SAE International

Department *of* NATURAL RESOURCES *and* ENVIRONMENT

SAE GREEN ENGINEERING & TECHNOLOGY TRANSFER WORKSHOP

How Can A Green Center Help the Automotive Industry Succeed?

Feasibility Study for Establishing a Center for Green Innovation & Technology transfer for the Automotive Industry in Michigan

Workshop Report

April 30, 2010

SAE Green Technology Workshop Steering Committee

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Executive Summary

SAE International hosted a workshop to examine the feasibility of creating a Center for Green Innovation and Technology Transfer for the automotive industry in Michigan. Funded by a grant from the Michigan Department of Natural Resources and Environment, with support from the Michigan Green Chemistry Roundtable, the workshop explored how the concepts and practices of green innovation could lead to cost-reductions and improved product and environmental performance for the auto industry.

The workshop attendees agreed that a center could be one means to achieve the goal of green innovation for the auto industry, but other approaches could be initiated, such as forming a virtual network that leverages individuals, existing resources, organizations, and/or centers.

Support from automotive Original Equipment Manufacturers (OEMs) and suppliers is the most critical element for any action in this arena, while language, terminology, definitions and environmental sustainability must be articulated for green, greener, green chemistry and engineering and what these mean for the auto industry.

All of the areas examined by the workshop were deemed important by the workshop attendees:

- Materials and Research and Development;
- Technology Transfer;
- Education, Re-training, and Workforce Needs; and
- Principles, Standards, and Regulatory Trends.

Standards, materials, and education were first priority, but there was also a wide diversity of other suggestions, indicating a broad need. However, there was also concern that standards and regulations might discourage potential innovation and solutions. Business development and job creation were also seen as important. To facilitate industry collaboration, a pre-competitive environment for research and technologies was recommended;

In response to the recommendations from the workshop attendees and with endorsement from the workshop Steering Committee, SAE has initiated the following actions over the next six months, using existing SAE infrastructure:

- An inventory and action plan for auto industry standards for environmental, sustainable, and green issues;
- Development of a strategy for greener and more sustainable auto vehicle materials; and
- Integrating green and sustainable concepts into professional development courses, with the goal of establishing a professional certification process.

The Steering Committee for the workshop recommended a mission statement for these initial SAE activities: “To become a network of green innovation for the global automotive stakeholders.”

Finally, the Steering Committee recommended reassessment of the needs for green innovation in the auto sector after these initial activities. If these are successful and supported by the industry, it will be clearer whether a center or collaboration with existing organizations, or a virtual network, would be the most practical, effective, cost-efficient means to implement green innovation in the auto industry.

Acronyms and Abbreviations

Auto 21	A network of Centres of Excellence in Canada
BEV	Battery Electric Vehicles
BSEE	Benchmarking Sustainable Engineering Education
BSI	British Standards Institute
CO_2	Carbon Dioxide
CP	Chlorinated paraffins
CRP	Cooperative Research Program
DEQ	Department of Environmental Quality
DfE	Design for the Environment
DNRE	Department of Natural Resources and Environment
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOL	Department of Labor
E3	Economy, Energy & Environment
EOL	End-of-Life
EPA	Environment Protection Agency
EPD	Environmental Product Declaration
EU	European Union
FAA	Federal Aviation Administration
FTC	Federal Trade Commission
GADSL	Global Automotive Declarable Substances List
GCC	GreenCentre Canada
GE	General Electric
GHG	Green House Gas
GM	General Motors
GSN	Green Suppliers Network
HEV	Hybrid Electric Vehicles
IMDS	International Material Data System
IP	Intellectual Property
ISO	International Standards Institute
LCA	Life Cycle Analysis
LEED	Leadership in Energy and Environmental Design
MAS	Material Assessment Strategy
MDS	Material Data Sheets
Nadcap	National Aerospace and Defense Contractor Accreditation Program
NIST MEP	National Institute of Standards and Technology Manufacturing Extension Partnership
NYP2I	New York Pollution Prevention Institute
OEM	Original Equipment Manufacturers
OESA	Original Equipment Suppliers Association
PCR	Product Category Rules
PHEV	Plug-in hybrid electric vehicles
PRI	Performance Research Institute
R&D	Research and Development
REACH	Registration, Evaluation, and Authorization of Chemicals
SAE	Society of Automotive Engineers
SBA	Small Business Administration
SME	Small and Medium Enterprises

SOC	Substance of Concern
SP	Suppliers Partnership for the Environment
SRG	Sustainable Research Group
Supply Chain	Suppliers
SVHC	Substances of Very High Concern
TSCA	Toxic Substances Control Act
USCAR	United States Council for Automotive Research
USDA	United States Department of Agriculture

I. Introduction and Background

In October 2006, Governor Jennifer M. Granholm issued Executive Directive No. 2006-6 (Directive), "Promotion of Green Chemistry for Sustainable Economic Development and Protection of Public Health." The Directive establishes state policy encouraging the use of safer, less toxic, or non-toxic chemical alternatives to hazardous substances and the research, development, and implementation of Green Chemistry in Michigan, which is the design of chemical products and processes that reduces or eliminates the use and generation of hazardous substances. To develop a framework for implementing the Directive, the State of Michigan worked with the Lowell Center for Sustainable Production to create an action plan to advance Green Chemistry in Michigan.

From this action plan, the State of Michigan seeks to garner support and commitments from stakeholders in Michigan to advance green chemistry, green engineering, or sustainable chemistry (Action 3), facilitate research and commercialization of new innovation technology (Action 9), as well as establish the Michigan Green Chemistry Program as a Model for Green Chemistry Innovation (Action 10). The Action Plan requires the Michigan Green Chemistry Roundtable to scope the feasibility of establishing a Green Chemistry Innovation Center to supplement or carryout the work of the Michigan Green Chemistry Program.

It was not clear how the automotive industry would participate in the Michigan Green Chemistry Program. The environmental issues confronting the automotive industry are legion at a time when the industry is not in the best position to respond. Concerns have been raised that the industry needs to be producing "green mobility products" without definition, specificity, or expression of customer need, beyond that "green" resonates with both consumers and elected officials. Business infrastructure and the regulatory landscapes are uncertain, but likely to be restrictive for the automotive sector, especially with regard to the environment and green issues.

Yet the importance and difficulty of commercializing new technology cannot be understated, particularly within the automotive community. In fact, as James E. Malackowski, president of a merchant bank specializing in intellectual property financial products and services in Chicago, noted "General Motors, Ford and Chrysler are collectively one of the world's primary sources for the research and development of green and fuel-efficient technologies." In an opinion piece published in The Detroit News, December 2, 2008, Malackowski further stated that "…the value of the automakers' green technologies is great …. In fact, much of the privately funded green and energy innovation in the United States will stall or likely never come to fruition if the domestic automobile industry fails."

Attention to the automotive sector as a source and example for green chemistry, green engineering, and green innovation is therefore critical both for the sector itself, the United States, and to the future success of green initiatives. Such attention is much more than fuel-efficiency, although that is a critical component. Paul Mandeltort, National Instruments, observed that ...."The role of the green engineer is more difficult than that of a traditional engineer because green considerations impact almost all aspects of a design. This includes everything from the operational impact of the product, a factor that is increasingly becoming relevant (especially for automobiles), to the end-of-life recycling of the product. Nearly every part of the design process is touched, affecting decisions in materials selection, manufacturing processes, electronics design, power train calibration, and vehicle testing. " Automotive DesignLine (07/30/2008)

SAE recognized that these are important and challenging concepts and topics, but for which no consensus or agreed upon pathway had been decided within the industry, although individual companies were active in the green arena. In the face of such uncertainty, SAE proposed actions the automotive industry could take:

- Address the issues before regulations are imposed;
- Make the Mobility Sector part of the solution and not just the problem;
- Change the industry's approach to be more environmentally responsive, yet also cost-effective and time-sensitive; and
- Assure the Mobility Sector is recognized as a leader for new, green technology.

To forge a path forward for the industry overall, SAE identified green innovation and technology transfer as key issues for the mobility sector. To explore these issues, SAE proposed and was subsequently awarded a grant from the Department of Natural Resources and Environment (DNRE, formerly the Department of Environmental Quality, DEQ) with support of the Michigan Green Chemistry Roundtable, to develop a workshop devoted to exploring the feasibility of establishing a Center for Green Innovation & Technology Transfer for the automotive industry in Michigan.

A Workshop Steering Committee was formed with individuals from industry, academia, and government with expertise in auto manufacturing and supply, engineering and education, sustainability and standards development, and public and environmental health. The Workshop Steering Committee developed the workshop agenda and identified topics and speakers, developed a survey for workshop attendees, reviewed the workshop report, and endorsed the workshop conclusions and recommendations.

II. Workshop Session Summaries

The workshop started by examining existing "green" centers that might serve as models for a Michigan center. Then four areas were explored that could be the focus of a green center: Materials and Research & Development; Technology Transfer & the Supply Chain; Education, Training and Workforce Needs; and Principles, Standards, and Regulatory Trends. Finally, Steering Committee members and audience discussions explored the need for a center and if a center would be of value, how these areas, either individually or together, could be integrated into a Center that could facilitate transition to a greener automotive industry and be of value to the automotive sector.

