Electrified Propulsion Aircraft - Standardization Challenges

Electrification Challenge for AIRcraft (ECLAIR) Consortium
By JAXA, 28 November 2018, Tokyo Japan

We make it fly
Creating a better connected, safer and more prosperous world

Richard AMBROISE
Electrification Flight Demonstrator
Head of Propelling
&
SAE E-40 « Electrified Propulsion» Committee Chairman
AVIATION POSITIONING VERSUS EXTERNAL TRENDS

ENVIRONMENTAL & SOCIETAL TRENDS
- Aircraft noise certification levels will become more stringent (ch14 - 9dB by 2028) and Airbus needs to meet ICAO Noise Sustainable Growth objective (-3dB / 10 years)
- Airbus committed to meet ICAO CO2 reduction targets: Aviation: Neutral 2020-2035, -50% in 2050 vs 2005
- Raw materials usage on electrical equipment (e.g. lithium, cobalt, rare earth) will become critical with increasing electrification mega-trend

AVIATION MARKET TRENDS
- UAM / Low-Zero emission aircrafts: strong competition in CS23 segment with many small and large players, wide design space enabled by electric or hybrid-electric propulsion,
- Heart Aerospace start-up disclosed Swedish National project to develop a 19-pax full-electric battery-based demonstrator
- Early 2019, UTC Group unveiled Project 804 to retrofit a Dash 8 turboprop with an Hybrid-Electric Propulsion System expected to yield an average fuel savings of 30 percent

SAFETY & SECURITY
- Certification rules on lithium batteries becoming more stringent
- Voltage / Power increases lead to higher risk of electrical arcing / fire to be handled
- Safe design & installation rules for storage & distribution of non-drop-in fuels for aviation to be developed

NON-AVIATION MARKET AND TECHNOLOGY TRENDS
- Distributed Propulsion and Wing-tip propellers, enabled by electric motors, open new configuration opportunities
- Electrification mega-trend disrupting all industry sectors, particularly automotive from 2020-22. It opens up new opportunities for aerospace
- Lightweight high-power-density electric motors and cost-efficient battery packs and semiconductors will soon become a commodity
- Carbon emission challenge will accelerate energy transition towards Non-fossil fuels
Battery cost & specific weight continues to decrease

Doubling of wind production over last 5 years

Five times more solar in last 5 years

Airbus research focused on continuing sustainable growth...

... whilst meeting aviation emission reduction objectives

Sources: Forbes, International Energy Agency, ATAG
Airbus 10-years background with hybrid and electric propulsion

- DA36
- E-Star
- E-Fan 1.2
- E-Fan 1.1
- E-Fan 1.0
- CityAirbus
- Vahana
- Siemens Extra 330LE
- E-Fan X

First flight:
- Cri-Cri: 2010
- e-Genius: 2011
- DA36 E-Star: 2011
- DA36 E-Star 2: 2013
- E-Fan 1.0: 2014
- E-Fan 1.1: 2016
- E-Fan 1.2: 2016
- Vahana: 2017
- CityAirbus: 2018
- E-Fan X: 2021

Power:
- 20MW
- 2MW
- 200kW
- 20kW
Proposed technology responses

Electrified Propulsion technology has been identified as a key enabler to reduce fleet carbon foot print.

- Urban Air Mobility
- Hybrid-Electric Aircraft
- Non-drop-in fuel aircraft H2burn/Hydrogen/CH4/LNG Combustion Aircraft
- Drop-in fuel aircraft Synthetic Fuel Aircraft

- Distributed Propulsion
- Hybrid/Electric Propulsion Systems & Components
- Gas Fuel Storage & Fuel System
- Engine & Fuel System Synthetic Fuel Compatibility

- More Electric Non-Propulsive Energy

NOTE: Hybrid-Electric Propulsion can be applied to non-drop-in or drop-in fuels with additive emissions benefit.

Source: Airbus/Cryoplane
The E-40 « Electrified Propulsion Committee » has been created in November 2018 and borned in February 2019 at Orlando.

