from Stanford University. He held a two-year postdoctoral fellowship in the Molecular Physics Laboratory at SRI International, Menlo Park, California.

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Theodore Bohn
Theodore Bohn is the principal investigator of plug-in hybrid electric vehicle (PHEV) prototype vehicle development in the Vehicle Systems Group at the Center for Transportation Research at Argonne National Laboratory. The primary focus of his efforts includes in-vehicle traction battery subsystem benchmarking and validation, as well as power electronics and embedded systems control optimization of the electric powertrain in PHEVs. Recent research includes energy storage system cost, safety, performance and reliability studies, performed as part of the Battery Hardware-in-The-Loop experiments. Smart charging and standards related to adaptive charging controls are also part of this research area.

Mr. Bohn has worked for each of the U.S. based automobile manufacturers as well as various Tier I automotive suppliers and has also held an adjunct faculty position at the University of Wisconsin-Madison. He is the current Advanced Battery Technology Chair for SAE Congress, actively serves on battery and PHEV related SAE technical standards committees, and is the chair of the SAE Electric Machine Rating Standards task force. Mr. Bohn received his B.S. and M.S. in Electrical Engineering from the University of Wisconsin-Madison.

Farhad Bolourchi
Dr. Bolourchi is currently a staff research engineer II with Nexteer Automotive Innovation Center where he designs algorithms for advanced chassis systems. Farhad helped develop Delphi's first electric power steering system, for which he received the company's highest technical award, the "Boss Kettering". Dr. Bolourchi previously worked for Hughes Aircraft Company and gained valuable experience in both missile systems controls and automotive applications. He was also a part time faculty member at the University of California - Davis and Sacramento State University. Farhad received GM's President Honors award in 1998, and was inducted to Delphi's Hall of Fame in 1999. He has numerous publications and patents related to control systems and automotive applications. Dr. Bolourchi has a B.S. in Mechanical Engineering from Northeastern University, a M.S. in Mechanical Engineering and a Ph.D in Nonlinear Control Systems from the University of California - Davis.

Paul Bonenberger
Paul Bonenberger holds a B.S. in Industrial Engineering from General Motors Institute, a M.S. in Engineering Management from the Univ. of Detroit and a M.S. in Training and Development from Oakland Univ. He spent more than 35 years with the automotive industry in final assembly and production engineering where, for 25 years, he was a subject matter expert in mechanical attachments. In 1990, he recognized that no systematic explanation of snap-fit technology existed and set about gathering and organizing snap-fit design practices into a rational knowledge construct. He is now president of FasteningSmart, Inc., a consulting company specializing in product design and training in snap-fit and threaded fastener attachments. Mr. Bonenberger is the author of The First Snap-Fit Handbook.

Raymond M. Brach
Dr. Raymond Brach is a consultant in the field of accident reconstruction and a professor emeritus of the Department of Aerospace and Mechanical Engineering at the University of Notre Dame. He has been practicing and carrying out research in the field of accident reconstruction for over 35 years. Dr. Brach is a fellow member of SAE and a member of ASME, ASA, INCE, and NAPARS and is a licensed professional engineer in the state of Indiana. In addition to over 100 research papers and numerous invited lectures, he has authored the book, Mechanical Impact Dynamics, published by Wiley Interscience in 1991 and is a co-author of the book, Uncertainty Analysis for Forensic Science, published by Lawyers and Judges Publishing Company, 2004. Dr. Brach is also a co-author of Vehicle Accident Analysis and Reconstruction Methods, published by SAE International. He was granted a Ph.D. in engineering mechanics from the University of Wisconsin-Madison, and a B.S. and M.S. in mechanical engineering from Illinois Institute of Technology.

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James Breneman
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David K. Callahan is a partner in the law firm of Kirkland & Ellis LLP in Chicago. His practice is focused on litigation in the areas of patent, trademark, trade secret, copyright and the Internet. He has participated in numerous bench and jury trials in Federal Courts, as well as appeals before the Federal and Seventh Circuits. In patent matters, he has represented clients in a diverse range of technologies, including semiconductors, abrasives, paper products, automotive products, business methods, cellular telephony, building products and agricultural equipment. In trademark actions, he has represented clients before Federal Courts, as well as the Trademark Office and the U.S. Customs Service. He also has extensive experience representing clients with respect to their rights in Internet domain names, including court and administrative actions to obtain domain names. He holds an A.B. from the Univ. of Chicago and a J.D. from the Univ. of Michigan Law School.

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Bernard Challen is an independent engineering consultant, active mainly in the automotive industry. Currently serving as a member of the SAE International Board of Directors, his technical areas of interest include electronics and control, instrumentation, the use of computer-aided engineering tools, and vehicle noise & vibration. Until 1991, he was Technical Director at Ricardo Consulting Engineers where one of his responsibilities was the formation of Ricardo North America. His technical responsibilities within Ricardo included noise and vibration, instrumentation and control, large engines and the business development of Ricardo in North America. Mr. Challen is active in a number of professional societies. A recipient of the SAE Forest R. McFarland award in 1983, 1990 and 1996, he was elected a Fellow of SAE in 1997 and in 2008 he was the recipient of the SAE Medal of Honor. Mr. Challen is a Fellow of the Institution of Mechanical Engineers (IMechE) and also the Institution of Engineering Technology (IET). He has served as General Chair for the SAE Noise and Vibration Conference from 1992-2003. In addition to being a regular contributor of technical papers to SAE, he also serves on the Engineering Meetings Board. Mr. Challen earned a B.Sc.(Eng.) in Mechanical Engineering and M.Sc. Noise and Vibration, Institute of Sound and Vibration Research, from Southampton University.

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K. T. Chau received his B.Sc.(Eng.) degree with 1st Class Honors, M.Phil. degree and Ph.D. degree all in Electrical & Electronic Engineering from The University of Hong Kong. He joined the alma mater in 1995, and currently serves as Professor and Director of the International Research Center for Electric Vehicles. He is a Chartered Engineer and Fellow of the IET. At present, he serves as Co-Editor of the Journal of Asian Electric Vehicles. Professor Chau has published over 300 refereed technical papers, co-authored a monograph, Modern Electric Vehicle Technology, and wrote two book chapters: "Electric Motor Drives for Battery, Hybrid and "Fuel Cell Vehicles" and "Hybrid Vehicles" in Electric Vehicles: Technology, Research and Development and Alternative Fuels for Transportation, respectively.

Professor Chau has received many awards: including the Chang Jiang Chair Professorship by the China's Ministry of Education; the Environmental Excellence in Transportation Award for Education, Training and Public Awareness by the SAE International; the Award for Innovative Excellence in Teaching, Learning and Technology at the International Conference on College Teaching and Learning; and the University Teaching Fellow Award by The University of Hong Kong.

Timothy Cheek
Mr. Cheek is a Principal Engineer with DELTA [v] Forensic Engineering, Inc. Since 1993, Mr. Cheek has been active in the fields of forensic engineering and accident reconstruction. He has considerable experience in both the design and development of commercial trucks as well as with the investigation of accidents involving commercial vehicles. Mr. Cheek is a member of the SAE J2728 Heavy Vehicle Event Data Recorder (HVEDR) subcommittee of the Truck & Bus Council and an organizer of the SAE Congress technical sessions on Event Data Recorder technology and has authored publications on the subject of HVEDRs. He received his Masters of Science in Materials Science and Engineering from the University of Florida and is a Registered Professional Engineer in multiple states.

Bruce Chehroudi
Dr. Bruce Chehroudi is currently a Principal Scientist at the Engineering Research Corporation Inc. He has been a Chief Scientist at Raytheon STX (formerly Hughes Aircraft STX) and is a former Professor of Mechanical Engineering, specializing in fluid mechanics and heat transfer, laser optical diagnostics, internal combustion engines, structure of sprays (their formation and combustion), gas turbine engines, furnace combustion, fuel injection issues (reciprocating, gas turbine, and rocket engines) and emission of pollutants. Dr. Chehroudi previously served as a Research Staff Member at Princeton Univ. where he engaged in experimental research in fluid mechanics and heat transfer of cold, vaporizing, and combusting sprays as well as characterization of turbulence in internal combustion engines using laser optical diagnostics. He was actively involved in the DISC (direct injection stratified charged) Engine Program, a cooperative project between the Department of Energy, General Motors Research Laboratory, Sandia-Livermore Combustion Laboratory, and Los Alamos Scientific Laboratory. Dr. Chehroudi established and directed an Engine Laboratory at the University of Illinois where he conducted numerous research projects to investigate the formation of pollutants and heat transfer/fluid mechanical aspects of combustion occurring in internal combustion and gas turbine engines. He is a member of Ta Beta Pi and the recipient of several SAE awards including the Arch T. Colwell Merit Award, the Ralph R. Teetor Award, the SAE Recognition Award and the SAE Forest R. McFarland Award in recognition of his contributions to the Professional Development Seminars. He has taught courses in the areas of internal combustion engines, thermodynamics, thermophysics of gas flows, combustion, and measurement system and has more than 100 publications in conferences, national and international journals. Dr. Chehroudi has a Ph.D. from Princeton University.

Howard Chesneau
Mr. Chesneau is the President of Fuel Quality Services, Inc. A recognized expert on fuel-related issues, he has over thirty years of experience in fuel additives, distillate fuel problems, fuel filtration, and tank remediation. Additionly, Mr. Chesneau has extensive knowledge and field experience in the area of microbial contamination and detection. Mr. Chesneau is on the IASH Board of Directors and is the past Chairman of the SAE Atlanta Section. He is an active

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Jeff Colwell
Dr. Jeff Colwell is a Principal Engineer in Exponent's Thermal Sciences practice in Phoenix, Arizona where he specializes in the engineering analysis of thermal and combustion processes, especially the cause, origin, and propagation of fires and explosions. Dr. Colwell has particular expertise investigating fires associated with automobiles, recreation vehicles, motorcycles, and heavy trucks, where typical fire scenarios include post-collision fires, structure fires involving vehicles, and fires that occur while the vehicle is being operated. He analyzes how these fire scenarios, along with vehicle design, operation, maintenance, repair, and aftermarket equipment, are related to mechanisms of fire causation, growth rate, and spread. He has specialized expertise in designing and conducting both component and full-scale tests to evaluate these complex relationships. Prior to joining Exponent, Dr. Colwell held research positions at AlliedSignal Aerospace, the Combustion Laboratory at Arizona State University, the High Temperature Gas Dynamics Laboratory at Stanford University, and the Thermal Sciences and Propulsion Center at Purdue University. He has a B.S. in Mechanical Engineering from the University of Wyoming, a M.S. in Mechanical Engineering from Purdue University, a M.S. in Engineering from Stanford university and a Ph.D. in Mechanical Engineering from Airzona State University.

Jess J. Comer
Dr. Jess J. Comer has significant teaching experience in the areas of machine design, dynamics of machines, metal fatigue and failure analysis. He is co-author of the text Fundamentals of Metal Fatigue Analysis and is a registered Professional Engineer in South Dakota. Dr. Comer is a member of SAE, ASME and ASEE. He holds a B.S. and an M.S. in mechanical engineering from South Dakota School of Mines and a Ph.D. from the University of Illinois at Urbana-Champaign.

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L.L. 'Buddy' Cressionnie
Mr. Cressionnie is currently the Americas IAQG 9100 Team Lead responsible for maintenance, revision, and clarification of the AS9100 standard. He is active in standards development as a voting member of the US Technical Advisory Group (TAG) to ISO/TC 176 which writes ISO Quality Management System standards. He serves on the US TAG Interpretations Committee and is the Aerospace Sector Liaison to the US TAG. Mr. Cressionnie represents Lockheed Martin in these roles where he works in the Aeronautics Business Unit, a 31,000 employee operation across nine sites. He led the implementation of AS9100/ISO 9001:2000 standards and quality process area for Capability Maturity Model Integration (CMMI®) at Lockheed Martin Aeronautics into a centralized, integrated quality system. Buddy Cressionnie is an ASQ senior member with quality manager and quality auditor certifications. He is a certified RABQSA aerospace experienced auditor and International Register of Certified Auditors (IRCA) lead auditor for ISO 9001 and ISO 14001. Buddy Cressionnie received his MBA degree from Texas Christian University and Bachelor of Science in Engineering from the University of Florida.