A. Models for a Michigan Center

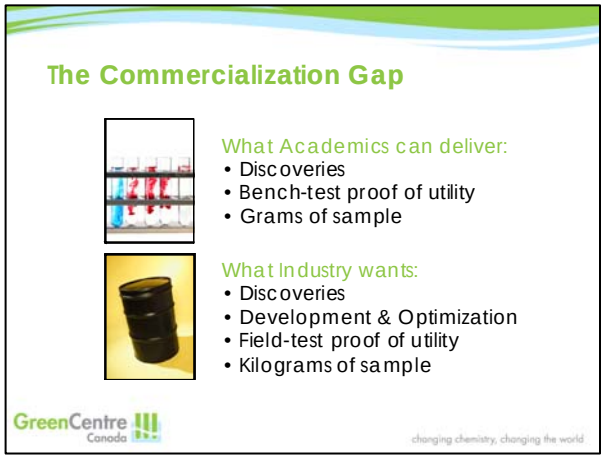
Three centers were highlighted that could serve as models for a new Center.

1. Warner Babcock Institute

The **Warner Babcock Institute**, presented by John Warner, is a for-profit organization formed two years ago, and applies the principles of green chemistry to focus on the molecular design of new molecules for businesses that are seeking to develop sustainable materials. In less than 2 years, it has initiated 120 patents, taken 5 products to market, and is cash positive. The institute demonstrates that the driving force of industry to invent and design new materials, without laws or regulations, has proven a viable approach and further demonstrates the power of the concepts of green chemistry. Warner noted that the United States lags behind other countries in the commitment to the development of green chemistry. For example, India requires an undergraduate student in chemistry to have one year of training in green chemistry and China has 15 national green chemistry laboratories developing green technologies. The Michigan Directive in Green Chemistry is unique in this arena and promises to advance green chemistry in significant ways.

2. GreenCentre Canada

The second model was presented by Rui Resendes. He presented goals and the mission for the **GreenCentre Canada** (GCC), a not-for-profit organization founded in 2009 by the governments of Canada and the State of Ontario to connect industry with Canadian green chemistry technologies. GCC's goal is to bridge the commercialization gap between academia and industry. Commercializing chemistry technologies and materials is a difficult task, characterized as the "Valley of Death", as there are hundreds of different technologies with no easy way to present them to industrial sponsors, where capital costs to implement a new process are enormous, and licensing and intellectual property issues are complex.

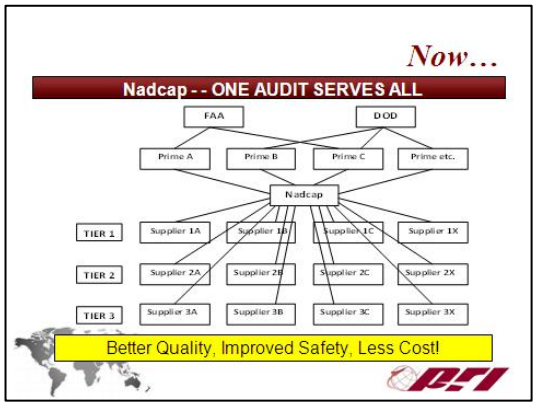


There are different roles for academia and industry in commercialization and technology transfer activities. Academic institutions deliver new technologies and generally can provide bench tests for proof of utility and only grams of sample. However, industry needs these new technologies developed and optimized, field tested, and require kilograms of sample. GCC represents a comprehensive and collaborative approach to commercializing green chemistry technologies by assessing technologies in GCC laboratories, developing bench-proof of utility and scale-up of materials, selecting technologies for licensing and managing the intellectual property issues for academic institutions. As it is a not-for-profit organization, 75% of the revenue generated from industry licensing fees is returned to the academic host institution. An industry coalition advises GCC on technology selection and aids in matching technologies with industry. GCC assumes all of the up-front risks and costs, which may be unique in the technology transfer arena.

3. PRI—Performance Review Institute

The third center presented by Bill Wagner was **PRI**, a wholly owned subsidiary of SAE International, a not-for-profit 501c3 professional engineering organization. PRI originated from the aerospace industry, with its mission to provide a full range of programs and services to improve manufacturing processes and product quality, by adding value, decreasing costs, and promoting teaming between global stakeholders in mobility and other industries.

Nadcap (formerly NADCAP, National Aerospace and Defense Contractor Accreditation Program) was used as an example to demonstrate how PRI achieved its goals with a consensus approach for oversight of the aerospace supply chain. The aerospace industry is highly regulated by the federal government (Federal Aviation Administration (FAA), Department of Defense (DOD)) and with multiple oversight mechanisms of the OEMs and their suppliers. Prior to the establishment of PRI, multiple audits with different criteria for the same issue were required by individual OEM's and Tier 1 suppliers, with significant overlap, duplication and expense. The major aerospace OEMs created a solution to this expensive and time-consuming problem by establishing PRI as certification association with oversight of the aerospace supply chain so that one audit would satisfy all. Audit criteria were standardized, auditor credentials were established, audit findings were shared, corrective actions uniformly developed and implemented, and non-destructive testing methodologies were developed.



There were dramatic changes in the industry as a result of PRI's activities. The audit process was significantly improved and there were reduced supplier escapes from audits. The program has grown internationally to the point that over 4900 audits were conducted in 2009, with ~1/3 in Europe and ~1/10 in Asia. Over 50 different prime manufacturers are now working together and there was a noticeable culture change. While savings are no longer tracked, in the early years, General Electric (GE) noted $1 M on direct costs had been saved annually through PRI activities.

Panel Discussion: Don Schomer, Bayer MaterialScience LLC; Karen Edlin, DNRE; John Warner, Warner Babcock Institute; Rui Resendes, GreenCentre Canada; and Bill Wagner, PRI.

The Canadian model for the GCC has a relatively broad base, focused on chemistry suppliers. Generally automotive OEM's do not get involved in chemistry. The question was posed as to whether the model is applicable for the auto sector. Funding for the GCC is from three sources: Canadian federal government, Canadian provincial government (Ontario), and industry, amounting to $40 M/ 5years. With this funding, GCC is able to assume all initial costs and risks up front, which may be a unique feature in the technology transfer arena. Other possible models for a center is Auto 21—a network with similar funding to GCC also from the Canadian government, but with university research in partnership directly with industry (http://www.auto21.ca/en/index.php). Auto 21 focuses only on the auto industry, and has 200 industry partners, 45 universities, 540 graduate students, and 260 professors involved in projects with industry co-funding. There are no physical facilities and it is a virtual organization.

Karen Edlin of the Michigan DNRE noted that the Michigan Directive is searching for ideas for green centers and exploring what industry needs to implement green chemistry broadly. The State wants to be a partner in the solutions.

The Panel discussion noted that the auto industry may need to change focus—to date it has viewed itself as a manufacturer of things and does not focus on chemicals in its products, relying on its suppliers to do so. Market based-incentives may be necessary to change the industry. An example of such a change is in the Green Building Industry, when it established Leadership in Energy and Environmental Design (LEED) incentives.

B. Materials and Research and Development

Four areas were examined for the types and categories of information that should be considered for a center. In some cases, the topic presented could be directly incorporated into a center; in other cases, the types of information that would be useful and appropriate were presented from other industry sectors as examples.

The first area to be discussed for inclusion in a Center was Materials and Research and Development. Increasingly, materials in vehicles are being examined for many reasons—health and environment, cost, fuel efficiencies, resource limitations, and product end-of-life considerations. Research and development efforts can address the materials issues, as well as advancing new technologies. The presentations illustrated these issues through a sustainability lens, reviewing

supply chain issues and how to reduce costs, highlighting substances of concern that are manufactured into vehicles, and how cooperative research programs can address industry-wide problems in a resource and cost-efficient manner.

1. Optimizing Extended Supply Chains using Lean and Clean Assessments – William Stough, Sustainable Research Group (SRG)

With a definition of sustainability offered by Bill Stough (SRG), there is an opportunity to bring new perspectives to competitive markets:

- A sustainable business is one that adopts strategies and activities that allow the enterprise and its stakeholders to realize their profit goals in ways that protect, sustain, and restore earth's life support systems for future generations.

Using the principles of sustainable development as the macro-lens to view the company's operations and lean and green assessments as the "on-the-shop-floor" tool, Stough proposed that Michigan companies become a low cost option for advanced manufacturing. Lean and green assessment have been developed under the Green Suppliers Network (GSN), a collaborative venture among industry, the U.S. EPA, and the U.S. Department of Commerce's National Institute of Standards and Technology's Manufacturing Extension Partnership (NIST MEP), which provides technical assistance to manufacturers. GSN works with large manufacturers to engage their small and medium-sized suppliers in low-cost technical reviews that focus on process improvement and waste minimization. EPA provides program support and funding. The purpose of a GSN Assessment is to show through the assessment that lean and environment go hand-in-hand; to show the client the dollar savings of an integrated approach; and to train the client to conduct an assessment and to take action by creating current and future value stream maps.

