SAE International Automation/Autonomy Update

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Background
Last year, SAE International hosted 2 workshops, which identified the current state of the industry and its needs to realize autonomy/full automation.

May 30, 2018 Silicon Valley: Representatives from both the automotive and aerospace sectors leverage the cross-sector expertise sharing their experiences on automation. *What would help aerospace in terms of industry collaboration, best practice, and development of industry standards to support technology development and ultimately certification?*

Participants saw value in another cross-sector discussion – lessons learned from the automotive sector very useful. Wanted discussion on specific issues including how to lessen the regulatory burden, simplification of certification process, means of compliance, performance standards, design assurance.
Last year, SAE International hosted 2 workshops, which identified the current state of the industry and its needs to realize autonomy/full automation.

October 4, 2018 Tysons VA: This workshop immediately followed the SAE Standards Summit.

• Automatic ("scripted" behaviors) vs. Autonomous (complex decision making).
• How to we assure that "learning enabled" systems do not grow into unsafe behaviors? What are the boundaries?
• Which functions would benefit from more automation? Where should AI apply?

The activity led to the formation of S-18UAS Autonomy Working Group.
To realize the top-level mission objectives, much underlying work must be validated, standardized, and certified.

**TOP-LEVEL MISSIONS**

Remote sensing, War fighting, Telecommunications, Air taxi operations, Package delivery & Cargo transport, Emergency/First response, Others

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**Components**
- Hardware
- Software
- Network
- Architecture
- Interoperability
- Ground Infrastructure

**Methods**
- Machine learning
- Adaptive control
- Sensor fusion
- Object recognition
- Decision-making
- Optimization

**Policy**
- Taxonomy
- Performance standards
- Test methods
- Verification & Validation
- Certification

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The G-34 organization mirrors the original pillars presented at the first autonomy workshop.

**TOP-LEVEL MISSIONS**

**G-34, Artificial Intelligence in Aviation**

- **ATM/UTM**
  - Hardware
  - Software
  - Network
  - Architecture
  - Interoperability
  - Ground Infrastructure

- **Aircraft Components**
  - Machine learning
  - Adaptive control
  - Sensor fusion
  - Object recognition
  - Decision-making
  - Optimization

- **AI Components**
  - Performance standards
  - Test methods
  - Verification & Validation
  - Certification

- **Taxonomy**
Where should standards support technology development and certification?

- Methods for verification of autonomy systems and neural networks (foiling systems-cybersecurity/statistical methods for data fusion)
- Software design assurance (auto can learn from aerospace)
- Modeling and simulation.
- Language-taxonomy
- Data and analytics
- Standardized format for airspace and volume (3d + time) data. USS format.
  - NASA + FAA defining services for USS
- Hardware including sensors
- Human/Machine interface
- Synergies and commonalities between aviation and automotive
- Machine-Machine interface
- A benchmark database to validate or certify autonomous systems.
Layered loops for existing and growing automation

Examples:

Surface:
- Actuation Servos

Maneuver/Stability:
- Attitude
- Speed
- Protection
- Load Alleviation

Path Following:
- Autoland

Route Planning:
- Flight Mgt Function

Contingency:
- Detect & Avoid
- Situation decisions
- Etc.
Committees & Standards
Which SAE Aerospace standards committees play a role in Autonomy/Automation and UTM/ATM/V2X connectivity?

- **G-32 Cyber Physical Systems Security Committee**
- **G-34, Applied Artificial Intelligence in Safety-Critical Sys**
- **S-18 Aircraft and Sys Dev and Safety Assessment Committee**
  - **S-18UAS Autonomy Working Group**
- **AS-4 Unmanned Systems Steering Committee**
  - **AS-4JAUS Joint Architecture for Unmanned Systems Committee**
  - **AS-4UCS Unmanned Systems Control Segment Architecture**
- **G-10U Unmanned Aerospace Vehicle Committee**
- **G-10V Vertical Flight Committee**
- **G-10 W Weather Information Systems Committee**
- **G-45 Human Systems Integration**
- **APMC Avionics Process Management**
The SAE AS-4JAUS Committee published AS8024 JAUS Autonomous Capabilities Service Set

This document defines a set of standard application layer interfaces called JAUS Autonomous Capabilities Services. JAUS Services provide the means for software entities in an unmanned system or system of unmanned systems to communicate and coordinate their activities. The Autonomous Behaviors Services represent the platform-independent capabilities commonly found in platforms across domains, including air, maritime, and ground. At present five (5) services are defined in this document:

- Comms Lost Policy Manager: Detect and recover from loss of communications with a control station
- Retrotraverse: Return along a path previously traveled
- Self-Righting: Attempt to recover from a tip over condition
- Cost Map 2D: Provides information about the current operating environment of the platform
- Path Reporter: Provides information about the previous or future planned path of the platform
The SAE AS-4JAUS Committee published ARP6128 Unmanned Systems Terminology Based on the ALFUS Framework.