Shuvra Das
Dr. Shuvra Das is Professor of Mechanical Engineering and the Associate Dean for Research and Outreach for the College of Engineering and Science at University of Detroit Mercy. His research and teaching interests include engineering mechanics, computational mechanics using finite and boundary element methods, modeling and simulation, inverse problems, mechatronics, modeling and simulation of mechatronics systems, condition based health monitoring of engineering systems, etc. Dr. Das, author of the text entitled Mechatronic Modeling and Simulation Using Bond Graphs has over fifty conference and journal publications and has received several awards, including the Best Teacher award from the North Central section of ASEE and the Junior Achievement award at University of Detroit Mercy. Dr. Das received his Ph.D. and M.S. degrees in Engineering Mechanics from Iowa State University. In addition, he received his B.Tech (Hons.) in Mechanical Engineering from the Indian Institute of Technology in Kharagpur, India.

James De Clerck
Jim De Clerck is currently the Structural Vibration Lead Engineer at the General Motors Noise and Vibration Center in Milford, Michigan. Jim has more than 20 years experience working and conducting research in the area of Noise and Vibration. Jim has been actively involved the GM Technical Education Program and recently completed teaching a graduate course in Automotive NVH at the University of Michigan. He is the author of more than 30 technical papers. Jim holds B.S., M.S. and Ph.D. degrees from Michigan Technological University.

Zhibing Deng
Dr. Zhibing Deng is currently a senior engineer specializing in side impact safety at Ford Motor Company. He has in-depth knowledge of side impact development, including setting targets for key vehicle components, developing & applying component/subsytem test methodologies, and implementing actural designs of vehicle components in achieving side impact performance targets. His work experience includes rear impact development and CAE support in front impact, roof crush and interior head impact. Prior to joining Ford, Dr. Deng was an Assistant Professor at South China University of Technology. He is a recipient of the Henry Ford Technology Award in 2005. Dr. Deng received a B.S. in Computational Mathematics and an M.S. in Applied Mathematics in China and a M.S. in Mechanical Engineering, M.A. in Statistics and Ph.D. in Applied Mathematics all from Wayne State University.

Eric Denys
Eric Denys is currently the Global NVH Director - Brakes at Material Sciences Corporation in Canton, Michigan. His career spans 16 years at Federal-Mogul and Material Sciences Corporation with technical specialization in brake NVH. Mr. Denys has lead teams to achieve best-in-class in brake squeal on numerous vehicle lines and is the recipient of the 2001 Ford Global Customer Satisfaction Award for his work on high mileage brake squeal reduction. His work has been published in numerous national and international papers, and in an SAE book on Disc Brake Squeal. He is a 6 Sigma Black Belt. Eric is co-chairman of the SAE Brake NVH Standards Committee. He received a B.S. in Mathematics from the Jean-Bart University, France and a M.S. in Mechanical Engineering from the University of Technology of

Compiegne, France. In 2010, he received his MBA from the University Of Michigan Ross School Of Business.

Philip Dingle
Philip Dingle is a Diesel Technology Specialist in the advanced engineering Innovation Center of Delphi Diesel Systems. He received his engineering education in England, and after graduating in 1972, joined the Research and Development group of Lucas Diesel Systems where he worked on several advanced engine and fuel system technologies. Transferred to Detroit, USA in 1975, he has worked closely with several US diesel engine manufacturers on the development of FIE for their engines. In the process, he gained broad experience in achieving performance and emissions targets from both DI and IDI combustion systems. He holds twelve US or European patents for fuel system innovation.

Peter T. Dishart
Peter T. Dishart manages the laminated glass business of PPG Industries Inc. He holds B.S. and M.S. degrees in mechanical engineering as well as an MBA. Dishart is a member of SAE and has served on the Glazing Committee. He is currently President of the Enhanced Protective Glass Automotive Association (EPGAA), an industry organization dedicated to laminated glass.

Joseph Doyle
Joseph Doyle is the principal of Strategic Insights, a Michigan-based consulting firm, specializing in executive leadership. He completed a 30-year career with General Motors Corporation, where he held a variety of management positions including: Internal Business Consultant with General Motors University, Senior Research Manager with the Corporate Organization Research and Development Activity, Manager of the Corporate Executive Development Activity, and Lead Consultant with the Corporate Strategy and Decision Support Activity. While at GM, he facilitated Global Task Teams in India, Indonesia, Thailand, England and Australia and served as the Corporate Liaison on Leadership and Strategy to the US Army War College and the National Defense University. Prior to joining General Motors, Mr. Doyle held positions with the U.S. Public Health Service, Ford Motor Company and the Management and Organization Development Department of General Motors Institute (now Kettering University). Dr. Doyle served as a teaching fellow for the Hartwick Leadership Institute and was a member of the advisory council for the Academy of Management Executive Magazine. He was a member of the Advisory Board for the Institute for Management Studies as well as member of the National Research Committee for the American Society for Training and Development. Dr. Doyle has served as an adjunct professor and lecturer at the University of Michigan Dearborn's School of Business, taught Engineering Administration at the University of Detroit's Graduate School of Engineering and Business Strategy at Oakland University's School of Business Administration. He holds a B.S. in Mathematics and Physical Science from Eastern Michigan University, a M.Ed. in Educational Evaluation and Research from Wayne State University and a Ph.D. in Organizational Behavior from the University of Michigan.

Timothy Drotar
Timothy Drotar is currently a product development engineer at Ford Motor Company where he specializes in chassis systems and vehicle dynamics for passenger cars and light trucks. He also has developed engineering training in suspension and steering. Previously, he worked for Saturn Corporation in product engineering. Tim is a member of the Course Industry Advisor Board for Chassis Systems Design at Kettering University, and a member of SAE and SCCA. He holds a B.S. in Mechanical Engineering from Lawrence Technological University and a M.S. in Mechanical Engineering from the University of Michigan.

Gordon L. Ebbitt
Gordon L. Ebbitt is a Manager of Advanced Acoustics at Carcoustics where he works with automotive sound package design and the development and validation of new acoustical and thermal materials and components. Mr. Ebbitt's experience includes the CBS Technology Center on projects involving musical instrument research and development including modal and finite element analysis on pianos, guitars, and other instruments. Mr. Ebbitt also worked for Brüel and Kjaer headquarters in Denmark where he addressed sound quality instrumentation, sound intensity measurements, and material measurements. At Brüel and Kjaer in Michigan he was an application engineer supporting their U.S. staff and lecturing on sound quality, acoustical measurements, and other topics. Following B&K, Mr. Ebbitt joined Masland Industries (later Lear Corporation) as Chief Acoustical Engineer where he was responsible for the construction and operation of an acoustical laboratory, the development of vehicle sound packages, full vehicle modeling using SEA, and acoustical product development. Mr. Ebbitt is a member of SAE, INCE, ASA, AES, and ASTM. Mr. Ebbitt received a B.A. in Mathematics from New York University and M.S. in Acoustics from The Pennsylvania State University.

Ed English
Mr. English is currently Vice President & Technical Director for Fuel Quality Services, Inc. where he oversees all aspects directly related to the research, development, and deployment of chemicals, antimicrobials and detection equipment for use in the various stages of the petroleum and biomass fuels industry from the refinery to the end user. He is also responsible for evaluating regulatory and industry issues, compliance with federal and state regulations, formulating policy and implementing programs to address regulatory and industry issues, and performing technical reviews and program audits. Mr. English previously worked in the nuclear power industry. He is nationally recognized for his knowledge and expertise in the area of microbial contamination of fuels, alternative fuels, and materials compatibility and has been an invited speaker for such organizations as the EPA, FAA, CALCUPA, NEIWPCC, PEI, NISTM, and SAE, DuPont, and Biofuels Americas. Mr. English is also an active member of numerous professional organizations including SAE, IASH, IATA, and ASTM. He has a B.S. in Chemistry from the University of Florida and two years post-baccalaureate work from the University of Miami.

David E. Ewel
David Ewel is the President of Dewel, LLC, a company specializing in the design, manufacturing, and marketing of hydraulic and mechanical devices that utilize embedded electronic technology for mobile markets. With over thirty years experience in the field of electrohydraulics, Mr. Ewel previously held the position of Director of Engineering at MICO, Inc. where he was responsible for the development of a wide range of components for brake-by-wire and the development of ABS, traction control and electronic stability control systems for 4X4, 6X6 and 8X8 vehicles. While at the Hydraulics Division of Eaton Corp., Mr. Ewel held the positions of Chief Engineer for Electronics and Chief Engineer for Valves and led the development of electro-proportional and CAN based pump controls. As an engineer at Moog, Inc., he designed the first industrial servoactuator that integrated a cylinder, servovalve and position sensor with embedded electronics. Other designs included embedded ramp control of a proportional valve and embedded closed loop position control of a servovalve. In addition, Mr. Ewel has worked on a wide variety of servosystem designs to control position, velocity, force, and pressure in such diverse applications as lumber and steel mills, earthquake simulators, turbine gas valve control and active suspensions. Mr. Ewel received both a B.S. in Mechanical Engineering and a M.B.A. from the State University of New York at Buffalo.

Ken Farsi
Mr. Farsi is currently the VP of Engineering and ODA Administrator for Dassault Aircraft Services in Wilmington, DE, where his responsibilities include oversight of engineering groups and practices at all Dassault Aircraft Services locations. He has over 24 years experience in aircraft certification and operations and has worked for aircraft manufacturers, airlines and modification centers conducting certification work on small and large transport category aircraft. He is an FAA Designated Engineering Representative (DER) with Interior Arrangement and Compliance Inspection, as well as Aircraft Loading Document approval authority on Part 23 and 25 aircraft.

Mr. Farsi has taught aircraft certification and Federal Aviation Regulations as an Adjunct Instructor at Northrop-Rice Aviation Institute of Technology in Los Angeles, and Aircraft Systems at San Mateo Community College in San Mateo, California. He has participated in and managed FAA certification programs for major U.S., European, Chinese, and Australian airlines as a consultant. He is a life time member of Tau Alpha Pi, the honor society for Engineering Technologies. Along with a Bachelor of Science in Aircraft Maintenance Engineering Technology from Northrop University, Mr. Farsi has participated in graduate studies in Aerospace and Aviation Operations and Management at Embry-Riddle Aeronautical University. He holds FAA Airframe and Powerplant as well as Private Pilot Certificates.

Kelley Fling
Mr. Fling currently teaches fluid power at the college level. He has extensive experience in the fluid power field and was previously the R&D lab manager for a manufacturer of cylinders for the mobile market. He is a former chairman of the SAE A-6 Committee, Aerospace Fluid Power, Actuation, and Control Technologies and has led seal research programs sponsored by each of the three armed services. Mr. Fling holds two seal patents. He received a B.S. in Mechanical Engineering from Texas A & M University and a M.S. in Mechanical Engineering from Southern Methodist University.

Wes Fulton
Mr. Wes Fulton is the Founder and CEO of Fulton Findings. Prior, he was a program engineer/manager for AiResearch Los Angeles Division, Allied-Signal Aerospace Corporation. As a program engineer for aircraft actuation projects he had engineering and management responsibility for the Indigenous Defensive Fighter (IDF) leading edge flap actuation system (LEFAS) development and production, the Rockwell/MBB X-31A LEFAS flight test program, and the F-16 Fighting Falcon LEFAS production and deployment support. He co-patented a multi-fuseable shaft (high performance drive train device). Additionally, Mr. Fulton has over 20 years of programming experience as a private programmer and developed SuperSMITH®; Visual, WeibullSMITH™, LogNormSMITH™, Normal+SMITH™, Visual*SMITH™, BiWeibullSMITH™, and MonteCarloSMITH™ analysis software. He received his B.S.M.E. from Georgia Tech and his M.S.M.E. from California State University at Long Beach.

Paul E. Geck
Mr. Geck is currently an independent consultant specializing in advanced high strength steels. Previously employed by Ford Motor Company, Mr. Geck specialized in several areas including Computer Aided Engineering, Noise, Vibration and Harshness, both as a testing and CAE expert, and vehicle weight reduction with an emphasis in steel selection. Administratively, Mr. Geck served in several managerial and technical specialist roles. He was recognized as the Ford steel expert and chaired the Auto/Steel Partnership (A/SP) and the internal Advanced High Strength Steel Strategy Team. Mr. Geck has a B.S. and M.S. in Mechanical Engineering, a M.S. in Engineering Mechanics, and an M.B.A., all from the University of Michigan.