SRG is working with furniture and automotive manufacturers and to date has completed over 40 Lean & Clean Assessments. Every supplier has a continuous improvement strategy; although generally not coordinated and there are not clear steps on how to integrate environmental and sustainable improvements into normal operational activities. SRG works with companies to assist them to include these steps in their assessments. The first step is to collect baseline environmental information over a one-year period:

- Energy data purchased;
- Water/sewer data, annual cost purchased;
- Emissions permits, list of liquid or hazardous waste permits and environmental reports submitted to environmental regulatory agencies;
- Hazardous waste costs;
- Trash, annual costs of trash disposal (solid waste);
- Chemicals, list of chemicals used on product line, or for operations and maintenance;
- Oils, purchased; and
- Recycling, list of all materials recycled; monthly volume and any revenue generated as a result of recycling.

From eleven of the first GSN assessments conducted at different small and medium-sized manufacturers, the overall average annual total savings from GSN Assessments has been ~$860K, ranging from ~$240K - ~$1400K. The average savings from the Green Assessment has been ~$200K, ranging from ~$28K - ~$550K. The average savings from the Lean Assessments has been ~$660K, ranging from ~$133K - ~$1200K. The key to these savings has come from the power of collaboration and the ability to share information and approaches by breaking down the silos between lean and environmental initiatives within the company.

Currently Detroit does not have a focal point for educating automotive suppliers about the business benefits of implementing sustainable development principles into their operations. A Green Technology Transfer Center could help

companies in the automotive supply chain profit by delivering sustainable growth solutions focused on eliminating waste and improving human and ecosystem health.

Stough suggested that SAE could work with automotive companies to train and develop qualified engineers and technicians to transfer sustainable business practices to the supply chain. SAE could further help prepare suppliers to compete in a market with higher cost raw materials and energy and with more restrictions on chemical materials.

2. Substances of Concern (SOC) – Chasing a Moving Target - Patricia Beattie, Arcalis Scientific

The key to determining if a material is green is an assessment of the health and environmental impacts of the chemicals that make up the material or product. The assessment is relevant for both the manufacturing process and the materials in the vehicle itself. Auto-sector companies primarily make this assessment by managing to lists of SOCs.

Regulatory drivers for SOCs started in the 1980's with the elimination of Chlorofluorocarbons, followed by the European Union End-of-life Vehicle Directive (2000), which restricted use of heavy metals (lead, cadmium, mercury, hexavalent chromium), and the EU Registration, Evaluation, and Authorization of Chemicals (REACH) Regulation (2006), which defined Substances of Very High Concern (SVHC).

The auto manufacturers developed individual lists of SOCs, which was inconsistent across companies, resulting in conflicting requests to Tier I Suppliers. Such individual OEM management of SOCs drove inefficiencies in the automotive supply chain. In 2000 the auto sector developed the International Material Data System (IMDS) to collect chemical data on parts as a global tool. IMDS includes over 70,000 suppliers and 25 million Material Data Sheets (MDSs). By 2005, the Global Automotive Declarable Substances List (GADSL) had been developed, which is updated annually and currently includes 139 categories (~2700 substances) prohibited and/or declarable in regulatory jurisdictions.

In 2007, Suppliers Partnership for the Environment (SP) initiated its Material Assessment Strategy (MAS) to develop a common screening process for assessing and prioritizing potential health and environmental impacts of substances in vehicle parts

Managing SOCs is of concern to all manufacturers as new lists are created and new substances are added to existing lists. For example, under the EU's REACH legislation, there are currently 29 substances on the SVHC Candidate List. It is updated twice/year and it is projected to eventually contain 200-300 substances. In another example, the proposed California Green Chemicals regulation identified 16 substances, 29 Lists of Lists, and approximately 10,000 SOCs. New global regulations are often focused on manufacturers of consumer products, not just chemical companies. It should be noted that vehicles are consumer products.

There is an evolution of SOCs that has been observed and which provides a strategic approach for enhancing the management of SOCs. Approximately 10 years before a chemical becomes an SOC, articles can be found in the scientific literature about the specific SOC and what its potential negative impact might be. As more articles appear in the literature, information begins to be shared in the media and public press, and finally regulators become involved. A role for an SAE Green Technology Center could be to provide a forum to develop a more strategic approach for managing SOCs. The current tactical approach of waiting for SOCs to be added to a list is unmanageable since decisions regarding materials that will be incorporated into vehicles are made 5 years before the material appears in a vehicle. The automotive industry has a wealth of data on materials and the Center could provide an initial focus on such materials. A proactive and predictive approach could be adopted in advance of regulations. The GADSL list (and others) could be prioritized to identify the substances that might be designed-out before they become restricted. Any of these efforts would decrease costs and increase efficiencies.

Beattie further noted that auto companies and suppliers do not have expertise in-house to develop a predictive SOC prioritization process, even while identification of SOCs will continue at an increasing pace. Establishing a common approach would reduce costs and improve efficiencies and accelerated assessment of substances through the MAS process would be a benefit. Such a program could be of interest to other industry sectors.

3. Model for Industry Collaboration - SAE Cooperative Research Program - Gary Pollak, SAE International

The SAE Cooperative Research Program (CRP) is a joint venture project management program where numerous organizations pool resources to study pre-competitive technical areas where results are shared by the participants. It allows industry organizations to share expertise, costs, and avoid duplication of efforts.

CRP was started in 1989 and has completed over 70 projects in the mobility sector, the majority of which are related to standards efforts. Projects have been initiated prior to the standards activity to acquire data, during standard development to test assumptions or performance levels, and post standard development to validate the standards or products made in the standards

SAE's role in a CRP is to

- Convene prospective partners for planning;
- Provide facilities and staff services for meetings;
- Provide a legal forum where industry can meet;
- Provide project management and coordination;
- Provide government contracting expertise;
- Take on the role of subcontractor administrator;
- Provide financial management for project funding and fiscal issues;
- Access SAE's mature and well-recognized information dissemination framework; and
- Ensure conformance to the National Cooperative Research Act.

A CRP has distinct characteristics. All participants must contribute financially and typically data generated in the project are proprietary to the funding partners. In some cases, the partners decide it is in their best interest to publically release the data and this can be accommodated by SAE's substantial and well-established information dissemination network. Funds can be a combination of government contracts and industry participation fees, but each project is a distinct joint venture. Currently there are 8 active CRPs, with 12-15 ongoing.

A noteworthy case study of a "green" CRP is SAE CRP 1234 Alternative Refrigerant Program. Over 35 global organizations (automotive OEMs and suppliers) participated in the joint venture of over $3 million in scope and effort. The phases of the project included health and environmental risk assessment, system efficiency, and material and chemical compatibility studies and testing.

The benefits of a CRP approach include

- Industry consensus;
- Elimination of duplicate testing;
- Understanding of both government and industry issues;
- Cooperative rather than adversarial;
- Technology developed to meet the spirit of the law, not just the letter of the law;
- Realistic government rule-making; and
- Achievable performance levels and timetables.

Panel Discussion: Clinton Boyd, Sustainable Research Group; William Stough, Sustainable Research Group; Patricia Beattie, Arcalis Scientific; Gary Pollak, SAE International

Boyd noted that Life Cycle Analysis (LCA) is critical to what is considered green. The LCA for a vehicle addresses both upstream and downstream issues and the pivotal position of manufacturing. The total environmental impact of a vehicle is locked in at the design stage so that applying "Design for the Environment" principles will be necessary to define green for the auto industry. He added that a center could focus on materials and green processes that would be biobased, bioavailable, and climate-neutral. It could include all attributes of materials, from sourcing, to materials flow in the industry, to recycling, reuse,

and disposal. As materials constraints and limitations grow for sources of key materials and components, and energy and transportation costs increase, a center could prepare regional companies to be ready for on-going and potentially drastic changes. The biggest cost savings could be realized through materials efficiencies.

A center could pull together the many and diverse "green" activities in which the auto industry is currently engaged. These activities are not coordinated or integrated or well-communicated.

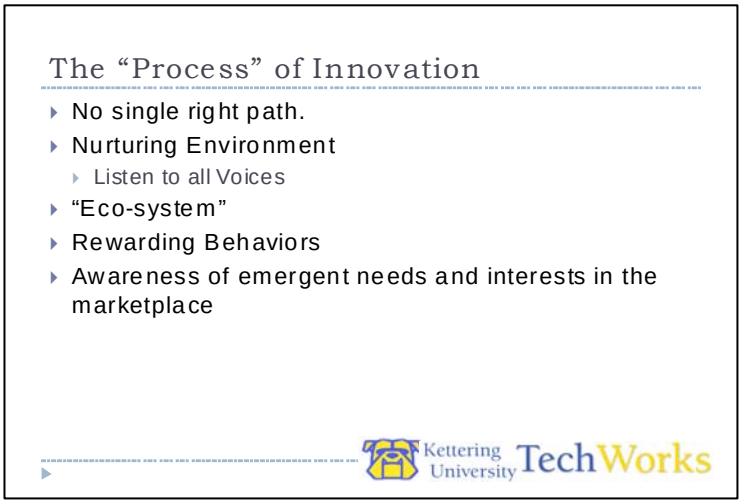
A workshop participant noted that small and medium enterprises (SMEs) have no environmental infrastructure and will not generally support fees for Lean & Green Assessments. Stough suggested that these companies still be included as all suppliers have continuous improvement programs and by including assessments in these efforts, potential of savings of 30% could be achieved through behavioral/cultural changes in the corporation. Additionally, the need for revolving loans for SME's was identified as a tool that could help and which could be supported through the State of Michigan, as are other revolving loan programs.