Today he is two meetings old

• Richard Ambroise is the Chairman.
• Ed Lovelace is the Vice Chairman.
• Gabriel Godfrey is the Secretary.
**Impetus for committee – industry need**

<table>
<thead>
<tr>
<th>From the beginning</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Need to Work together</strong></td>
<td><strong>Standards need</strong></td>
<td><strong>Scope definition</strong></td>
<td><strong>SAE validation</strong></td>
<td><strong>Public announcement</strong></td>
</tr>
</tbody>
</table>
| At Toulouse Sept 2018, the legacy aircraft propulsion actors shared the view on the need of working together | An initial shopping list of standards has been established at Toulouse Sept 2018 meeting | A scope of a new group has been drafted | The creation of a new group has been approved by the SAE AEROSPACE Council Nov 2018 | Press released and E-40 presentation in Nov 2018 at:  
  • SAE ASTC, London  
  • JA2018, Tokyo |

**“Electrified Propulsion” technology:**

Considered as to be an enabler to reduce carbon footprint of our industry

E-40 “Electrified Propulsion”

A tool to pave the way of the introduction of electrical technology to the propulsion of our future aircrafts
The SAE International E-40 Electrified Propulsion Committee is a technical committee in SAE’s Aerospace Propulsion Systems Group with the responsibility to develop and maintain technical reports (Aerospace Standards, Aerospace Recommended Practices and Information Reports) covering electrified propulsion for aircraft. The committee recommends standardized nomenclature, defines applicable terms and example architectures, and addresses considerations for performance, airworthiness, safety, aircraft integration, components and interfaces within and between propulsion system and other aircraft equipment.
In addition, the E-40 committee provides recommendations to and **collaborates with** the SAE Electric Aircraft Steering Group and **other relevant standards committees** to develop necessary standards, recommended practices and information reports in related areas, including but not limited to:

E-40 #1 Meeting Attendance

45 Members are present in Orlando Feb 19 (including 2 SAE representatives).

**Markets:**
- Rotorcraft
- Large Commercial Aircraft
- General Aviation & Urban Air Mobility
- Business Aircraft
- Automotive

E-40#1 Industry Segments

- Engine Manufacturer: 13%
- Aircraft Manufacturer: 25%
- Helicopter Manufacturer: 17%
- e-motor manufacturer: 8%
- Research: 4%
- Automotive: 13%
- System Manufacturer: 8%
- MRO: 8%
54 Members are present in Barcelona Sept 19 (including 3 SAE representatives).

**Markets:**
- Rotorcraft
- Large Commercial Aircraft
- General Aviation & Urban Air Mobility
  - Business Aircraft
  - Automotive

E-40 #2 Industry Segment

- Engine/Motor Manufacturer: 34%
- Aircraft Manufacturer: 23%
- System/Component Manufacturer: 21%
- Government/Regulatory Agency: 13%
- Research/Academia: 9%
Online survey launched between E-40#1 & E-40#2 to:

- Refine Industry Road Map
- Measure E-40 Industry Representativeness
- Measure E-40 Skills

• 70 members have responded (out of 123 on the committee roster)
E-40 Member Survey Results

Markets:
- Rotorcraft
- Large Commercial Aircraft
- General Aviation & Urban Air Mobility
  - Business Aircraft
  - Automotive

E-40 Roster Main Skills

- Gas Turbine/Piston Engine: 33
- Power Electronics: 31
- Electric Generator: 25
- Electric Motor and Electric Motor Control: 20
- Aircraft Propulsion Installation and Integration: 18
- Electric Distribution/ Energy Management: 16
- Safety and Certification: 15
- Energy Storage (including Batteries): 10

Note: based on 70 responses
E-40 Member Survey Results

Member Companies/Organizations

Aircraft/Rotorcraft Manufacturer | Government/Regulatory Agency | Research Institute | Engine/Motor Manufacturer