Geoff Goddard
Geoff Goddard is Professor in Motorsport Engineering Design and Head of the Vehicle Engineering Research Group in the School of Technology at Oxford Brookes University in the UK. Following a position in the gas turbine industry as a Rolls Royce University Apprentice, he joined Cosworth Engineering in 1970 and was later promoted to Chief Designer by Keith Duckworth. The engines he designed made the Cosworth name synonymous with winning including the F1 World Championship as well as World Sportscar, World Touring Car, and World Rallycar championships. Victories also spanned USAC, CART, F3000 titles, and many other prestigious events including the Indy 500, Le Mans, Monaco GP, and Monte Carlo Rally. The Cosworth design portfolio for advanced road engine included engines for Mercedes, Opel, Ford, Chevrolet, Pontiac, and VW, all establishing new industry benchmark standards.

In 1995, he joined TWR as Director of Engine Design responsible for the design and development of engines for clients including Aston Martin DB7, Volvo, Ducati, Renault, SAAB, Audi, GM, Ford, Nissan, and the Oldsmobile Aurora. Many of these programmes included the manufacturing and delivery of engines to the car production lines. Others made TWR and its clients synonymous with winning major championships including the British Touring Car Championship (BTCC), World Superbikes Championships, Indy Racing League Championships (IRL), Australian V8 Supercar Championships, plus many prestigious events including the Indy 500, Le Mans, Bathurst, and World Rally Championship events.

While working in these companies, he led the open design-led structure favoured by Duckworth, which allowed a free-flow of information across the boundaries of all technical areas, enabling design engineers to expand their knowledge and vision at an incredible pace. This was demonstrated by their winning results, making Cosworth the best post-graduate university in the world. By joining Oxford Brookes University, he brought some of this vision to their engineering courses and helped initiate new MSc courses in Racing Engine Design and Motorsport Engineering. He has also underpinned PhD research programmes for F1 clients and industrial programmes covering advanced combustion research into future fuels, nano-particle additives, and various championship winning racing programmes. Geoff's external activities include Director of Geoff Goddard Engines Ltd consulting on engines, Ambassador for EEMS, the British Government's Energy Efficient Motor Sport body, and co-chair for the SAE Motorsport Conference Engine and Drivetrain Panels.

Michael Grimmer
Michael Grimmer is a Staff project engineer with the General Motors Powertrain Division at the GM noise and vibration laboratory in Milford, Michigan. Mr. Grimmer has worked for GM for over 20 years in the powertrain noise and vibration area. His work has focused on noise requirement allocation technology; vehicle integration; engine design; noise development and problem solving of engine, transmission, and accessory systems; component bench test design; sound quality measurement and metric development; and signature analysis for engine defect detection. Mr. Grimmer received a B.S. in mechanical engineering from the University of Wisconsin-Madison and M.S. in mechanical engineering from the University of Michigan-Dearborn.

Suresh T. Gulati
Dr. Suresh T. Gulati was a Research Fellow in the Science and Technology Division of Corning, Inc. where he specialized in the behavior of glass, glass-ceramics and ceramics subjected to mechanical and thermal loads, their fatigue and fracture properties, and their long-term reliability. Before joining Corning, he held positions with Cornell University, the University of Colorado, and Continental Can Company. Dr. Gulati has authored over 200 publications in the area of ceramic catalyst supports, fiber optics, liquid crystal display glasses, cathode ray tubes, space windows, automotive windshields, and stepper lenses

made from high purity fused silica. He is a member of American Men and Women of Science and Who's Who in Technology Today. Dr. Gulati has a Ph.D. in applied mechanics from the University of Colorado, an M.S. in mechanical engineering from Illinois Tech., and a B.S. in mechanical engineering from the University of Bombay, India.

Thomas J. Hall
Thomas J. Hall is currently the Manager of Engineering for Brake Systems of full size trucks and SUV's for the Robert Bosch Chassis Systems Division. Prior to that, he was the Engineering Manager for System Design and Validation at ITT Automotive, Continental Teves. His experience also includes development of ABS, TCS and Stability Control Systems, responsibility for application system engineering principles and process to the brake industry and development and promotion of brake system proposals and advance braking technologies. Mr. Hall has a B.S. in mechanical engineering from the University of Michigan.

Robert F. Hand
Robert Hand has more than 40 years of experience in the measurement and control of noise and vibration. A former research engineer with the Acoustics and Seismics Laboratory at the University of Michigan, Willow Run Laboratories, he has served as the noise and vibration control specialist for the Corporate Laboratories of Clark Equipment Company, and later the general manager of Clark Engineering Services. Mr. Hand founded Redbud Technology Group, a noise and vibration consulting business. He has served as chairman of the SAE Con. Ag. Sound Level Technical Committee and the CIMA Acoustics Committee, and has produced the SAE technical video tutorial, Basic Noise Control, and regularly teaches the SAE noise control seminar. Mr. Hand has lectured at the University of Michigan, University of Wisconsin and Western Michigan University, as well as participated in numerous SAE technical sessions, and has taken graduate studies at the University of Notre Dame and is an active member of the SAE, INCE and ASA. He has a B.S. in electrical engineering from the University of Michigan and an M.A. in management from Nazareth College.

Johanna Hassan Hollowich
Ms. Hassan Hollowich is the founder and president of Potencium Limited, an international training and consulting company with clients throughout Europe, the Asia-Pacific, and the Americas. Recognized and respected as an international consultant, Ms. Hassan Hollowich has successfully facilitated international business solutions in over 20 countries for global reaching clients such as Boeing, GM, and Manitowok. Known for her innovative and motivational style of training, she has presented more than 500 training programs as well as designed a variety of online learning courses. A native of England, Ms. Hassan Hollowich has offices in London and Los Angeles. She is an adjunct faculty member at the University of California, Los Angeles (UCLA) Extension Department of Engineering, Information Systems and Technical Management. Prior to forming Potencium, Ms. Hassan Hollowich was a senior consultant for Canning International UK and Rostrum Pharmaceutical Training, a division of MDS Pharma Services UK. Ms. Hassan Hollowich holds a Master's Degree in Adult Learning and Education from the City University (London) with a focus on training intervention techniques, group dynamics, mentoring, and management development.

William Haughey
Bill Haughey is a respected consultant and instructor in the areas of Failure Modes Effects Analysis, Design for Manufacturability and Assembly, Design Review Based on Failure Modes, Design Review Based on Test Results, and other GD3 methodologies. He is a current member of the issuing committee of the SAE J1739 FMEA standard, SAE Automotive Quality and Process Improvement Committee; the SAE Automotive Electronic Systems Reliability Standards Committee; and the AIAG FMEA Fourth Edition Recommended Practice Committee. Mr. Haughey was recently approved to lead the development of a new SAE DRBFM Recommended Practice (J2886). Mr. Haughey formerly worked for GM, where he held various managerial, manufacturing, and engineering positions including Process Lead and Supervisor for FMEA and DFM/A. While at GM, Mr. Haughey also supported Tatsuhiko Yoshimura in the global implementation of the GD3 (DRBFM) methodology. Yoshimura considers Mr. Haughey to be a subject matter expert in the GD3 methodologies, including DRBFM and DRBTR. Mr. Haughey received a B.S. degree from the University of Michigan and M.S from Central Michigan University, and has the following certifications: Black Belt in GD3 (DRBFM and DRBTR); Master Design for Manufacturability and Assembly Engineer; and Certified Internal Auditor.

Gary Hazelton
Gary Hazelton is an Engine Lead Noise and Vibration Engineer for gasoline and diesel engines at General Motors Powertrain Division. He has more than 17 years of noise and vibration experience in engine, accessory drive system, and accessory component level measurement and analysis. Gary began his career in 1986 at Delphi Automotive Systems, in Lockport, NY, where he worked to improve air conditioning system and compressor noise levels. He then moved to Powertrain where he was responsible for accessory drive noise and vibration development, and component level benchmarking activities. Gary has a BSME degree from the University of Cincinnati, with a concentration in mechanical vibrations and acoustics.

Barry W. Heathcotte
Barry W. Heathcotte is an individual consultant specializing in training and consulting services on the subject of Geometric Dimensioning and Tolerancing. He has more than 30 years experience in the subject matter and has been a lecturer at both public and in-plant seminars and training programs. Mr. Heathcotte has trained more than 15,000 people from well over 1,500 companies, the military, technical and trade schools, universities, and technical societies in the United States, Canada, Mexico, and Europe. He is a former designer, group supervisor and technical coordinator with the Babcock & Wilcox Company, where he worked on the breeder reactor and nuclear reactors for both commercial and military installations. Mr. Heathcotte has more than 40 years of industrial experience, is a Certified Manufacturing Engineer, a senior member of SME, and a member of ASME. He has been an active member of the ASME Y14.5 Committee on Dimensioning and Tolerancing since 1982 and is a nationally-recognized expert on its application and interpretation.

Ronald Heck
Dr. Ron Heck is currently an independent consultant. Previously, he was a research manager responsible for developing catalyst technology for Engelhard Corporation's worldwide customers in automotive catalyst. He has worked on the development of catalytic processes in SCR NOx, NSCR NOx, automotive catalyst, diesel catalyst, PremAirTM catalyst systems, hydrogenation technology, ozone abatement, volatile organic compound abatement, ammonia oxidation, chemical feedstock purification and chemical synthesis. He is a member of American Men and Women of Science and Who's Who in Technology Today. Dr. Heck is the author of over 80 publications in commercial applications of catalysts and holds 28 U.S. patents on catalytic processes. He is the co-author of the book with Dr. Farrauto entitled, Catalytic Air Pollution Control: Commercial Technology, and is the co-editor of the NewsBrief section of Applied Catalysis B: Environmental. Dr. Heck received his B.S. in chemical engineering and his Ph.D. from the University of Maryland.

Edmund Herman
Mr. Herman is President of Creative Concepts Company, Inc. Prior to establishing his consulting business, Mr. Herman worked for General Motors Corporation where he was responsible for new process development in the areas of draw die development for sheet metal stamping dies, mold development for sheet molding compounds, and

pressure die casting dies and processes. He was instrumental in the shift from physical plaster developments to total CAD design of sheet metal draw die developments. Mr. Herman is also an experienced instructor and served as the Education Director for the Society of Die Casting Engineers (now the North American Die Casting Association). He has taught continuing education courses in die casting, stamping and injection molding through Oakland and Wayne State Universities. Mr. Herman is a registered professional engineer in the state of Michigan and has a Bachelor of Science in Industrial Engineering from General Motors Institute and a Master of Science in Industrial Engineering - Operations Research from the University of Michigan.

Craig J. Hoff
Dr. Craig J. Hoff is an Associate Professor of Mechanical Engineering at Kettering University, teaching the areas of thermal and mechanical design, with applications in automotive engineering and biomedical engineering. His research interests include loop heat pipes, electronic and vehicle thermal management, and alternative automotive powertrains. Dr. Hoff is the faculty advisor to the Kettering Formula SAE racecar team and is the Chair of SAE International's Scholarship Committee. He is the co-author, with Dr. Gregory Davis, of the text *Introduction to Automotive Powertrains*.

Arthur E. Howle
Arthur E. Howle is NVH Senior Technical Specialist, Roush Industries, Inc. Mr. Howle's career includes six years at a General Motors production facility and 27 years in vehicle development with Ford Motor Company. He has experience with many aspects of vehicle NVH, particularly powertrain and driveline related NVH including: front, rear, and all wheel drive architectures. He is an expert in the utilization of high tech testing and CAE to predict, identify, and solve difficult NVH issues. He has also been a major contributor to many advanced vehicle programs and launches. Mr. Howle has a BSME from General Motors Institute and a MSME from Ohio State University.