C. Technology Transfer & the Supply Chain

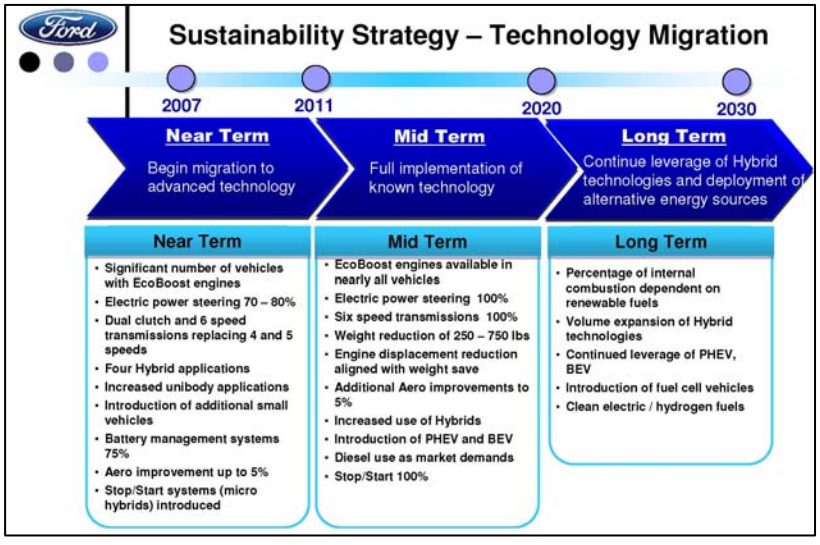
The business relationships between the automotive OEM's and their supply chains are complex and frequently difficult to understand or predict. Additionally, how the process of innovation is integrated into technology transfer is not well understood, frequently due to proprietary interests. Four viewpoints were presented in this session, with the first on the process of innovation and commercialization from the view-point of an engineering research university, followed by two OEMs' approaches to green and sustainable technology transfer, with a concluding presentation on what a center would have to do to be successful in the automotive arena.

1. Process of Innovation / Intellectual Property (IP) / Commercialization - Neil Sheridan, Kettering University

Kettering University routinely graduates more mechanical engineers than any other American university. It fosters innovation, entrepreneurship, and commercialization through its course work and industry partnerships. The innovation process for suppliers is complex and cumbersome because of the challenges associated with intellectual property and the commercialization processes. There is no single path for innovation success. The issues of IP and commercialization, that is, moving ideas to market, need to be addressed early in the process with competent legal assistance and commercialization experts.



2. Ford's Existing Technology Transfer Model - John Viera, Ford



Ford's plan to address climate change and energy independence includes a comprehensive strategy to increase fuel economy and reduce emissions through the migration of advanced technology that is affordable and attainable in high volumes. The rationale for the fuel economy and carbon dioxide (CO_2) strategy is that ~98% of Ford's carbon footprint is from emissions from the vehicles it sells. Ford will leverage global platforms to balance engine types and power sources from the present until 2030, utilizing gasoline engines, diesel engines, biofuel vehicles, hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV), battery electric vehicles (BEV), and eventually hydrogen fueled vehicles.

Ford will begin migration of new technologies such as hybrids over the near term (2010-2011), where fuel efficiencies could have big impacts. The Ecoboost engine technology is a key feature in the near-term, using direct gasoline injection and turbo charging, to provide increased fuel economy without loss in performance. In the mid-term (2011-2020), technologies such as electrification and lightweight materials, will be implemented. Standards will be needed for these technologies, but it is not yet known what fuel system will be used predominantly in the future. Every automaker is focusing on lightweight materials that are sustainable, renewable, recyclable, and affordable. Over the long-term (2020-2030), Ford will continue leverage of hybrid technologies and deployment of alternative energy sources. The key for future success in the market place will be an electric vehicle that can be mass-produced and sold.

It will be critical that these new technologies be affordable, with reasonable payback times. In addition, these new technologies have to be at least at parity in cost with less sustainable products. While these strategies are specific to Ford, all automakers have similar challenges. A Center could help automakers think about these strategies for the benefit of the entire industry.

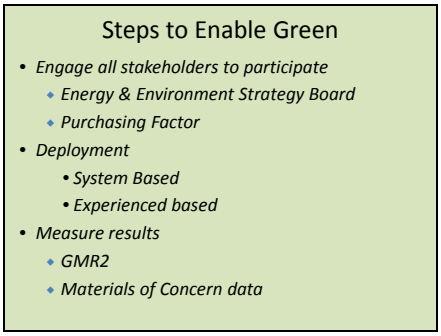
3. General Motor's (GM) Technology Transfer Methods - John Bradburn, GM

GM uses Design for the Environment (DfE) as a tool for green:

- The DfE mission is to integrate life-cycle type considerations into product development, material selection, manufacturing processes, in order to reduce product and facility impacts, minimize costs, as well as promote environmental sustainability.

Using DfE techniques, green projects can be deployed resulting in product or process design changes with cost, quality, human health, and environmental improvements realized. In addition to life cycle type considerations of materials, manufacturing processes, and output material control issues, external stakeholder needs must be aligned with corporate environmental principles and regulations, and vehicle program specific goals should be established.

GM has developed seven steps to enable green technologies.



Bradburn provided examples where this approach has been used within GM to achieve environmental and sustainability goals. In most cases, GM works directly with suppliers to develop technologies to achieve goals, such as converting or recovering waste materials.

- Landfill: Since 2005, GM has achieved 80% of its 2010 goal to be landfill free, with 58 global operations now landfill free out of 144.
- Waste: Since 2000, GM's progress toward total waste reduction has achieved a 41% decrease in waste, with 91% of all waste recycled.
- Vehicle Component Recovery: vehicle components with minor dents and scratches are sent to an outlet shop for the secondary market; the program serves all GM North American plants and selected dealerships. (SPO Outlet Shop, Grand Blanc, MI)
- Rolled Media Recycling: a significant contributor to the GM Powertrain machining industrial waste stream contains a mix of polymers, metals, and other materials. Most of this material is now reclaimed and recycled into various processes, preventing materials being sent to landfill. Waste Free is one of GM's recyclers and was represented at the workshop.
- Oil recycling: in 2009 GM recycled 19,000 tons of used oil in the US; in 2010, GM North America started converting all hydraulic oils and lubes to recycled products and saved ~ $300,000 based on 2008 volumes. General Oil Company, Livonia, MI, is working with GM on this program and was represented at the workshop.

- Purge Solvent Recycling: vehicle paint system purge solvent from GM assembly plants recycled for reuse. Gage Products, Ferndale, MI, is a service provider to GM for this technology.
- Converted cardboard and recycled textile fibers into non-woven substrates for use as acoustic materials; this eliminated waste at assembly plants. Federal Mogul's Quietshield was described as an example of this technology.

Today these systems-based approaches are needed since OEM's have reduced numbers of staff, as well as reduced levels of staff experience. With continued retirements and downsizing, there continues to be high levels of key staff turnover, along with increased pressure for results. Traditional methods of technology transfer relied on personal interactions and relationships, but these are not as effective as in the past. Because of this, a Center with a common agreed upon and utilized system could relieve some of the burden of daily activities in OEMs and suppliers and enable green innovation and creative thinking.

4. Green Ideas versus the Bottom Line Buyer/Decision Maker - Dave O'Ryan, Asset Recovery & Management Group

O'Ryan cautioned that before the feasibility of a Center for Green Innovation and Technology Transfer can be considered, it has to be recognized that new and green technologies have to be able to contribute to the bottom-line success of the companies. Costs are paramount to the internal OEM buyers and decision-makers.

The Center's roll would have to be taken very seriously by the automotive sector. The "buy- in" from the automotive sector and the OEM's in particular, will be the single most difficult item to obtain; harder than funding, harder than good ideas, and harder than willing participants.

What areas should a Center include? It should include both innovative products and their validation, and innovative processes and their validation.

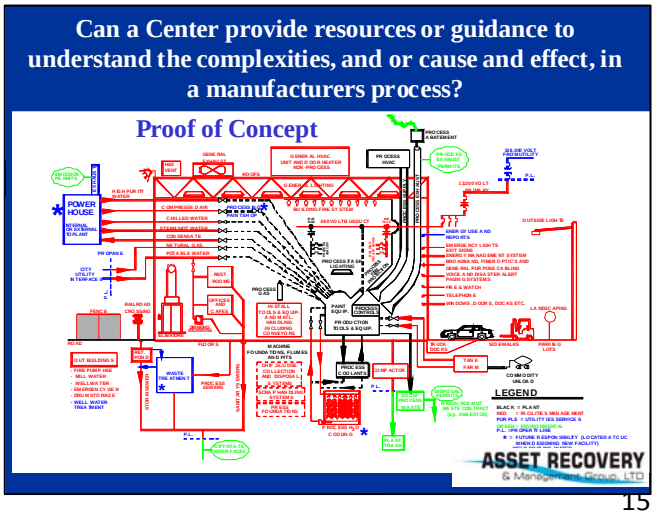
Could a Center facilitate industry-academic-government partnerships? If there is acceptance and "buy-in" from the automotive sector, the other sectors will have to cooperate. O'Ryan noted that it must be considered and managed as to how taking ideas and funding from existing organizations into a new organization will be viewed.