System/Component Manufacturer | Airline/MRO | Automotive

E-40 Member Survey Results

Expectations from E-40 Members – Main Keywords

- Safety
- Regulation/Certification
- Standards & Guidance
- Technology
- Collaboration
- Future

Introduction
E-40 workgroups, the voice of our industry

**E-40 Subgroup Main Skills**

ARP 8676 Skills
Subgroup Size: 11

- Gas Turbine/Piston Engine
- Gas Turbine/Piston Engine Control
- Electric Distribution/ Energy Management

ARP 8677 Skills
Subgroup Size: 28

- Power Electronics
- Aircraft Propulsion Installation and Integration
- Electric Motor and Electric Motor Control
- Electric Generator
- Safety and Certification

AIR 8678 Skills
Subgroup Size: 19

- Electric Distribution/ Energy Management
- Power Electronics
- Aircraft Propulsion Installation and Integration
- Electric Motor and Electric Motor Control
- Electric Generator
- Safety and Certification
- Energy Storage (including Batteries)

ARP 8676: Nomenclature & Definitions for Electrified Propulsion Aircraft
ARP 8677: Safety Considerations for Electrified Propulsion Aircraft
AIR 8678: Architecture Examples for Electrified Propulsion Aircraft
Industry Need for New Publications – Main Proposals

Importance of Publication for Industry (Based on # of Times Proposed)

Now
- High Voltages Standards
- Charging Standards
- Energy Management for EP Aircraft
- Power Quality Standards
- Ground safety (maintenance, post-crashworthiness, MRO Training)

Within 2 Years
- Airframe Integration & Installation of:
  - EP/HEP Systems
  - Battery/Energy Storage Systems
- EP Testing/Qualification (Standards, Criteria, Procedures, including Endurance Testing)
- Certification considerations and compliance guidelines (Part 33 vs Part 25/23 or others, application of 25/23 safety continuum to EPUs)
E-40 Survey Conclusion

Online survey had confirmed:
• Our Road Map
• The E-40 Industry Representativeness
• The Skills Requested to Deploy our Road Map

The E-40 Committee is the appropriate one to produce the standards for Electrified Propulsion
E-40 Committee Addresses All Facets of Electrified Propulsion
E-40 Liaisons

SAE Committees
- EASG Electric Aircraft Steering Group (keiichi)
- AE-7 Aerospace Electrical Power Systems (Kamiar)
- AE-7D Aircraft Energy Storage & Charging (John )
- AE-2 Lightning (TBD)
- AE-4 Electromagnetic Environmental Effects (TBD)
- AE-8 Aerospace Electrical/Electronic Distribution Systems (Arnaud)
- AE-9 Electrical Materials (Eddie)
- A-21 Aircraft Noise Measure & Emissions Modelling (Ed to find a name)
- A-6 Aerospace Actuation, Control and Fluid Power Systems (TBD)
- E-36 Electronic Engine Controls (Bill)
- E-32 Aerospace Propulsion Systems Health Management (Nasser)
- HM-1 Integrated Vehicle Health Management (Nasser)
- S-18 Aircraft & Systems Development and Safety Assessment (Louis – David)
- S-12 Helicopter Powerplant (Louis – David)
- E-39 (Mark)+ SAE hybrid ground vehicle+ Fuel cell automotive (Tao)

Other Organisations
- ASTM F-39, F-44 (Bill. F + Gary)
- GAMA EPIC/ELC (Luciano)
- AIAA Electric Propulsion Technical Committee (Keiichi)
- RTCA/EUROCAE (David)

Ambassadors List
E-40, an Itinerant International working group

**E-40 policy:**

To alternate face to face meetings with Americas, Europe and Asia.

Past:
- E40#1: Orlando, USA Feb 2019
- E40#2: Barcelona, Spain Sept 2019

Upcoming:
- E40#3: Tokyo, Japan March 2020
- E40#4: San Diego, USA Sept 2020
JOIN US ....

THANKS !!!!!!!!!!!
!!!!!!!!!!!!
!!!!!!!!!!!!
!!!!!!!!!!!!
!!!!!!!!!!!!