Emad Isaac
Emad S. Isaac is Chief Technology Officer for the Morey Corporation, an electronics development and manufacturing services company focused on the design, development, testing, validation and manufacturing of ruggedized electronic assemblies for harsh environments. Mr. Isaac oversees and is responsible for the strategic technical direction and development engineering across all products and platforms which include displays, telematics, and controllers. Mr. Isaac's prior experience includes 15 years of broad responsibilities in the wireless communications, systems, and embedded technologies industries. Previously, he was Lead Systems Architect for Motorola's Telematics Group, served on the Motorola Patent Committee, led several corporate wide innovation initiatives, identified new standards and standard bodies for regional and global Telematics, and served as Distinguished Member of Motorola's Technical Staff. In addition, Mr. Isaac briefly served as vice-chairman for the SAE J1939 committee. Mr. Isaac has also held various leadership roles within the military, government, and aerospace industry prior to joining Motorola. Mr. Isaac holds several key patents and is a dedicated advocate of various projects and school programs that inspire children in the areas of Math, Science, and Engineering. Mr. Isaac holds two BS degrees in Applied Physics and Mechanical Engineering from McGill University. He also holds a MS in Biomechanics from the University of Arizona, as well as a Master of Engineering Management degree from Northwestern University.

Ali Jamnia
Dr. Ali Jamnia is an independent electro-mechanical engineering design and product development consultant for the medical, automotive and telecommunications industries. His experience covers areas in computational solid mechanics, fluid dynamics and heat transfer. His career began as a lecturer for Clemson Univ. and shortly thereafter, as a consultant for Reliance Electric (working on residual thermal stress calculations). His tenure continued when he joined Ansys, Inc. to develop technical short courses and seminars. Later, he joined Fluid Dynamics as a research scientist to develop projects under contract to Benz in Germany, Westinghouse and NASA. At Airtronic Services, Inc. Dr. Jamnia worked in the capacity of Director of Engineering and Research and focused his attention to developing products for the medical field. In his capacity as a program manager and later as a senior mechanical engineer at De Amertek Corporation, he developed several products for automotive industries. To this end, he has applied for four patents in 2004. He received his Ph.D. from Clemson University where his primary area of research was application of finite element methods to the hydrodynamic equations in the presence of shock waves and nonlinear fluid-solid interaction.

Jianzhong Jiao
Dr. Jianzhong Jiao is an internationally recognized lighting expert for light sources and lighting products design, technology development, testing, industry standards and government regulations. Dr. Jiao has been actively involved in professional and industry organizations and standardization activities. He is the Chairman of the SAE Lighting Committee, past Chairman of the Next Generation Lighting Industry Alliance (NGLIA), Chinaman of the NEMA SSL Section Technical Committee, and active member of IESNA Committees, ANSI-NEMA SSL Working Groups, UL LED Standard Technical Panel, as well as member of CIE, SPIE, ITE and other organizations. Dr. Jiao is the SAE Follow, and has received several industry awards.

Dr. Jiao holds a Ph.D. degree in Electrical Engineering from Northwestern University, a M.S. degree in Applied Physics, and a B.S. degree in Mechanical Engineering. He is titled to 9 U.S. Patents and has over 20 technical publications. Dr. Jiao currently serves as the Director of Regulations and Emerging Technologies at OSRAM Opto Semiconductors Inc. He also served as an adjunct professor teaching physics and electrical engineering courses at Purdue University and Lawrence Technological University. He has been teaching SAE seminars since 2003.

Paul Johnston
Paul Johnston is Senior Director of Compression and Braking at Meritor WABCO and is responsible for application engineering, product planning and new product development. Previously at ArvinMeritor, Johnston was Senior Director of the North American Foundation Brake Business Unit and Worldwide Director of Product Engineering for the CVS Worldwide Braking Division. He has over 38 years of experience in commercial vehicle air and hydraulic braking systems and products. A member of SAE International, Mr. Johnston was the recipient of the 2007 SAE Award for Outstanding Technical Committee Service. Mr. Johnston is active in the Truck & Bus Council, Truck & Bus Brake Committee, and related subcommittees to develop new brake products and system recommended practices. Mr. Johnston's experience includes that of Chairman and member of the Heavy Duty Brake Manufacturers Council. He has been involved in the Technology & Maintenance Council and the Commercial Vehicle Safety Alliance regarding technical products and commercial vehicle practices. Mr. Johnston received a B.S. in Mechanical Engineering from Ohio Northern University, a M.S. in Mechanical Engineering from Cleveland State University, and a M.B.A. from Baldwin Wallace College.

Stephen Kang
Dr. Stephen Kang is currently a Technical Specialist in the Safety Core and Strategy Department of Ford Motor Company where he is responsible for developing safety methods such as component test methods, CAE methods and best practices. He was responsible for developing a truck program from beginning to production launch, and for meeting safety requirements. Dr. Kang has conducted occupant safety and CAE trainings; designed and conducted extensive dynamic component tests; established several Ford internal component design requirements and is responsible for the establishment of an Occupant

CAE database at Ford. Dr. Kang is the recipient of the Henry Ford Technology Award in 2005. He serves as an Advisory Board Member for TNO North America and is a certified six-sigma black belt. Dr. Kang has a Ph.D. in Biomechanics from Wayne State University.

B. V. Karlekar
Dr. Karlekar holds a B.E. in Mechanical Engineering from the Univ. of Baroda, India, an M.S. and a Ph.D. in Mechanical Engineering from the Univ. of Illinois - Urbana. He served as Head of the Mechanical Engineering Department at Rochester Institute of Technology. During his tenure there, Dr. Karlekar was awarded RIT's Eisenhardt Outstanding Teacher Award, published numerous papers and authored three textbooks. Later, he was appointed Director of the Center for Integrated Manufacturing Systems. Dr. Karlekar is an ASME Fellow and continues to take active interest in Mechanical Engineering students at RIT by assisting them in the Engineering Learning Center.

Magdi Khair
Magdi Khair is an Institute Engineer in the Department of Emissions Research at Southwest Research Institute. He is experienced in the areas of engine testing and exhaust emissions control. His prior experience was with AlliedSignal Automotive Catalyst Company with the development of catalytic aftertreatment for light-duty and heavy-duty diesel engines; Ford New Holland with primary responsibility for the development of the 6.6 and 7.8 liter midrange diesel engines to meet 1991 emissions standards; Bendix Diesel Engine Controls where he led the development of advanced electronically controlled diesel fuel injection systems and also established several cooperative engineering programs with European and North American engine manufacturers; and with Chrysler Corporation where he converted the slant six gasoline engine into an open chamber, pilot injected, and electronically controlled diesel engine, supervised a combustion kinetics project, and participated in the design and development of electronic controls for a passenger car turbine engine. Mr. Khair holds 18 U.S. patents in electronic fuel injection, turbocharging, exhaust gas recirculation, and aftertreatment systems. He has also authored and co-authored numerous SAE and ASME papers. Mr. Khair received a B.S. in Automotive Engineering from Ain Shams University, an M.S. in Thermodynamics from the University of Birmingham, England, an M.B.A. from Michigan State University.

Kenneth Kipers
Dr. Kenneth Kipers has over 25 years of experience in additive synthesis, fuels, formulation, field testing, and customer service, is a Certified Lubrication Specialist and is currently involved in the consulting and training field specializing in fuels and lubricants. He is an adjunct professor at Richland College in Dallas and an instructor for Dale Carnegie courses, as well. Dr. Kipers has been an expert witness in many cases involving gasoline, diesel, and aviation fuels. He is also an active member of ACS, SAE, and STLE. Dr. Kipers received a B.S. from San Diego State University and a Ph.D. in physical organic chemistry from the University of California-Los Angeles.

Athanasios Konstandopoulos
Dr. Athanasios G. Konstandopoulos, recipient of the 2006 Descartes Laureate, is the founder and head of the Aerosol and Particle Technology Laboratory (APTL), a well-known European diesel emission control laboratory at the Chemical Process Engineering Research Institute (CPERI/CERTH) in Thessaloniki, Greece. In 2006, he was elected as Director of CPERI and member of the Board of Directors of the National Centre for Research and Technology-Hellas (CERTH). Since 2006, he has also been a member of the faculty of Chemical Engineering at Aristotle University in Thessaloniki. Dr. Konstandopoulos is a specialist in combustion aerosols and nanoparticles and he has extensive research and engineering consulting experience in the design, modeling, and testing of diesel particulate filter systems and monolithic reactors. Dr. Konstandopoulos, an SAE Fellow, has authored more than 70 scientific and technical papers and is a frequent invited speaker at conferences throughout the U.S. and Europe. His educational accomplishments include a Diploma in Mechanical Engineering from Aristotle University of Thessaloniki, an M.S. in Mechanical Engineering from Michigan Technological University and an M.S., MPhil and a Ph.D. in Chemical Engineering from Yale University.

Paul Kurowski
Dr. Paul Kurowski is a professor in the Department of Mechanical and Materials Engineering at the University of Western Ontario in London, Ontario. His teaching experience includes finite element analysis, machine design, mechanics of materials, kinematics and dynamics of machines, and product development. He is also the President of Design Generator Inc., a consulting firm specializing in product development, design analysis and training in Computer Aided Engineering methods. Dr. Kurowski has published multiple technical papers and taught professional development seminars for SAE International, the American Society of Mechanical Engineers, the Association of Professional Engineers of Ontario, the Parametric Technology Corp. (PTC), Rand Worldwide, SolidWorks Corp. and other companies and professional organizations. He contributes regularly to several engineering publications focusing on the implementation of CAE methods into the product development process. He is a member of SAE International and the Association of Professional Engineers of Ontario. Dr. Kurowski obtained his M.Sc. and Ph.D. in Applied Mechanics from Warsaw Technical University and completed postdoctoral work at Kyoto University.

DeWitt Lampman
DeWitt Lampman is a Staff Engineer with PPG Glass Research, where he has been in the Automotive OEM Process and Product Development Division since 1973. Mr. Lampman was a major contributor to the development of thin laminated sidelites, where he was involved with developing product specifications and process capability requirements for production, and conducting modeling and stress level measurements on vehicles to define glass and door design specifications, having worked with four automobile manufacturers in these areas. To date, Mr. Lampman holds seven U. S. Patents. Mr. Lampman graduated with a B.S. degree in Ceramic Engineering from Alfred University, Alfred, NY.

Michael Levin
Michael Levin holds the position of Technical Expert at Ford Motor Company. Mr. Levin has been with Ford Research and Advanced Engineering since the late 1970s. His current responsibilities include development of hydrocarbon and urea dosing for advanced Diesel aftertreatment systems. Mr. Levin co-authored 18 publications and holds 13 patents. He received his MSME in 1974 from Moscow Automobile and Road Institute in Russia.

Russell E. Levine
Russell E. Levine, P.C., CLP, is a partner in the law firm of Kirkland & Ellis LLP where he specializes in patent infringement litigation and patent licensing. He has over 20 years of experience. During his career, both as lead counsel and in conjunction with other Kirkland & Ellis partners, Russell has litigated over 200 patents and has analyzed and counseled clients with respect to several hundred more. He has obtained over $100 million for his clients through settlements, awards and licensing revenue. He also has successfully defended his clients from damages claims totaling in the billions. He has represented clients and continues to represent numerous Fortune 500 companies and other small and large publicly-held and privately-owned entities. He has litigated matters involving a broad array of patented technology such as automotive wheel aligners, wheel balancers, digital camera technology, and semiconductor memory chips. He currently serves as an International Delegate to the Licensing Executives Society International (LESI) organization and as Chair of the LESI Patent and

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Richard Lundstrom
Dr. Richard Lundstrom is an independent research and project engineer specializing in dynamic system engineering, automotive chassis development , and application of the science of improvement. He teaches Chassis Design, Systems Analysis and Mechanical Control Systems at Kettering University, where he also served as team leader for the annual Kettering Industry Symposium. Dr. Lundstrom previously taught several mechanical engineering courses, developed Vehicle Dynamics and Thermal System Design courses, and founded and directed the Vehicle Dynamics Lab at Lawrence Tech. He has worked as a product engineer with Ford Motor Company and developed and taught a Fundamentals of Vehicle Design course. Dr. Lundstrom is a member of SAE, ASME, ASQ, ASEE and SCCA. He received a B.S. in Mechanical Engineering from the University of Illinois, a M.S. from the University of Michigan and a Ph.D. from Oakland University.