Can a Center have sufficient staff expertise in multiple areas? It would depend on the resources, but for a manufacturing example, staff expertise would have to include at least four major areas:

- Environmental Impacts:
- Operations
- Finance
- Facility Design

Could a Center foster green technology in the automotive sector? Yes, if the Center is a think-tank-type that could facilitate existing and future green innovation concepts, staffed with resources to coach/mentor companies and individuals in transferring the technology to a willing automotive audience.

Could a Center influence or streamline the automotive industries traditional practice of wanting facts, details, and data to support innovation? In reality it takes considerable time, people, and funding to create and validate products and processes. Expectations of the market to "change course" and embrace new solutions in a short period of time is at times naïve.



The proof of concept for a Center will be to determine whether it can provide resources or guidance to understand the complexities, and/or cause and effects, in the automotive manufacturing process.

Can a Center prepare inventors, investors, and entrepreneurs to understand that the automotive industry does not take single paths in any technology? The industry has to "hedge bets" and maintain flexibility as new technologies are developed and

deployed and new fuels and power sources are introduced. Water-based and powdered-based paints are examples of different technologies for the same endpoint.

Can a Center provide resources or guidance to manage the realities of the cost issues? Auto plants want lower operating costs, lower labor costs, lower energy costs, yet more robust designs and better quality. Can these be achieved? Will the Center be able to teach and increase understanding of industry costs and address capital costs versus operating costs? Will a Center be able to help value engineer-design advantages?

Lastly, the role of the State of Michigan in a Center is not clear. There are currently at least 13 business incubators or accelerators in the state. How would a Center for the automotive industry be integrated or supported in comparison with these existing efforts?

5. Stephen Ranzini, University Bank

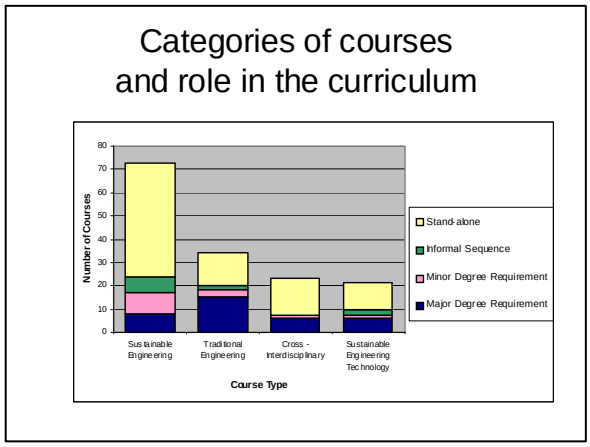
A National Institute for Green Chemistry Research has been proposed for an Ann Arbor location, with a consortium of 20 organizations. Among the reasons to support such an effort are a number of factors specific to Ann Arbor including the availability of 2,000,000 square feet of wet lab and a state of the art Kilo Lab facility in space formerly occupied by Pfizer; the headquarters of MichBio and the many local bio-tech firms including many started by ex-Pfizer employees; The Ecology Center; NSF International, which is developing a Greener Chemistry Standard; the National Center for Manufacturing Sciences, which is the national center for manufacturing R&D excellence; the presence and participation of the University of Michigan; and low cost labor. Ranzini's vision is that the Institute focus would include toxicology testing of new and existing chemicals, green chemistry consulting services including analysis of product processes to optimize design according to Green Chemistry Principles and bankable feasibility studies including small scale manufacturing test runs for new greener production processes, a commercial production incubator of industrial sites leveraging existing chemical manufacturing facilities offered by Dow Chemical and others, educational components leveraging the state's extensive distance learning resources, and a venture capital fund to support green chemistry related entities and to commercialize new technologies spun out of the National Institute for Green Chemistry Research and its associated entities.

D. Education / Re-Training / Workforce Needs

In considering whether a Center should have an education, retraining, and workforce needs element, examples of existing and on-going programs were presented. The first presentation examined a report on how engineering programs around the US are implementing sustainability into curricula. The second presentation highlighted how one company created programs to engage their workforce in programs to protect the environment and enhance their bottom-line. The third presentation described the impact of a single course in environmentally conscious design and manufacturing and steps taken to transition to greening the curriculum.

1. Benchmarking Sustainable Engineering Education – David Allen, University of Texas

A survey of sustainable engineering programs in the US was carried out in 2008 under support by the US Environmental Protection Agency. Benchmarking Sustainable Engineering Education (BSEE) is the report from the survey. Over 1500 department chairs and program heads were contacted in the benchmarking process, with a response rate of 75%.



More than 350 sustainable engineering faculty champions were identified through the survey and over 155 sustainability courses were described. The categories of the course and role in the curriculum were described. There were four major course types: sustainable engineering, traditional engineering, cross-interdisciplinary, and sustainable engineering technology.

In general, upper level undergraduate and graduate students take the sustainability courses. The courses are likely stand-alone and not part of a formal sequence at this stage.

An example of categorization of course content was provided for the automobile, starting at its most focused and progressing to a broader focus:

- The automobile subsystem, e.g., engine, paint;
- The automobile, e.g., manufacture, use, recycle;
- Infrastructure technologies, e.g., built infrastructure (highways) and supply infrastructure (petroleum industry); and
- Social structure, e.g., dispersed communities and businesses, malls.

While there is a wide range of course content, there are common elements in the courses, including life cycle methods, green materials, recycling and reuse, and integration into product and process design.
Allen concluded that sustainability concepts are being accepted widely into engineering programs, with 80% of the top 100 engineering programs having at least one course.

2. Creating Workforce Engagement through Education, Training and Communication – David Rinard, Steelcase

About 15 years ago, Steelcase realized that some its environmental progress was reaching a plateau and as they set out to find out why, they found that they were not actively engaging their employees as well as they could. Steelcase set new and more aggressive business and environmental goals and then began a very focused campaign to create engagement with their work force, making sure they linked efficient use of resource, costs, and environmental impacts, so that the goals were linked to business drivers. They created company programs and engaged their workforce through education, training, and communication to achieve these dual, aggressive goals. Rinard outlined the lessons Steelcase learned.

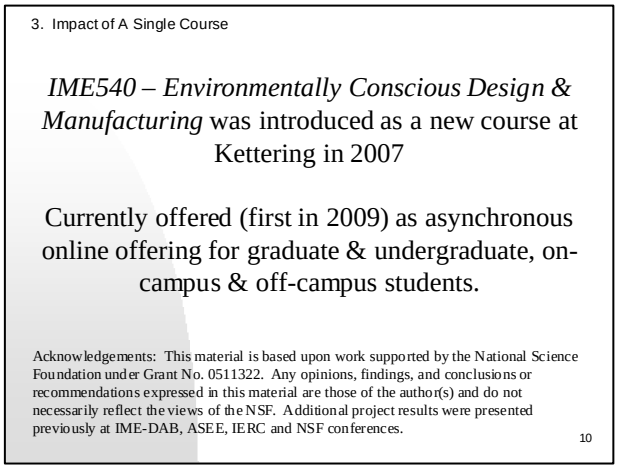
Corporate initiatives in sustainability need to connect with business drivers and to relate to employee values in order to achieve business goals. In order to succeed, there is the need to break stereotypes in environmentalism and connect to business performance and results. An effective tool to do this is to survey employees to determine their values, why they value it, what they are doing about it, and do they connect it with their job. It is important to make connections to what employees know—not develop a new message. Rinard advised to keep the message simple, make it frequent, avoid marketing buzz words, avoid the message of fear and hopelessness, seek opportunity to innovate, and have some fun!

An example of successful sustainability and business performance for Steelcase is the reduction in Green House Gas (GHG) emissions. Starting in 2006, the goal of 25% reduction in GHG emissions was set for 2012. With employee engagement, they have achieved a 42% reduction by 2009.

Steelcase's overall message is Small Green Steps and to Think Big. Start Small. Begin Now.

3. From Single Course to Greening the Curriculum - Terri Lynch-Caris, Kettering University

Sustainability is at the intersection of economic, social, and environmental values, the so-called triple bottom line. Sustainable engineering is defined as engineering for human development…."that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Bruntland Commission 1987)



Currently educational learning objectives related to environmental sustainability are found in environmental engineering programs. The current workforce is not trained in sustainability or environmental engineering, although these are becoming part of the core curriculum.

An example of the impact of a single course was presented from Kettering University, where the course was introduced in 2007. The course, Environmentally Conscious Design & Manufacturing, is currently offered (2009) online for graduates and undergraduates, on-campus and off-campus. The course has multidisciplinary

content and covers the historical and ethical issues associated with sustainability, design, and manufacturing; green chemistry; life cycle analysis; business; end of life; manufacturing process design; and material selection. Students work in groups and re-design products throughout the course. They use quantitative metrics to select materials for the re-design and the re-designed product has to be profitable.