This document describes terminology specific to unmanned systems (UMSs) and definitions for those terms. It focuses only on terms used exclusively for the development, testing, and other activities regarding UMSs. It further focuses on the autonomy and performance measures aspects of UMSs and is based on the participants’ earlier work, the Autonomy Levels for Unmanned Systems (ALFUS) Framework, published as NIST Special Publication 1011-I-2.0 and NIST Special Publication 1011-II-1.0. This Practice also reflects the collaboration results with AIR5665.

This document establishes recommended practices for the specification of general performance, design, test, development, and quality assurance requirements for the flight control related functions of the Vehicle Management Systems (VMS) of military Unmanned Aircraft (UA), the airborne element of Unmanned Aircraft Systems (UAS).

The recommended flight controls requirements in this document are applicable to the Autonomous, Assisted and Manual operational modes of operation of the UA.

Note: A revision activity, ARP94910A, was launched two weeks ago!
The SAE S-18UAS Autonomy Working Group is launching a document on the applicability of ARP4754 and ARP4761 to UAS Development.

Deliberations from the SAE Autonomy Workshops identified a need for the establishment of S-18UAS. The need was reinforced by industry stakeholders and the ANSI UASSC Roadmap. The S-18UAS initial Work in Progress includes:

1. Perform a gap analysis. Determine the places in ARP4754A and ARP4761 that present real and unique challenges to UAS (GS inclusive) development.

2. Set an example(s) UAS configuration.
   a) Define functions/architecture and begin safety assessment
   b) Review process assurance.

Thus expand the capability of the accepted and well-established practices of ARP4754 and ARP4761.
Which SAE **Ground Vehicle** standards committees play a role in Autonomy/Automation and UTM/ATM/V2X connectivity?

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<td><strong>On-Road Automated Driving (ORAD) committee</strong></td>
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Which SAE **Ground Vehicle** standards committees play a role in Autonomy/Automation and UTM/ATM/V2X connectivity?

Automated Vehicle Safety Consortium

Testing, Training, Meetings
SAE On-Road Automated Driving (ORAD) Committee Organization

On-Road Automated Driving Committee

- J3164 Taxonomy and Definitions
- J3131 Reference Architecture
- J3092 Test Procedures V&V
- J3164 Behaviors & Maneuvers
- J3171 User Issues for Persons with Disabilities
- J3206 Safety Principles

Level 0 No Driving Automation
Level 1
Level 2
Level 3
Level 4
Level 5 Full Driving Automation
Where can I find more information on automated & connected technologies and activities?

Knowledge Hubs on SAE Mobilus: Automated & Connected
https://saemobilus.sae.org/automated-connected/

Over 900 publications and growing!

Get Involved
Locate and join an SAE technical committee
https://www.sae.org/standards/development
Unsettled Topics Concerning Automated Driving Systems and the Transportation Ecosystem

Rahul Razdan

Published Today!

How has automation transformed aviation?

U.S. Air Force invests in Explainable AI for unmanned aircraft

Collins Aerospace helps to update the C-130H with modern avionics}

The 17th Air National Guard and U.S. Air Force Reserve Lockheed C-130H Hercules fleet is receiving new Collins Aerospace Systems avionics that will help extend the life of the legacy aircraft by 20 years.

Read More

Featured Event

New Energy & Intelligent Connected Vehicle Technology Conference

September 21-22, 2019 | Shanghai, China | SAE International | 2 Day Conference

The SAE 2019 New Energy & Intelligent Connected Vehicle Technology Conference is a dual-track event that combines the annual SAE New Energy Vehicle Forum and the SAE Intelligent and Connected Vehicles Symposium.

Learn More

Featured SAE MOBILUS Publications

Unsettled Technology Areas in Autonomous
How do the G-32, G-34, S-18 and Other Committees Interact?
For More Information, Contact

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Join an SAE International standards committee!

Thank You!

Mark DeAngelo in a fully electric aeroplane.