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James Masiak
James Masiak has more than 25 years of experience in the implementation of business processes for General Motors. Mr. Masiak's most recent activities include the implementation of an enhanced engineering product cost management process within GM North America, the alignment of cross functional organizational initiatives, and development of an engineering resource allocation plan for GM Regions. Mr. Masiak was also responsible for the development and implementation of Global Engineering and Business Strategies across all of General Motors International Operations. Mr. Masiak received his B.S. in Mechanical Engineering from Wayne State University, his M.S. in Mechanical Engineering from Massachusetts Institute of Technology, and his M.B.A. from Michigan State University Executive Management Program.

Mansour Masoudi
Dr. Mansour Masoudi is currently a Senior Engineer at the Robert Bosch Corporation. Prior to that, he worked at Corning Incorporated and Delphi Corporation. Throughout his career, he has carried out various engineering responsibilities working on diesel emission control components and systems, including analyzing their fluid dynamics, conversion efficiency, pressure drop, thermal behavior, design and optimization, as well as particulate transport, deposition and regeneration. In addition, he has significant experience in analyzing hydrodynamics and thermal behavior of other engineering systems. He is a member of SAE, the American Physical Society and the American Society of Mechanical Engineers. Dr. Masoudi has a B.S. and M.S. in Mechanical Engineering from the University of Nevada-Reno and a Ph.D. in Mechanical and Aerospace Engineering from the University of California-Irvine with a specialty in fluid dynamics, thermal sciences and combustion.

Abul Masrur
Dr. Masrur currently works for the US Army RDECOM-TARDEC (Research Development and Engineering Command), in the Ground Vehicle Power and Mobility Department within TARDEC (Tank Automotive Research Development & Engineering Center), where he is involved in vehicular electric power system architecture concept design, modeling and simulation, electric power management, and military applications. He previously worked with the Scientific Research Labs of Ford Motor Company where he was involved in research and development related to simulation and control for electric drives for electric and hybrid electric vehicles and power electronics, advanced automotive electric energy management, electric active suspension systems for automobiles, automotive multiplexing systems, electric power assist steering, and automotive radar applications, including the Computer Aided Engineering development and simulations for such applications. Dr. Masrur has authored more than sixty publications and has co-authored eight U.S. patents and is the recipient of SAE's Environmental Excellence in Transportation Award in Education, Training and Public Awareness. He has a B.S. in Electrical Engineering from Bangladesh Engineering University, a M.S. in Computer Engineering from Wayne State University, a M.Eng. in Electrical Engineering from the University of Detroit and a Ph.D. in Electrical Engineering from Texas A&M University.

Ronald D. Matthews
Professor Ron Matthews, currently serving as a member of the SAE International Board of Directors, is Head of the General Motors Foundation Engines Research Laboratory on the campus of the University of Texas at Austin. He has been actively involved in engines research for 35 years, including engine control systems since the initial introduction of on-board computers. Mr. Matthews, a Fellow of SAE International, founded the Formula SAE competition in 1981 and has been the Faculty Advisor for a Formula SAE team each year since. He has been author or co-author on over 200 technical papers and reports, mostly in the field of engines.

Harold E. McCormick
Harold McCormick is currently President of C-K Engineering Inc., an engineering firm specializing in providing analysis instrumentation gauging and other consulting services for engine and lubricant manufacturers. He was formerly Director of Engineering, Ramsey Plant TRW-Valve Division, with ongoing responsibility for research and product engineering. Mr. McCormick's past experience there includes design engineer for retaining rings, project engineer conducting programs to develop automotive rotary shaft seals based on facets of the Ramsey product line, primarily in automotive piston rings, and chief engineer. He has also completed 57 graduate hours in Applied Mechanics and Metallurgy at St. Louis University. He holds more than 30 U.S. patents and has authored or coauthored numerous technical papers for the SAE as well as other automotive engineering organizations. Mr. McCormick holds a B.S. in mechanical engineering from University of Missouri-Rolla and an MBA from St. Louis University.

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Mark was formerly a manager of the CAE group within a tier-one powertrain supplier to world automotive markets, a consulting engineer in vehicle dynamics with Gear Consultants, Inc., and a project manager of traction systems for off-highway vehicles with

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Chris Mi
Dr. Mi is currently an Associate Professor at the University of Michigan - Dearborn , and Chief Technical Office of 1Power Solutions, Inc. His teaching and research interests are in the areas of power electronics, hybrid electric vehicles, electric machines and drives, and renewable energy and control. At 1Power Solutions, Inc., he is responsible for the powertrain electronics, plug-in hybrid electric vehicle battery management systems, energy engineering solutions, and technical strategy. Prior to that, he worked with General Electric as an Electrical Engineer responsible for the design and development of large electric motors and generators. In addition, Dr. Mi has also worked in China for the Rare-Earth Permanent Magnet Machine Institute of Northwestern Polytechnical University and the Xi'an Petroleum Institute and was a visiting scientist at the University of Toronto. Dr. Mi is the recipient of many awards including the Government Special Allowance (China), Technical Innovation Award (China), the Distinguished Teaching Award from the University of Michigan - Dearborn, and SAE's Environmental Excellence in Transportation Award in Education, Training and Public Awareness and has published more than 80 papers. Dr. Mi received a B.S. and M.S. in Electrical Engineering from Northwestern Polytechnical University, Xi'an, Shaanxi, China, and a Ph.D in Electrical Engineering from the University of Toronto, Canada.

Gerald J. Micklow
Gerald Micklow, Ph.D. PE is currently a full professor of Engineering at East Carolina University and is a licensed engineer in the state of North Carolina. For nearly three decades, Dr. Micklow has been actively involved in the design and evaluation of advanced power producing systems. Dr. Micklow's research over the years has been heavily funded by NASA, the National Science Foundation, the Department of Energy, the Federal Aviation Administration, Argonne National Labs and others with the majority of the work being related to fuel injection and low pollutant emission combustion systems for aircraft and on-road and off-road automotive/trucking/machinery applications. Dr. Micklow has received numerous awards from NASA including being inducted into the NASA/U.S. Space Foundation Innovative Technology Hall of Fame in 2000 and receiving the NASA Space Act Award for work performed on the Space Shuttle in 2002. In addition, Dr. Micklow's industry experience includes eight years of designing advanced aircraft and missile configurations where he maintained top-secret security clearances. With well over 60 engineering publications, Dr. Micklow received both a B.S. and M.S. in Aerospace Engineering from Pennsylvania State University and a Ph.D. in Mechanical Engineering from Virginia Polytechnic Institute and State University.

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Cindy A. Miller is currently an Engineering Specialist at Cessna Aircraft Company. Ms. Miller is the lead human factors engineer working on new development programs such as the CJ4 and 850 Columbus projects. Ms. Miller is a member of HFES and AOPA and holds a private pilot license. She has a B.S. in Mechanical Engineering from Milwaukee School of Engineering, a MAS in Aviation Safety and Management from Embry-Riddle University, a M.A. in Human Factors Psychology and is currently ABD for her doctorate in Human Factors at Wichita State University.

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Michael J. Oliver
Michael J. Oliver is Vice President of Electrical / EMC Engineering at MAJR Products Corporation, where he is responsible for customer EMC design and consulting and new product development. He is also the company's ISO-9001:2000 management representative. An expert in EMI/RFI shielding technology, he has experience in electronics, military shelter electrical systems, and high power antenna/radome design.

His experience also includes the design and testing of aerospace antennas, shielding of military shelter electrical systems, and discrete EMC shielding components. Mr. Oliver has expertise in open and anechoic chamber radiated testing to military standards and has utilized various antennas and radiated test systems. In addition, he has written numerous technical papers and publications on electromagnetic shielding components, product testing and design, and military antenna/radome test methodology standards. Mr. Oliver is the founder and currently serves as Chairman of the IEEE Pittsburgh EMC Chapter. He is Co-Chairman of the SAE AE4 Electromagnetic Compatibility Committee, and a member of the IEEE EMC Standards Advisory Coordination Committee (SACCom). Mr. Oliver has three patents (one pending) on EMC shielding-thermal management devices and he received a B.S. in Electrical Engineering Technology from Gannon University.

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Joseph Palazzolo is employed at GKN Driveline Torque Technology Group where he manages the mechanical design and development of new automotive torque transfer devices, concepts, and integration into production applications. He previously held positions at Visteon Corporation, Warn Industries, and Ford Motor Company. Mr. Palazzolo is an ASE certified Master Technician, chaired the SAE All-Wheel Drive Standards Committee, and has been an active SAE member since 1990. Mr. Palazzolo is a recipient of the SAE Forest R. McFarland Award for distinction in professional development and education. He has received numerous patents for his work and creativity in advancing mobility systems He holds a Bachelors degree in Mechanical Engineering from Cleveland State University and a Masters degree in Automotive Engineering from Lawrence Technological University.

Vincent Piacenti
Mr. Piacenti is Manager, Systems Engineering for Bosch Corp. He is responsible for systems engineering of all diesel fuel injection systems and components used in the US, including diesel fuel injection hydraulic systems integration for North American diesel engine applications. This encompasses simulation, adaptation and testing of high-speed, high-pressure fuel injection systems with a concentration on common rail systems, both solenoid-valve and piezo. Included is research of alternative fuels for diesel engine applications. He has experience in all types of diesel fuel injection and various gasoline systems and is a contributing author to the Springer Handbook for Mechanical Engineers. Mr. Piacenti holds a B.S. in Mechanical Engineering and has been with Bosch for almost thirty years, seven of which were at the Bosch Headquarters for Diesel Fuel Injection in Stuttgart, Germany.

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Jeffrey A. Pike is President, Biomechanics Consulting, Inc. and Adjunct Professor, Biomedical Engineering, Wayne State University. He previously held the position of Senior Technical Specialist, Occupant Injury/Biomechanics, Ford Motor Company, from which he recently retired. He has extensive professional experience in biomechanics, injury mechanisms and causation, occupant protection, testing, regulatory requirements and regulatory process and medical records review. Mr. Pike has organized and presented at numerous technical forums, including sessions at two White House Conferences as well as SAE Symposia on Vehicle Rollovers, Occupant Protection and Lower Limb Injuries. He has also taught SAE regulatory and forensics seminars for 21 years and has been a guest lecturer at MIT, the Medical College of Wisconsin, the University of Michigan, Harvard Medical School and the University of Virginia. Mr. Pike is an SAE Fellow and received the Forest R. McFarland Award in 2004 for his contributions to SAE professional development activities. His publications include technical papers, book chapters and principal author of two textbooks published by SAE: Automotive Safety: Anatomy, Injury, Testing and Regulation and Neck Injury: The Use of X-Rays, CT's and MRI's to Study Crash-Related Injury Mechanisms. His educational background includes studies at Polytechnic Institute of Brooklyn, New York University and the University of Michigan.

Juan R. Pimentel
Dr. Juan R. Pimentel, Professor of Computer Engineering at Kettering University in Flint, Michigan, is an expert in the area of safety-critical systems and computer networks, particularly issues related to real-time protocols, safety-critical protocols, dependable automotive embedded systems, and distributed embedded systems. He has performed extensive research in the U.S., Germany, Spain, and Colombia and is a recognized international expert in the area of industrial communications and real-time protocols. In 2001, Dr. Pimentel was a Fulbright scholar performing teaching and research in the area of dependable embedded systems at the Universidad de los Andes, Bogota, Colombia. In 1987-88, he was a Guest Professor at the Fraunhofer Institute in Karlruhe, Germany, where he developed an industrial LAN encoder used in a German National Standard (DIN). From 1991-1993, he was a visiting Research Professor at the Universidad Politecnica de Madrid, Spain where he worked on a research project on autonomous intelligent mobile robots. He has participated in several projects with GM, Visteon, Delphi, and Vector CANTech Inc, and has authored books on computer networks and multimedia systems.

Alexander (Alex) J. Porter
Alexander J. Porter is the Chief Engineer for Programs, Performance, and Durability for Intertek, and has been with the company since 1992. Since 1996, he has been developing accelerated testing methods for mechanical components and systems. Mr. Porter has three patents relating to accelerated testing equipment and has authored over 40 articles and technical papers on accelerated testing. Alex is the author of the book, Accelerated Testing and Validation, Elsevier 2004. His work in the past has included implementation of FEA in a laboratory setting and development of a thermal management system for an advanced data acquisition package developed by NASA's Drydon Flight Research Facility. Alex is a member of SAE and IEEE. He holds a B.S. in aircraft engineering and an M.S. in mechanical engineering, both from Western Michigan University.