Using the multidisciplinary content from this one course, flexible modules could be developed into a Senior Design Project that incorporates a life cycle analysis module. A Professional Certification Course could be developed incorporating business, manufacturing process design, and life cycle analysis modules.

Kettering is mapping core courses to sustainable concepts and the modules allow integration and flexibility. Topic level, type of learning material, and time required for instruction can be tailored to the user. Lynch-Caris noted that through collaboration with multiple educational institutions, sustainability concepts could be integrated throughout the engineering curricula. Currently Kettering University, Michigan Tech University, Purdue University, and Delta College are participating in a collaborative educational partnership.

4. Guy Williams, G.O. Williams & Associates, Michigan Green Chemistry Roundtable.

Environmental justice is concerned with the environmental impact on disadvantaged communities. Thus, there is a need to focus on green jobs and education at all levels of the workforce and community. There are numerous community impacts involved in going green. Green chemistry with training and education has the potential to create new green jobs and potentially blue-collar green jobs. To date, the federal focus and funding has been on climate change and energy efficiency, not on autos and retraining. There is a new approach in Michigan 2011: Institute for Innovative Industries, which offers a certificate for an environmental technician. In addition, there are many organizations that can help with workforce issues: Corporation for a Skilled Workforce, Michigan Academy for Green Mobility through the Michigan Department of Labor and Economic Growth, MichiganWorks, Goodwill Industries, and Acquinas College Courses.

E. Principles, Standards and Regulatory Trends

1. Emerging Trends in Regulations/Standards in the Automotive Industry-Tom Murray, EPA

In 2010, the EPA Administrator's key themes are climate change, improving air quality, assuring the safety of chemicals, protecting America's waters, cleaning up our communities, environmentalism and environmental justice, and strong state and tribal partnerships. Within each of these themes, are regulatory priorities and issues that are beyond regulatory. EPA's priorities impact the automotive industry in many ways.

For example, within the regulatory approaches, including potential legislation for climate change, all of the issues are important and critical to the automotive industry: endangerment finding for carbon dioxide, Green House Gas emission standards, fuel economy standards, and renewable fuel standards. Beyond the regulatory approach, life cycle impacts are being examined through the supply chain, in manufacturing, in product use, and in retirement of products.

The priority of improving air quality will also be important to the auto sector, both for manufacturers and parts suppliers, but also for raw materials and energy products. The priority of assuring the safety of chemicals will impact beyond the chemical industry to their customers, which includes the auto sector. Regulations may be expanded, especially the Toxic Substances Control Act (TSCA), requiring firms to track chemical substances during manufacture, processing, distribution in commerce, use, or disposal, or any combination of these for chemicals that may present unreasonable risk of injury to health or environment. If there is unreasonable risk, substances may be prohibited or banned. The Principles for Reform for TSCA reauthorization include sound science and risk-based criteria, adequate information from manufacturers, consideration of sensitive populations, consideration of substitutions, timely action, and promotion of green chemistry.

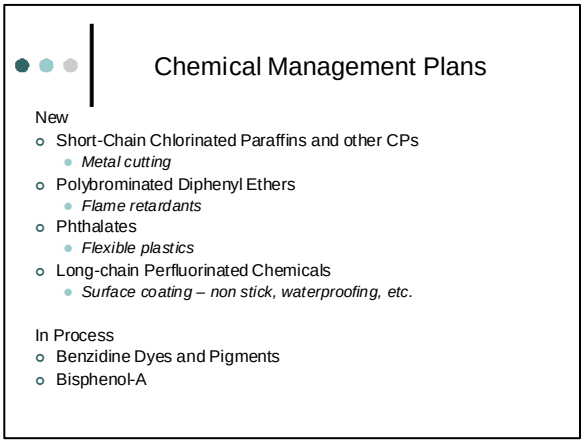
Chemical management plans are being developed for a specific list of high priority chemicals, many of which are used in the automotive industry. For example, short-chain chlorinated paraffins (CP) and other CP's are used in metal cutting. Polybrominated diphenyl ethers are used as flame retardants. Phthalates are used in flexible plastics. Long-chain perfluorinated chemicals are used in surface coating to be non-stick and for waterproofing. Other substances in progress for developing chemical management plans are benzidine dyes and pigments and bisphenol-A.

EPA's Research Priorities address endocrine disruptors, nanotechnology, and emerging contaminants of concern.

On April 23, 2010, Earth Day, the name of the Office of Pesticides and Pollution Prevention will be changed to the Office of Chemical Safety and Pollution Prevention, emphasizing the focus and priority for assuring chemical safety.

Murray noted that the concept for a Center is excellent and would help address many of these issues, but practical challenges are great. Green has to be part of a business case and the larger issue of sustainability.

At the federal level, many agencies are involved in sustainability: Environmental Protection Agency (EPA), Department of Energy (DOE), Department of Labor (DOL), Small Business Administration (SBA), Department of Commerce (DOC), so that the environment has to be considered in the context of sustainability. A federal, cross-agency group meets monthly to focus on Small to Medium Enterprises (SMEs) and sustainability. A Center could increase the conversation among these diverse groups and broaden the dialogue to incorporate green jobs (DOL) and loan programs (SBA). DOC initiated CommerceConnect in Detroit for one stop information about DOC initiatives to make businesses more competitive and create jobs. CommerceConnect will assist business's needs—such as access to capital, intellectual property protection, export promotion or guidance on how to make operations more efficient.



Murray suggested that a few key items be examined before going forward with a center: what are the goals, what problem are we trying to address, why is this needed, and who else, if anyone, is doing some or all of this. A center could incorporate topics related to EPA's priorities of cleaning up communities, environmentalism and environmental justice, and state & tribal partnerships. It could include topics for the future such as the green economy for jobs, products, and energy; sustainable clean up and green brownfields; smart growth and transportation; the Green Suppliers Network, and E3—economy-energy-environment. A center could be an opportunity for Detroit and Michigan.

2. Emerging issues around green standards - Clinton Boyd, Sustainable Research Group

The key to a center is determining what it can do for the automotive industry. Standards development is the most likely place to start. The demand is there, but have to first establish what makes a product green.

The demand for green products is driven by regulatory issues, procurement programs, bid-specifications, eco-labels, certifications and standards. So what is "green" and what makes a product green?

- The concept of green is related to the size of the environmental footprint of a product, i.e., the degree to which a product has a negative impact on human health and ecosystems.

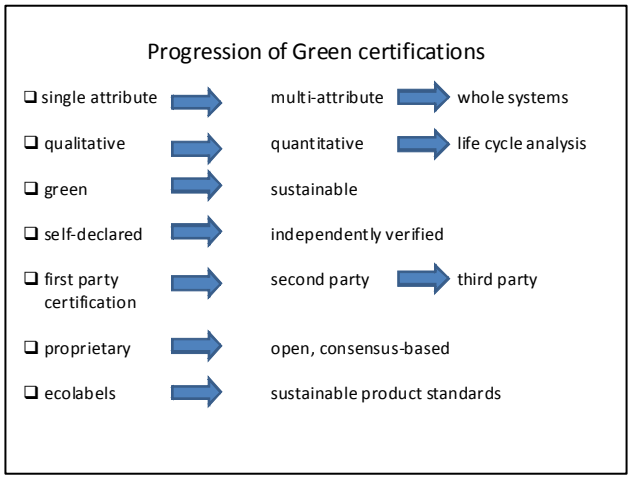
Green is a relative term, with additional terms such as "greener" and "greenness" being used to describe the field. Thus, there is a need to standardize definitions and the scope of green, measurements of green, and communication of green. There is a progression of green certifications from single attributes to sustainable product standards.

There are many green standards currently in development or developed. These are environmental issue-specific, product-specific, and industry-specific. Two examples of environmental issue-specific standards are the "Specification for the assessment of the life cycle greenhouse gas emissions of goods and services" (BSI PAS 2050) prepared by BSI British Standards and an ISO Standard in draft form for a Product Carbon Footprint. Environmental standards, using the terms sustainable or green or greener, have been developed for many products or industries, including buildings, carpets, cleaning products, electronics, office furniture, packaging, resilient floor coverings, textiles, and wood and composite wood.

With such a diversity of standards and the growing demand for green or sustainable products, environmental marketing claims have proliferated. The Federal Trade Commission (FTC) has established "Guides for the Use of Environmental Marketing Claims", with such claims defined as a product label or other marketing communications that make a claim regarding the environmental performance of a product or service. These "Green Guides" are currently under review to address a new wave of claims regarding carbon neutral (carbon offsets), renewable energy credits, sustainable, renewable, and claims based on life cycle.

An ISO standard for Environmental Labeling (ISO 14020) identifies three types of eco-labels, with Type III defining Environmental Product Declaration (EPD). EPD's must be based on life cycle stages and impacts and be quantified in accordance with ISO 14040 series for Life Cycle Analysis; must be informative, with no statement or claim of "environmental quality" or "environmental superiority"; must be independently verified (business to business), or third-

party verified (business to consumer), and must adhere to ISO 14025 for Type III environmental declarations. The ISO/TC 207/SC 3 N284 Guidelines for Making and Assessing Environmental Claims was recently released to address these issues.



In general, all of these standards are attempting to define what green is and how to measure it. Many industries are addressing the same issues and there are many commonalities across these efforts. It will be necessary to figure out what is needed specifically for the automotive industry. Of concern is the development of Product Category Rules (PCR), which are a specific set of rules, requirements and guidelines for developing Type III environmental product declarations (EPD) for one or more product categories. The possible impact on the auto-industry is for PCRs to be developed without their input, for example PCRs for key auto materials and components, PCRs for automobiles, and PCRs for transportation equipment and systems. In addition, the US Department of Agriculture (USDA) BioPreferred Program is currently seeking comment on development of guidelines for the designation and voluntary labeling of biobased content of complex assemblies, including automobiles.

Boyd posed the question of what group or groups are representing or making decisions for the automotive industry in the development of these rules programs?

3. Example of leadership practices working with industry to be proactive and ahead of regulations - John Warner, Warner Babcock Institute

To make progress to reduce hazards and foster green chemistry, Warner counseled that we must allow an evolution to take place. It will be an incremental process as everything can't be done at once. Warner advised starting with small pieces that can be done now. Products may not be able to meet standards, but still have to get started and develop standards. Recognize the aspirational goals of moving to green chemistry and sustainability, but balance those against practical goals. Collaboration is essential between academia and industry, even though there is a disconnect between what is taught and what is practiced, and there is the concern that academia does not value industry funding, primarily because the incentives are different in academia and industry. We need to bridge this gap. For a Center, be mindful of the common ground and recognize opportunities to take even a little hazard out of a product or process.

Panel Discussion: Bill Hill, retired - General Motors and Chair, SAE Interior Climate Control Committee; Kyle Williams, Bosch; Andy Hobbs, Ford.

Hill noted that global cooperation from OEM's from India, China, Korea, Japan, Europe, and the United States was achieved for the SAE standard that will be used for the new automotive refrigerant. The Cooperative Research Program examined the total impact of the refrigerant on the environment for the safety and risk standard. Regulations are the drivers for such standards, in this case regulations from Europe, and the next level of regulation will be concerned with the energy impact and energy consumption of the car.

Williams noted that the auto industry is driven by regulations, including corporate average fuel economy standards. Fuel economy is being used to reduce CO_2 emissions, since vehicle emissions are 98% of carbon footprint for the auto sector.

Hobbs commented that the impact of the car is bigger than what it takes to make it. In these difficult economic times, with reduced OEM staff and areas of expertise diminished, a center could pull the industry together.

Overall, the panel indicated a need for a wider inter-disciplinary focus that would include information from emerging areas such as nanotechnologies and training and education materials for writing multi-attribute standards. While a center could be helpful with these efforts, the scope of a center has to be determined and how it would be funded.

F. Summary Steering Committee and Audience Discussion

Information in Table 1 was assembled from the final discussion session of the workshop. The themes, concerns, and observations are independent of each other and were used to categorize a wide variety of comments.

Table 1 Summary of Steering Committee and Audience Discussion

Themes	Concerns	Observations
Green technologies • Desired, but not at extra cost	Need to define scope for activities before any decision on center;	Key for autos is to recognize green is an issue;
Coordination/Cooperation • State, federal, global industry	Need feedback from the auto industry about what is needed; What is • Industry commitment • Industry funding;	Standardization was a key to all four workshop sessions;
Communication/language • Definitions • Scope for activities • Information exchange	Need achievable and practical goals;	State of Michigan will follow auto activities for lesson to be learned for the larger/broader Green Chemistry Center for Michigan;
Education • Limiting factor • Need at all levels, especially for executives, purchasing, finance staff	Local versus global issues • Cultural changes that occur with acquisitions (e.g., Chrysler-Mercedes-Daimler now Fiat);	Explore Lessons learned • USCAR[1], OESA[2] • Other centers, other networks • Economies of scale;
Standards • Bridge gaps with existing activities • Certification • Metrics • Cost reduction	Using laboratory facilities for technology validation, rather than toxicology testing; better to use labs for Supplier One-stop technology demonstration for OEMs;	Need success stories • Identify "non-controversial" topics to get started • Speed and simplicity to start;
Pre-competitive environment • Facilitates industry working together	Need more engagement with groups outside the auto industry;	Consider what a center would look like in 2020;
Develop goals • Short, medium, long-term • Customers, contributors, funders	Must keep the momentum from the workshop going.	Don't be afraid to try something and don't be afraid to fail.

[1]USCAR: United States Council for Automotive Research; www.uscar.org

[2]OESA: Original Equipment Suppliers Association; www.oesa.org

III. Summary of the Survey

Following the conclusion of the workshop, participants were asked to complete a survey about the workshop, as well as their views on green engineering, technology transfer and "green practices." About half of the 70 participants responded to the survey. The full results will be available online in the near future. The following is a summary of the survey results.

1. What are your views on a green engineering and technology transfer center?

   The concept of a center was well received; however, there are items that need further discussion. The first item would be to define green and what green means to the automotive sector. Second, identify a mission, scope, goals and deliverables for a center. It was suggested that a center would be most useful if it does not reaffirm the status quo, but would focus on hazard reduction, encourage continuous improvement and cutting edge design changes to make the industry a global leader. A critical issue would be obtaining support from the global Original Equipment Manufacturers (OEMs) community.

2. What areas should be included in a center? List the areas.

   In general, without first establishing a mission and vision for a center, all areas covered by the workshop were recommended for inclusion in a center, with standards, materials, research and development and education emphasized. Pre-competitive research and development were highlighted as important so that OEMs could more easily work together.

3. Could a center facilitate industry-academic –government partnerships?

   All respondents agreed that a center could bring together these important groups to create partnerships that focus on green industry issues. However, a high priority will be to obtain OEM support.

4. Could a center foster green technology in the automotive industry?

   All respondents agreed that a center could foster green technology in the automotive industry. There was a wide range of responses as to how, with OEM involvement seen as critical. A few respondents suggested that a center not be industry-specific. Other issues identified for a center for the automotive industry were the importance of including purchasing agents to support green technology, sharing best practices, and preventing intellectual property issues from becoming an obstacle. Through collaboration, standardization and anticipation of regulations, a center could provide a forum for communication and exchange of ideas.

5. What is the single most important action that would help advance the implementation of green chemistry and green engineering education?

   Several suggestions were made, including defining green chemistry and engineering for the automotive industry, requiring green chemistry and engineering training courses at universities, defining metrics for the benefits of green technology, finding the right stakeholders, gaining OEM and supply chain support. Determining funding for a center would be a vital factor.

6. What is the most important aspect of green to you?

   All four areas from the workshop were rated important, with materials and research and development leading the way. In addition to the workshop areas, business development and jobs were listed as important.

	1st Choice	2nd Choice	3rd Choice	4th Choice
Materials and R&D	9	2	1	4
Technology Transfer	6	7	0	1
Education	5	2	4	4
Principles, Standards and Regulatory Trends	5	1	7	3

7. Does your organization currently make use of green practices or are you looking for further information on how to become green?

   Over 70% of the respondents answered yes to this question, indicating that many companies have implemented some type of green initiative within their organization. However, many are still looking for more ways to be green and cost effective.

8. What new skills or knowledge do you need to perform green efforts/activities?

   While a wide range of responses were made to this question, the most consistent response was education; whether employee education, or education on how to provide cost effective alternatives, how to evaluate new chemical impacts, how to use tools such as life cycle analysis, or how environmental regulations impact vehicle materials.

9. What barriers, if any, stand in the way of implementing green practices at your organization? Would a center help your organization be successful?

   A wide range or responses were made to this question, but cost and the perception that green always costs more was the most frequent barrier identified. A center could show examples of successes and expand green efforts. It was noted there is a lack of understanding from leadership about the benefits of a green approach and a center might be able to provide more people and businesses information that they currently do not have.

10. Any additional comments regarding this workshop?

    Respondents indicated that workshop provided an excellent exchange of ideas, bringing a diversity of presenters and key industry people together. Respondents stressed that critical steps are to define what green means, define the scope and goals for a center, and gain stakeholder buy-in and commitment. Next steps should be implemented quickly to maintain momentum.

IV. Conclusions and Recommendations

A. Introduction

The enthusiastic response from the attendees to this workshop was gratifying to SAE and the Steering Committee. It highlighted that the automotive industry is seeking green innovation, but that there is uncertainty about how to approach this concept and implement change.

The purpose of the workshop was to explore the feasibility of establishing a center for green innovation and technology transfer for the automotive industry in Michigan. SAE originally proposed this concept to the State of Michigan because it brought together several important and challenging concepts and topics for the automotive industry, but for which no consensus or agreed upon pathway had been decided.

Thus, the workshop was a first step in a process to determine the concepts of green and whether a Center for Green Innovation and Technology Transfer for the Automotive Industry in Michigan would have utility and value. The issue was not so much a center per se, but the elements that could be brought together under a center to achieve improved environmental performance and cost reduction for the industry.