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Thomas Prucha is Principal Applications Engineer at Protean Electric, Inc., a manufacturer of in-wheel electric motor propulsion systems for vehicles. Mr. Prucha is responsible for the continuing development, demonstration, and maintenance of Protean's vehicle fleet in North America. Prior to his current position, he was a Sr. Technical Specialist at FEV, Inc., a world-renowned vehicle integrator for hybrid and electric vehicle applications. Mr. Prucha has more than 30 years of engineering experience in automotive powertrain, mechanics, and electronics. He has specialties in Model-based design, Rapid Controller Prototyping, high voltage power distribution systems, Energy Storage Systems, and all aspects of hybrid and electric vehicle control systems.

Sam Reddy
Dr. Reddy is currently a Technical Fellow in the Chemical and Environmental Sciences Laboratory at GM Research and Development Center. Prior to that, he was a Principal Research Engineer in the Fuel and Lubricants Department. Dr. Reddy has been working on evaporative emission research and development for more than twenty years with significant research in the area of diesel fuel cold temperature wax plugging problems and diesel fuel stability. He holds twenty six U.S. patents and has authored ten SAE papers in the same field. Dr. Reddy obtained his B.S. CHE from Osmania University in India, M.S. CHE from UCLA, and Ph.D. CHE from the University of Michigan and is a licensed engineer in the state of Michigan.

Thomas Reinhart
Thomas Reinhart is Program Manager for NVH in the Engine, Emissions, and Vehicle Research division of Southwest Research Institute. Previous roles include Senior Manager for NVH at Visteon Chassis Systems, where Mr. Reinhart was responsible for the NVH analysis and development of axles, driveshafts, and power steering systems. From 2001 to 2004, he was NVH Program Manager at Roush Industries, Inc. where he was responsible for NVH testing and development of diesel and gasoline engines, as well as transmissions, axles and accessories. Diesel fuel system noise was a special focus of this work. Prior to Roush, he was Director of Noise & Vibration Technology at Cummins, Inc. Mr. Reinhart has been involved in solving noise and vibration issues in engines, as well as in a wide variety of engine applications, including pickup trucks, heavy duty trucks, construction equipment, and marine. Mr. Reinhart has developed noise reduction features for diesel engines, four of which have been patented. He has published 15 technical papers on Powertrain NVH topics. Mr. Reinhart received his B.S. and M.S. in mechanical engineering from Purdue University. He also spent a year studying automotive engineering at the Technical University of Hannover, Germany. His master's thesis focused on the application of acoustic intensity measurements to diesel engines.

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Jack Rosebro has taught hybrid, plug-in hybrid, and electric vehicle technology to a wide variety of industry professionals for the past seven years. He consults, writes, and conducts training seminars for Perfect Sky, Inc. throughout North America and Europe. Jack also writes on sustainable mobility for Green Car Congress. He received his M.Sc. in Engineering from Blekinge Institute of Technology in Sweden.

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Dr. Roslund joined General Motors at Detroit Diesel Allison, transferred to Saturn, and retired from GM in 2007. Dr. Roslund spent 24 years at General Motors solving problems using statistical methods and providing in-house consulting on a daily basis. He also developed numerous course textbooks and conducted over 200 seminars providing a wealth of experience and a vast number of case studies. Dr. Roslund is a member of SAE, ASQ, and the Society

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Manfred C. Rumpel
Manfred C. Rumpel is the manager of the Chassis Systems Integration Department at the Ford Motor Co. His work is concentrated on analyzing and assessing suspension systems for meeting functional vehicle requirements, the scope of which spans from cars to light trucks. Mr. Rumpel's previous work includes advanced chassis concepts design responsibilities. During this phase, he received 13 patent awards in suspension system design which have been incorporated in several production vehicles. Mr. Rumpel has more than 25 years of experience in the auto industry, including seven at Porsche A.G. in Germany where he conducted chassis systems design and analysis work on passenger cars, race cars and off-road vehicles. He received his degree in mechanical engineering in 1968 from the Engineering College in Kaiserslautern, Germany. He has taught courses on the global development process at the Univ. of Michigan and fundamentals in chassis systems engineering and design within Ford. Mr Rumpel has been a member of SAE since 1977 and is active in the SAE suspension, steering and chassis committee. He was chairman of that committee from 1992-1994.

Drexel L. Rutledge
Mr. Rutledge is currently an Aerospace Consultant with Integrity Engineering, Inc. where he works with several aerospace companies in the area of Product Support and Sustainment. His principal areas of expertise are in project management, technical information development and delivery, and proposal development activities. Most recently, his expertise in performance based logistics and international support applications have been sought out by several DFW area providers. Prior to joining Integrity Engineering, Inc, Mr. Rutledge was employed by Lockheed Martin Aeronautics Company as the Systems Engineering Director responsible for developing and delivering the technical information needed to operate and maintain all aircraft manufactured or supported by Lockheed Martin Aeronautics by all U.S. and foreign operators.

Mr. Rutledge is a Certified Professional Manager, a Past Chairman of the Product Support Executive Board of Directors of the Aerospace Industries Association, a Past President and Chairman of the Board of Directors of the General Dynamics Management Association, a member of the Air Force Association, and an Honorary Lifetime Member of the International Office and Professional Employees Industrial Union. He has served as the Industry Representative and co-chair of multiple Department of Defense and Industry project teams including the 2003 Logistics Transformation Initiative. He is the recipient of the 2006 Leonard Ross Memorial Award for Outstanding Contributions in the field of Logistics. Mr. Rutledge has a Bachelor of Science in Business Management as well as a Master of Business Administration from LeTourneau University in Texas.

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Dr. Saha is the Lead Faculty Member of the SAE Vehicle Interior Noise Engineering Academy and has organized SAE topical symposia. He was the General Chairman of the 2005 SAE Noise and Vibration Conference. He is the past-chairman of the SAE Acoustical Materials Committee and has helped develop several standards in acoustics. Dr. Saha is an active member of ASA, ASME, INCE, NSPE, the SAE International, and a contributing editor of Sound and Vibration publication. He has presented technical papers, organized and chaired numerous technical sessions sponsored by SAE and other professional organizations. Dr. Saha has also won several awards presented by the SAE International and the Michigan Society of Professional Engineers (MSPE) and has been named an SAE Master Instructor. Dr. Saha holds a B.S. in Mechanical Engineering from the University of Calcutta, a M.S. in Engineering Sciences from the University of Florida and a Ph.D. in Mechanical Engineering (Acoustics Specialty) from the Georgia Institute of Technology.

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Steven R. Schmid
Dr. Schmid is an Associate Professor at the University of Notre Dame, where he conducts research and teaches courses in manufacturing, metal forming, tribology and design. Prior to joining academia, Dr. Schmid was a project engineer at Triodyne, Inc., a consulting firm specializing in machine and manufacturing/product consulting with a special emphasis on safety. As such, he has visited hundreds of manufacturing facilities as diverse as sugar cane plants in Hawaii to battery factories in Vermont, and has been a consultant to industry and government. He is a past recipient of the Society of Manufacturing Engineers John T. Parsons Outstanding Young Manufacturing Engineer Award, has won numerous teaching awards, and was named a Kaneb Center Teaching Faculty Fellow at the University of Notre Dame in 2003. Dr. Schmid has organized numerous conferences, and has written over 80 technical papers and eight books and book chapters. He holds a Professional Engineer's license and is a Certified Manufacturing Engineer. Dr. Schmid is a graduate of the Illinois Institute of Technology and Northwestern University.

Peter J. Schubert
Dr. Schubert is currently a Senior Director of Research and Development at Packer Engineering, Inc. where he has served as principal investigator on engineering research grants from NASA, the USDA, the Department of Energy, and the General Services Administration. He has over twenty years experience in automotive electronics and was previously a Technical Fellow at Delphi Electronics & Safety where he worked on advanced crash sensing and occupant detection methods. Dr. Schubert teaches vehicle rollover sensing and discrimination algorithms for SAE, has taught numerous courses in model-based design, and delivered an introduction to nanotechnology for the U.S. government. He has 26 U.S. patents and over 50 technical publications covering a wide range of engineering fields. Dr. Schubert has a B.A. in Physics from Washington University, a M.S.E.E. in Electrical Engineering from the University of Cincinnati, and a Ph.D. in Electrical Engineering from Purdue University.

Howard (Lon) Scott
Lon Scott is currently the Vice President of Operations for SL King & Associates, an engineering services firm located in Atlanta, Georgia. His principal areas of expertise include management of engineering and support teams as well as providing the processes and tools necessary to successfully coordinate and accomplish major technical design tasks. Prior to joining SL King & Associates, Mr. Scott worked for Lockheed Martin Corporation, an aircraft and defense product manufacturer. As a Senior Manager and Director he was responsible for providing top level system engineering integration and coordination relating to the design and development of aircraft and associated support systems for foreign and US military programs. Mr. Scott's professional affiliations include AIAA, the National Defense Industrial Association, SAE and the National Management Association. He received a B.S. in Electrical Engineering from the University of Texas at Arlington.

Jörge Segers
With an educational background in automotive engineering, Jörge Segers has been involved with racing disciplines such as GT and sportscar racing, single seaters, and touring cars since 1998. He began with an apprenticeship at PK Carsport (formerly GLPK Racing), a Belgian team active in international GT racing. Mr. Segers became the team manager only three years later. After finishing his studies, he was employed at BPR Competition Engineering as track engineer in the International Sports Racing Series and later as development manager at Eurotech Racing. At Eurotech, he was responsible for the GT racing activities of British sportscar manufacturer Marcos Cars.

In 2001, Mr. Segers became the youngest team manager ever in an FIA organized championship. At PK Carsport he is still responsible for the team's activities and the FIA GT Championship. Subsequently, he has been working for other teams such as Henrik Roos Motorsports (FIA GT), Racing for Holland (Le Mans 24 Hours) and Carsport Modena. SAE published Mr. Segers' first book, *Analysis Techniques for Racecar Data Acquisition*, in 2008.

Andrew F. Seybert
Andrew F. Seybert, Ph.D., P.E..is a Professor of Mechanical Engineering at the University of Kentucky where he has been a faculty member since 1977. In 1996, Dr. Seybert helped organize the Vibro-Acoustics Consortium, a group of companies interested in the development and use of noise prediction technology. He has been active in the development of numerical methods in acoustics and vibrations, particularly boundary element methods. Dr. Seybert is a Fellow of the Acoustical Society of America and of the American Society of Mechanical Engineers. He remains active in SAE and the IIAV. Dr. Seybert received a B.S. degree from the University of Cincinnati and M.S. and Ph.D. degrees from Purdue University.

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Ramesh K. Shah
Dr. Ramesh K. Shah is currently with Subros Ltd, New Delhi, India. Previously he was with Delphi Harrison Thermal Systems and General Motors Corporation for almost 30 years. During 1995-97, he was the Professor and Chairman of the Dept. of Mechanical Engineering at the Univ. of Kentucky. He has taught short courses and presented keynote lectures/seminars on heat exchanger design at various universities and research institutes in 30 countries worldwide. He is extensively published in the areas of heat exchangers and laminar internal flow forced convection. Dr. Shah is Co-Founder and former Editor-in-Chief of the international journal, Experimental Thermal Fluid Science. He is the past President of the Assembly of World Conferences on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics. Dr. Shah's business career includes all aspects of automotive heat exchangers and air-conditioning and engine cooling systems. He is a member of the Society of Automotive Engineers, an SAE Fellow and a Fellow of the ASME, where he served as the Chairman of the Heat Transfer Division and a Technical Editor of the Journal of Heat Transfer. He has received many awards including ASME Heat Transfer Memorial Award and AIChE D.Q. Kern Award. He received his B.E. from Gujarat University, India, and M.S., Engineer, and Ph.D. degrees from Stanford University.

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Dr. Tao has assisted the automobile industry in revising existing fuel delivery procedures and establishing new ones. He has also successfully established mathematical models for these fuel delivery systems using nonlinear stochastic system theory. He then utilized these models to investigate the physics essentials of the interactions among contaminants, additive packages, fuels and fuel delivery system components. Dr. Tao has authored and co-authored numerous technical publications in related fields. He is a graduate of the Mechanical and Aerospace Engineering Department at Oklahoma State University.

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SAE PROFESSIONAL DEVELOPMENT SCHEDULE FOR 2011

Seminars, Academies, and Webinars

(Courses are added throughout the year, please check online for the most current schedule at www.sae.org/pdevent/bydate/.)

Troy, MI - SAE Automotive Headquarters

Jan 10-11 Diesel Engine Technology - I.D.#93014
Jan 13-14 Advanced High Strength Steels for Vehicle Weight Reduction - I.D.#C0916
Jan 17-19 Chassis & Suspension Component Design for Passenger Cars & Light Trucks - I.D.#95025
Jan 20-21 Product Liability & The Engineer - I.D.#82001
Jan 24-25 Sheet Metal Stamping: Robust Formability -I.D.#C0713
Jan 27-28 Acquiring and Analyzing Data from Sensors and In-Vehicle Networks - I.D.#C0522
Jan 31-Feb 1 Selective Catalytic Reduction for Diesel Engines - I.D.#C0913

Webinar - via telephone/internet

Jan 11-13 Variable Compression Ratio (VCR) Webinar - I.D.#WB1012
Jan 17-21 Homogeneous Charge Compression Ignition (HCCI) Webinar - I.D.#WB1013
Jan 18 - Feb 3 Design of Experiments (DOE) for Engineers Webinar - I.D.#WB0932
Jan 31 - Feb 4 Design FMEA Update: What's New in J1739 Webinar - I.D.#WB0955

Warrendale, PA - SAE World Headquarters

Jan 10-13 IAQG Sanctioned Aerospace Auditor Transition Training (AATT) - I.D.#C1034

Troy, MI - SAE Automotive Headquarters

Feb 3-4 Program and Risk Management - I.D.#C0409
Feb 7-8 Introduction to Commercial and Off-Road Vehicle Cooling Airflow Systems - I.D.#C0738
Feb 9-11 Designing On-Board Diagnostics for Light and Medium Duty Emissions Control Systems - I.D.#C0707
Feb 9-11 Strategic Leadership - I.D.#C0620
Feb 14-15 Side Impact Occupant Safety and CAE - I.D.#C0717
Feb 21-23 Fundamentals of Modern Vehicle Transmissions - I.D.#99018
Feb 23-23 Exhaust Flow Performance and Pressure Drop of Exhaust Components and Systems - I.D.#C0235
Feb 24 Introduction to Gears - I.D.#C0822
Feb 28-Mar 1 Modern Fluids for Crankcase Engines: An Overview - I.D.#C0704
Feb 28-Mar 2 Combustion & Emissions for Engineers - I.D.#97011

Webinar - via telephone/internet

Feb 14-Feb 18 Process FMEA Update: What's New in J1739 Webinar - I.D.#WB0956
Feb 15 Introduction to Hybrid Powertrains Webinar - I.D.#C0903
Feb 17 Basic Hybrid and Electric Vehicle Safety Webinar - I.D.#C0904
Feb 22 Plug-in Hybrids: Opportunities and Challenges Webinar - I.D.#C0905
Feb 24 Hybrid and Electric Vehicles: Current Production, Future Strategies Webinar - I.D.#C0906

Warrendale, PA - SAE World Headquarters

Feb 14-17 IAQG Sanctioned Aerospace Auditor Transition Training (AATT) - I.D.#C1034

Troy, MI - SAE Automotive Headquarters

Mar 3-4 Vehicle Frontal Crash Occupant Safety and CAE - I.D.#C0621
Mar 7-8 Accelerated Test Methods for Ground and Aerospace Vehicle Development - I.D.#C0316
Mar 7-8 The Basics of Internal Combustion Engines - I.D.#C0103
Mar 9-11 Motor Fuel: Technology, Performance, Testing, and Specifications - I.D.#98003
Mar 14-15 Automotive Powertrain and Battery Cooling Airflow Systems: A Vehicle Perspective - I.D.#C0616
Mar 17-18 In-Vehicle Networking with LIN and FlexRay Applications - I.D.#C0136
Mar 21-22 Evaporative and Refueling Emission Control - I.D.#C0928
Mar 23-25 Turbocharging Internal Combustion Engines - I.D.#C0314
Mar 23-25 Vehicle Dynamics for Passenger Cars and Light Trucks - I.D.#99020

Webinar - via telephone/internet

Mar 1-24 Fundamentals of Geometric Dimensioning & Tolerancing (GD&T) Webinar - I.D.#WB0933
Mar 29-31 Powertrain Control Unit/Transmission Control Unit Technology Webinar - I.D.#WB1001

Warrendale, PA - SAE World Headquarters

Mar 28-31 IAQG Sanctioned Aerospace Auditor Transition Training (AATT) - I.D.#C1034

Detroit, MI - Detroit Marriott at the Renaissance Center

Apr 11 Emissions-Related OBD Systems: A Design Overview - I.D.#C0708
Apr 11 Fundamentals of Shielding Design for EMC Compliance - I.D.#C0835
Apr 11 Design Reviews for Effective Product Development - I.D.#C0004
Apr 11 A Familiarization of Drivetrain Components - I.D.#98024
Apr 11 Brake Friction Materials: Testing, Quality and Selection - I.D.#C1020
Apr 11 Patent Law for Engineers - I.D.#88007
Apr 11 Common Rail Diesel Fuel Injection - I.D.#C0920
Apr 11-12 The Role of the Expert Witness in Product Liability Litigation - I.D.#92054
Apr 11-12 Threaded Fasteners and the Bolted Joint - I.D.#95030
Apr 11-12 Improving Fuel Efficiency with Engine Oils - I.D.#C0914
Apr 11-12 Diesel Emissions and Control Technologies - I.D.#C0206
Apr 11-13 Weibull-Log Normal Analysis Workshop - I.D.#86034
Apr 11-13 Fundamentals of Heavy Truck Dynamics - I.D.#C0837
Apr 11-13 Gasoline Direct Injection (GDI) Engines - I.D.#C1009
Apr 12 Fundamentals of All-Wheel Drive Systems - I.D.#C0305
Apr 12-13 Catalytic Converters: Design and Durability - I.D.#98017
Apr 13-15 Injuries, Anatomy, Biomechanics & Federal Regulation - I.D.#85049
Apr 13-15 Electrohydraulic Controls for Mobile Equipment & Vehicles - I.D.#C1011
Apr 13-15 Fundamentals of Metal Fatigue Analysis - I.D.#94024
Apr 13-15 Principles of Cost and Finance for Engineers - I.D.#C0828
Apr 14 The Tire as a Vehicle Component - I.D.#C0101
Apr 14-15 Metal Corrosion and Its Prevention - I.D.#99006
Apr 14-15 Tolerance Stack-Up Analysis - I.D.#C0022
Apr 14-15 Homogeneous Charge Compression Ignition Engines - I.D.#C1010
Apr 14-15 Engineering Project Management - I.D.#99003
Apr 14-15 Leading High Performance Teams - I.D.#C0410
Apr 15 Tire & Wheel Safety Issues - I.D.#C0102

Troy, MI - SAE Automotive Headquarters

Apr 11-12 Vibration Analysis using FEA: A Hands-on Workshop - I.D.#C0830
Apr 26-27 Control Systems Simplified - I.D.#C0525
Apr 27-28 Introduction to Hydraulic Hybrid Systems for Road Vehicles - I.D.#C0833
Apr 27-29 Internal Combustion Systems: HCCI, DoD, VCT/VVT, DI and VCR - I.D.#C0613
Apr 29 Understanding and Using the SAE J2534-1 API to Access Vehicle Networks - I.D.#C0733

Webinar - via telephone/internet

Apr 4-8 Review of AMT and DCT Technology Applied to Automotive Powertrain Webinar - I.D.#WB1003
Apr 19-21 Fundamentals of Continuously Variable Transmission Technology Webinar - I.D.#WB1002
Apr 26-May 5 Principles of Electric Drives Webinar - I.D.#WB0941

Grand Rapids, MI - DeVos Place Convention Center

May 16 Basic Noise Control - I.D.#86028
May 16-17 Practical NVH Signal Processing Methods - I.D.#C0431
May 19 Brake Noise Problem Resolution - I.D.#C0831

Greer, SC - BMW Performance Center

May 2-4 Applied Vehicle Dynamics - I.D.#C0414

Troy, MI - SAE Automotive Headquarters

May 2-3 A Holistic Introduction to Commercial Telematics - I.D.#C0947
May 2-3 Introduction to FMEA for Product Design & Manufacturing Process Design - I.D.#92002
May 2-3 Diesel Engine Technology - I.D.#93014
May 4-5 Mechatronics: Introduction, Modeling and Simulation - I.D.#C094
May 9-10 Design of Experiments for Engineers - I.D.#C0406
May 9-10 Introduction to Hybrid and Electric Vehicle Battery Systems - I.D.#C0626
May 9-10 Fundamentals of Commercial Vehicle Aerodynamics - I.D.#C0919
May 11 Safe Handling of High Voltage Battery Systems - I.D.#C1019
May 16-17 Powertrain Selection for Fuel Economy and Acceleration Performance - I.D.#C0243
May 16-17 Piston Ring Design/Materials - I.D.#86009
May 16-18 Advanced Vehicle Dynamics for Passenger Cars and Light Trucks - I.D.#C0415
May 19-20 Embedded Control Systems Design Workshop - I.D.#C0922
May 23-24 Finite Element Analysis for Design Engineers-Hands-On FEA Workshop - I.D.#93006
May 25 Statistical Tolerance Design - I.D.#88033

Webinar - via telephone/internet
May 10-19 Root Cause Problem Solving: Methods and Tools Webinar - I.D.#WB0931

Troy, MI - SAE Automotive Headquarters
Jun 6-10 Diesel Engine Technology Engineering Academy - I.D.#ACAD03
Jun 8-10 Hydraulic Brake Systems for Passenger Cars & Light Trucks - I.D.#C0509
Jun 13-14 Alternative Fuels: Impact on SI and CI Fuel Systems, Distribution, and Storage - I.D.#C0729
Jun 16-17 Fundamentals of Steering Systems - I.D.#C0716
Jun 20-21 Selective Catalytic Reduction for Diesel Engines - I.D.#C0913
Jun 20-22 Geometric Dimensioning & Tolerancing - I.D.#C0133
Jun 22-24 Commercial Vehicle Braking Systems - I.D.#C0233
Jun 23-24 Acquiring and Analyzing Data from Sensors and In-Vehicle Networks - I.D.#C0522
Jun 23-24 Fundamentals of Automotive Fuel Delivery Systems - I.D.#C0303
Jun 27-28 Advanced High Strength Steels for Vehicle Weight Reduction - I.D.#C0916
Jun 27-29 Chassis & Suspension Component Design for Passenger Cars & Light Trucks - I.D.#95025

Webinar - via telephone/internet
Jun 14-16 Displacement on Demand Systems (DoD) Webinar - I.D.#WB1010
Jun 15-17 Patent Litigation in the U.S.: What You Need to Know Webinar - I.D.#WB0940
Jun 20-24 Variable Cam and Valve Timing (VCT) & (VVT) Webinar - I.D.#WB1011

Troy, MI - SAE Automotive Headquarters
Jul 11-13 Introduction to Metallurgy and Its Practice - I.D.#99015
Jul 14-15 Sheet Metal Stamping: Robust Formability - I.D.#C0713
Jul 18-20 Fundamentals of Heavy Truck Dynamics - I.D.#C0837
Jul 18-20 Combustion & Emissions for Engineers - I.D.#97011
Jul 21-22 Product Liability & The Engineer - I.D.#82001
Jul 25-27 Designing On-Board Diagnostics for Light and Medium Duty Emissions Control Systems - I.D.#C0707
Jul 28 Exhaust Flow Performance and Pressure Drop of Exhaust Components and Systems - I.D.#C0235

Webinar - via telephone/internet
Jul 12-14 Variable Compression Ratio (VCR) Webinar - I.D.#WB1012
Jul 18-22 Homogeneous Charge Compression Ignition (HCCI) Webinar - I.D.#WB1013
Jul 26-26 Introduction to Hybrid Powertrains Webinar - I.D.#C0903
Jul 28-28 Basic Hybrid and Electric Vehicle Safety Webinar - I.D.#C0904