Three significant observations were made during the workshop discussions. In seeking green innovation for the automotive industry:

- A center could be one means to achieve the goal of green innovation;
- Other approaches could also achieve the goal of green innovation through leverage of other resources or organizations or existing centers; and/or
- A network of interested individuals and practitioners could be established to further explore and refine these issues and concepts.

Whatever approach is taken, developing definitions and scope for green innovation, green chemistry, green engineering in the automotive industry will be critical, as will developing goals and a plan for achieving a greener auto sector. Additional information and background materials from the workshop may be found in the electronic Appendices http://www.sae.org/events/green

Appendix A About SAE and the Michigan Department of Natural Resources and Environment

Appendix B Bios for Steering Committee Members, Speakers, and Panel Members

Appendix C Final Workshop Agenda

Appendix D Survey Results

Appendix E Additional Resource Information (reference list with links)

Appendix G Videotape of Workshop Presentations (*coming soon*)

Appendix H SAE Press Release

From the workshop discussions and results from the survey, the Steering Committee has made the following Conclusions and Recommendations.

B. Workshop Conclusions Endorsed by the Steering Committee

- The concept of a Center for Green Innovation and Technology Transfer was strongly supported by the workshop attendees, understanding that:
    - The mission, scope, governance, and funding have to be determined;
    - Support from OEMs and suppliers is the most critical element for any action in this arena;
    - Language, terminology, and definitions must be articulated for green, greener, green chemistry and engineering and what these mean for the auto sector;
    - The areas examined by the workshop were all important:
        - Materials and Research and Development; Technology Transfer; Education, Re-training, and Workforce Needs; and Principles, Standards, and Regulatory Trends.

        - Standards, materials, and education were first priority, but there was also a wide diversity of other suggestions, indicating a broad need. However, there was also concern that standards and regulations might discourage potential innovation and solutions.
        - Business development and job creation were also seen as important.
        - Approaches for making the four areas work toward common goals would be important; for example, R&D could work toward job creation.
    - To facilitate industry collaboration, a pre-competitive environment for research and technologies was recommended.

- The key to any approach is that the automotive industry has to recognize that green is an issue and has the potential to benefit the industry overall;

    - The first step is to define green for the industry;
    - A collaborative framework will be critical to achieve agreement on what green means for the auto sector and eliminate duplication of effort;
    - Industry feedback will be critical as to what is needed.

- A business case or roadmap for green innovation should be developed for the auto sector, either through establishment of a new center or through leveraging existing centers, organizations, or networks. The information presented in Table 2 can be used to leverage activities and facilitate initial collaborations.

Many of the attendees encouraged SAE to take a lead role in the next steps for achieving green innovation goals, however these goals might be defined in the future.

C. Steering Committee Recommendations

In response to the recommendations from the workshop attendees and with endorsement from the workshop Steering Committee, SAE has initiated the following actions over the next six months, using existing SAE infrastructure to continue efforts to establish a green innovation center. SAE issued a media press release following the workshop.

1. SAE's Organizational Structure to Support Standards Development

One of SAE's core competencies is the development of consensus-based industry standards. SAE can immediately begin the process of creating industry standards as recognized during the workshop.

As a first action, SAE has formed a Green Technology Systems Group to serve as a nucleus body for standardization for all environmental, sustainability and green issues.

The SAE process takes the concept of new standards ideas through the respective standards Council for approval. In this scenario, the SAE Motor Vehicle Council would be the approving body for standards related to green technologies. Once the concept is approved by the Council, SAE will do a call for experts to obtain additional expertise to the existing Green Technology Steering Committee members used for this workshop. The current Steering Committee members have agreed to continue to serve on this new group.

The Green Technology Systems Group will review existing standards and begin discussing new standards that need to be created. Task forces will be created with experts for the specific task at hand. Three topics for new standards have been identified as a result of the workshop discussions: Terminology, Definitions, and Best Practices. In addition, an inventory of existing standards will be reviewed and assembled in the context of green innovation. Specifically, Green House Gas emissions have been noted as areas where SAE could immediately begin the standardization process.

Once a task force drafts a document, it will follow SAE's consensus based two-level balloting for approval. After approval of the document, it can then proceed to publication and becomes a new industry standard.

The Steering Committee noted that while the Green Chemistry Principles (Green Chemistry: Theory and Practice, Paul T. Anastas and John C. Warner. Oxford, UK: Oxford University Press, 1998) are important as guidance for best practices, the principles cannot be transformed into standards.

2. SAE's Organizational Structure to Support Materials Research

The topic of Materials in vehicles was strongly recommended as an element for inclusion in the Center by the workshop attendees. It is proposed to organize a workshop in the next 6 months to focus on automotive vehicle materials to develop a strategy and plan for greener and more sustainable automotive vehicle materials. Recommendations for tools to assess materials included the principles of green chemistry and engineering, life-cycle approaches, Design for the Environment principles, assessing human and health impacts of materials and managing lists of Substances of Concern. Other important topics to include are 1) approaches and practices for light-weighting of vehicles, 2) a business case for materials in the design cycle, and 3) purchasing practices and integration into green and sustainable approaches.

A Steering Committee would be needed for this workshop, with the approach similar to that taken for the current SAE-MI workshop. A funding plan would have to be developed, as there is no other support for this at the present time.

3. SAE's Organizational Structure to Support Professional Development and Potential Professional Certification

SAE and Kettering University will follow up on several suggestions from the workshop regarding integrating green and sustainability concepts into professional development courses, with the goal of establishing a professional certification process for green and sustainable engineering practices. In addition, SAE videotaped the workshop presentations. SAE will post the edited tape on the SAE website to make available to those who could not attend the workshop (www.sae.org).

- The Steering Committee recommends that SAE evaluate its action plan and their outcomes within the next 6-12 months to determine the impact and support for green innovation activities.

- To assist SAE in focusing green innovation activities over the next few months, the Steering Committee recommends a virtual network be established, focused on OEMs and suppliers, with such have activities to have a plan for to be self-sustainable over time. Further the Steering Committee recommends a general mission statement for these first generation activities:

  "To become a network of green innovation for global automotive stakeholders."

- To keep the momentum from the workshop going, the Steering Committee suggests SAE

  - Prepare progress reports about its activities periodically;
    - Examples: press releases, summary of the survey, workshop report, announcements of Motor Vehicle Council actions, Green Technology Systems Group charter; synopsis of Presidential Green Chemistry Awards in the auto sector;
  - Establish a website for SAE's Green Innovation Actions; and
  - Link to Michigan DNRE green chemistry website.

- One result of the workshop was to recognize the wide diversity of current "green" and sustainable practices currently implemented in the auto sector, and to further recognize the lack of awareness of these green activities either within or outside the auto sector.

- A communication plan should be developed to enable discussions with other groups, including the wider auto industry, similar centers and organizations, as well as legislative and executive branches of state and local governments.

- The Steering Committee recommends reassessment of the needs for green innovation in the auto sector after these initial activities. If these are successful and supported by the industry, it will be clearer whether a center or collaboration with existing organizations, or a virtual network, would be the most practical, effective, cost-efficient means to implement green innovation in the auto sector.

Table 2 Comparative Features of Existing Centers or Networks

Center	Governance/Funding	Purpose	Client Sector	Comments	Topics Covered
Warner Babcock Institute, www.warnerbabcock.com	For-profit/Private sector	Define what society needs	Not industry specific	Physical facility/ laboratories	Materials & R&D Tech transfer; supply chain[1]
GreenCentre Canada, www.greencentrecanada.com	Not-for-profit / public & private; federal government of Canada and state of Ontario	Bridge gap between commercialization of green chemistry technologies and industry	Academic chemistry and specific industry sectors;	Physical facility / laboratories	Materials & R&D Tech transfer; supply chain
PRI; www.pri-network.org	Not-for-profit/private sector	Provide program and services to improve manufacturing process and product quality	Aerospace and mobility industry	No laboratories	Tech transfer & Supply chain Regulatory trends and Standards

Other Centers Suggested for Consideration during the Workshop

Center	Governance/Funding	Purpose	Client Sector	Comments	Topics Covered
Auto 21; www.auto21.ca./en/index.php	Not-for-profit/public and private; federal government of Canada and some states; Industry co-funding;		University research partnerships with auto industry	Virtual organization	Materials & R&D
New York Pollution Prevention Institute (NYP2I); www.nysp2i.rit.edu	Not-for-profit; New York State funded; partnership of four universities and ten regional development centers;	To provide a state-wide, comprehensive and integrated program of aimed at making New York State more sustainable	Not industry specific	Virtual organization and physical facilities / laboratories through the partnership organizations	R&D, Diffusion; Technical Assistance; Community Grants Programs; Training, Education and Outreach; Info Exchange
GreeningDetroit.com, a private sector network; www.greeningofdetroit.com	A resource for businesses and individuals across the Metro Detroit region. Endorsed by the City of Detroit. Private sector funded.	To provide a website which includes suppliers of green products and services, along with successful organizations, governments, schools, and informational resources – in support of creating an environmentally sound future for our communities.	Commercial & industrial buildings; green homes; metro communities	Participating advertisers provide info and resources to help consumers make smart, environmentally conscious decisions about greening their environments – in their homes or businesses, manufacturing facilities or community centers	Product & Service Directories

[1] Supply chain: suppliers