Troy, MI - SAE Automotive Headquarters
Aug 1-3 Fundamentals of Metal Fatigue Analysis - I.D.#94024
Aug 3-5 Electrohydraulic Controls for Mobile Equipment & Vehicles - I.D.#C1011
Aug 4-5 Threaded Fasteners and the Bolted Joint - I.D.#95030
Aug 8-9 Modern Fluids for Crankcase Engines: An Overview - I.D.#C0704
Aug 10-12 Vehicle Dynamics for Passenger Cars and Light Trucks - I.D.#99020
Aug 15-17 Fundamentals of Modern Vehicle Transmissions - I.D.#99018
Aug 18 Introduction to Gears - I.D.#C0822
Aug 18-19 Evaporative and Refueling Emission Control - I.D.#C0928
Aug 22-24 Gasoline Direct Injection (GDI) Engines - I.D.#C1009
Aug 22-24 Strategic Leadership - I.D.#C0620
Aug 25-26 Side Impact Occupant Safety and CAE - I.D.#C0717
Aug 29-30 Improving Fuel Efficiency with Engine Oils - I.D.#C0914
Aug 29-31 Turbocharging Internal Combustion Engines - I.D.#C0314

Webinar - via telephone/internet
Aug 2-11 Tolerance Stack-up Fundamentals Webinar - I.D.#C0842
Aug 3 Plug-in Hybrids: Opportunities and Challenges Webinar - I.D.#C0905
Aug 5 Hybrid and Electric Vehicles: Current Production, Future Strategies Webinar - I.D.#C0906

New Orleans, LA - New Orleans Marriott
Sep 22 Brake Friction Materials: Testing, Quality and Selection - I.D.#C1020

Rosemont, IL - Donald E. Stephens Convention Center
Sep 12 Introduction to Hydraulic Hybrid Systems for Road Vehicles - I.D.#C0833
Sep 12-13 Homogeneous Charge Compression Ignition Engines - I.D.#C1010
Sep 12-13 Introduction to Commercial and Off-Road Vehicle Cooling Airflow Systems - I.D.#C0738
Sep 12-13 Selective Catalytic Reduction for Diesel Engines - I.D.#C0913
Sep 14 Heavy Vehicle Ride Comfort Engineering - I.D.#C0948
Sep 14 Common Rail Diesel Fuel Injection - I.D.#C0920

Troy, MI - SAE Automotive Headquarters
Sep 12-13 Accelerated Test Methods for Ground and Aerospace Vehicle Development - I.D.#C0316
Sep 12-14 Motor Fuel: Technology, Performance, Testing, and Specifications - I.D.#98003
Sep 15-16 The Basics of Internal Combustion Engines - I.D.#C0103
Sep 19-21 Injuries, Anatomy, Biomechanics & Federal Regulation - I.D.#85049
Sep 26-27 Controller Area Network (CAN) for Vehicle Applications - I.D.#C0120
Sep 26-27 Vehicle Frontal Crash Occupant Safety and CAE - I.D.#C0621
Sep 29-30 Leading High Performance Teams - I.D.#C0410
Oct 3 Fundamentals of All-Wheel Drive Systems - I.D.#C0305
Oct 3 Patent Law for Engineers - I.D.#88007
Oct 3-4 Introduction to Hybrid and Electric Vehicle Battery Systems - I.D.#C0626
Oct 5 Safe Handling of High Voltage Battery Systems - I.D.#C1019
Oct 5 Internal Combustion Systems: HCCI, DoD, VCT/VVT, DI and VCR - I.D.#C0613
Oct 7 A Familiarization of Drivetrain Components - I.D.#98024
Oct 10-11 Diesel Engine Technology - I.D.#93014
Oct 10-12 Advanced Vehicle Dynamics for Passenger Cars and Light Trucks - I.D.#C0415
Oct 12-14 Principles of Cost and Finance for Engineers - I.D.#C0828
Oct 13 The Tire as a Vehicle Component - I.D.#C0101
Oct 14 Tire & Wheel Safety Issues - I.D.#C0102
Oct 17-18 Catalytic Converters: Design and Durability - I.D.#98017
Oct 17-19 Weibull-Log Normal Analysis Workshop - I.D.#86034
Oct 18-19 Diesel Emissions and Control Technologies - I.D.#C0206
Oct 24-25 Design of Experiments for Engineers - I.D.#C0406
Oct 27-28 Mechatronics: Introduction, Modeling and Simulation - I.D.#C0949
Oct 31-Nov 1 Fundamentals of Steering Systems - I.D.#C0716

Webinar - via telephone/internet
Oct 11-13 Powertrain Control Unit/Transmission Control Unit Technology Webinar - I.D.#WB1001
Oct 17-21 Review of AMT and DCT Technology Applied to Automotive Powertrain Webinar - I.D.#WB1003
Oct 18-27 Principles of Electric Drives Webinar - I.D.#WB0941

Greer, SC - BMW Performance Center
Nov 14-16 Applied Vehicle Dynamics - I.D.#C0414

Troy, MI - SAE Automotive Headquarters
Nov 3-4 Powertrain Selection for Fuel Economy and Acceleration Performance - I.D.#C0243
Nov 3-4 Introduction to FMEA for Product Design & Manufacturing Process Design - I.D.#92002
Nov 7-9 Metal Corrosion and Its Prevention - I.D.#99006
Nov 10-11 Tolerance Stack-Up Analysis - I.D.#C0022
Nov 14-15 A Holistic Introduction to Commercial Telematics - I.D.#C0947
Nov 17-18 The Role of the Expert Witness in Product Liability Litigation - I.D.#92054
Nov 17-18 Fundamentals of Automotive Fuel Delivery Systems - I.D.#C0303
Nov 21-22 Finite Element Analysis for Design Engineers-Hands-On FEA Workshop - I.D.#93006
Nov 21-22 Practical NVH Signal Processing Methods - I.D.#C0431
Nov 28-30 Fundamentals of Metal Fatigue Analysis - I.D.#94024
Nov 29-Dec 1 Hydraulic Brake Systems for Passenger Cars & Light Trucks - I.D.#C0509

Webinar - via telephone/internet
Nov 1-3 Fundamentals of Continuously Variable Transmission Technology Webinar - I.D.#WB1002
Nov 9-18 Root Cause Problem Solving: Methods and Tools Webinar - I.D.#WB0931

Troy, MI - SAE Automotive Headquarters
Dec 1-2 Threaded Fasteners and the Bolted Joint - I.D.#95030
Dec 2 Brake Noise Problem Resolution - I.D.#C0831
Dec 5-7 Fundamentals of Heavy Truck Dynamics - I.D.#C0837
Dec 7-9 Geometric Dimensioning & Tolerancing - I.D.#C0133
Dec 12-14 Commercial Vehicle Braking Systems - I.D.#C0233
Dec 14-16 Electrohydraulic Controls for Mobile Equipment & Vehicles - I.D.#C1011
Dec 15-16 Homogeneous Charge Compression Ignition Engines - I.D.#C1010

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Eaton Corp.
Edison Welding Institute
Elgin Sweeper
Emerson Electric
Engelhard Corp.
Engineering Systems Inc.
Engineered Machined Products
Environment Canada
Environmental Systems Products
EWD
Exco Engineering
ExxonMobil Corp.
Faurecia Automotive
Federal Mogul Corp.
Fel-Pro Inc.
Ficosa North America
Flexible Metal, Inc.
Fontaine Trailer Co.
Ford Motor Co.
Forest Engineering Research Institute of Canada
Freightliner Corp.
Freudenberg-Nok
Gables Engineering Inc.
Gamesa Corporacion Tecnologica
Gates Power Drive Products
Gates Rubber Inc.
GE Lighting
GE Medical Systems
General Dynamics Corp.
General Motors Corp.
General Motors de Mexico
General Seating
Global Thermoelectric, Inc.
Goodyear Tire & Rubber Co.
Graco Children's Products
Grand Haven Stamped Products (GHSP)
Grote Industries, LLC
Grupo Antolin N.A.
H2Gen Innovations, Inc.
Harley-Davidson Motor Co.
Hayes-Lemmerz Int'l. Inc.
Hendrickson Truck Suspension Systems
Henkel Technologies
Hitchiner Mfg. Co.
Honda of America Inc.
Honda of Canada, Inc.
Honeywell
Husky Corp.
Husqvarna Turf Care
Hybrid Design Services, Inc.
HyClone Laboratories
HydrogenSource
Imperial Oil
INA Engine Components
Indiana Mills & Manufacturing
Industrial Technology Centre
Infineum USA LP
International Truck and Engine Corp.
Intier Automotive Inc.
Isuzu Motors America Inc.
ITT Industries Inc.
J & L Development, Inc.
Jet Propulsion Laboratory
Johns Manville
Johnson Controls
Just Born, Inc.
Karl Schmidt Unisia
KB Bendix Mexico Operations
Kellogg Crankshaft Co.
Keykert USA
King Abdullah II Design & Development Bureau
Knoll Inc
Kohler Engines
Komatsu Mining Systems Inc.
Kostal of America Inc.
Lear Corp.
Lockheed Martin
Lubrizol Corp.
Luk USA LLC
Magna Powertrain Engine Technologies Group
Magna Steyr
Mahle Technology, Inc.
Mark IV Automotive
MascoTech
Matsushita Communications Indus. Corp.
McDonald's Corp.
Mercedes-Benz USI
Mercury Marine - MerCruiser
Meritor Automotive Inc.
Metaldyne Sintered Components
Motorola, Inc.
MTS Systems Corp.
Nachi Robotics Systems, Inc.
NASA
National Renewable Energy Laboratory
National Security Agency
Naval Air Warfare Center Aircraft Div.
Navistar
Neapco
Nelson Metal Products
New Venture Gear Inc.
Neway Anchorlok
NHTSA
NREL
NxtGen Emission Controls
Nissan Tech Center NA
Nissan Mexicana
Norcold Inc.
Novabus Inc.
NSK Corp.
Optis
Oshkosh Corporation
PACCAR Inc.
Panasonic Automotive Systems of America
Paulstra C.R.C.
Perkin-Elmer, Inc.
Peterbilt Motors Co.
Philips Technologies
Polaris Industries
Pollak Corp.
Ponderosa Associates
PPG Industries
Pratt & Whitney Canada
Prestolite Electric Inc.
Pro-Dex
Purolator Products Co.
Qualcomm, Inc.
Quality Industries
Quantum
Ricardo, Inc.
Robert Bosch Co.
Robertshaw Tennessee
Saft America Inc.
Schukra of NA
Siemens Automotive Corp.
Siemens Components
Siemens VDO Automotive Corp.
Sika Corp.
Simula Automotive Safety Devices, Inc.
Sinclair Community College
SKF (formerly Chicago Rawhide)
SL America
South Central College
Southwest Research Institute
Sowilo Networks
Spartan Chassis Systems
Splitcraft Engineering
Square D Co.
SSI Technologies Inc.
Stant Manufacturing Inc.
Steelcase, Inc.
Stewart & Stevenson Tactical Vehicle Systems, LP
Swagelok Co.
Synerject LLC
Systems Research Laboratories Inc.
Takata Automotive Systems Laboratory
Taylor Made Industries
TEAM Industries
Technologies M4 Inc.
Teradyne Inc.
TESMA Engine Technologies
Texas Instruments Inc.
The Budd Co.
The Timken Co.
TI Automotive
TM4 Inc.
Toyota Motor Corp.
Trelleborg Automotive
TRW Inc.
U. S. Air Force
U.S. Army
U.S. EPA
U.S. Navy
U.S. Steel Corp.
U.S. Tsubaki Automotive Division
Unicell Corp.
United Defense LP
UQM Technologies, Inc.
Valeo
Van-Rob Stampings
VDO Control Systems, Inc.
VDO Yazaki Corp.
Visteon Corp.
Visteon Electronics
Volkswagen de Mexico S.A. de C.V.
Volvo Truck North America Inc.
Vought Aircraft
W.E.T. Automotive Systems Ltd.
Wabash Technologies
Warn Industries
Webasto Sunroofs, Inc.
Webb Wheel Products, Inc.
Wellman Products Group
Westport Innovations
Wheel to Wheel Inc.
Woodward Governor Co.
Yamaha Motor Mfg. Corp. of America
Yazaki North America, Inc.
ZF Batavia
ZF Industries
ZF Lemforder

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