Clean Sky Info Day

The CleanSky “Smart Fixed Wing Aircraft Integrated Technology Demonstrator” (SFWA-ITD)

Brussels, 20th of April 2012

Helmut Schwarze (SFWA-PO)
Presentation Content

- Introduction
- SFWA-ITD key objectives
- SFWA-ITD large ground and flight demonstrators
- Actual status of work and planning selected demonstrators
- Conclusion
- Call#12-Research Topics
Presentation Content

- **Introduction**
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Clean Sky Concept

Technology Evaluator

Concept

Aircraft

Smart Fixed Wing Aircraft

Green Regional Aircraft

Green Rotorcraft

Sustainable and Green Engines

Systems for Green Operations

Eco-Design

TECHNOLOGIES & DEMONSTRATORS

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SFWA-ITD organisation and setup

- All market segments addressed
- Current promising Green technologies will be integrated

Vehicle ITD

Eco-design
For Airframe and Systems

Leaders: Dassault Aviation & Fraunhofer Institute
116 M€

Sustainable and Green Engines

Leaders: Rolls-Royce & Safran
424 M€

Systems for Green Operations

Leaders: Liebherr & Thales
305 M€

Smart Fixed-Wing Aircraft

Leaders: Airbus & SAAB
393 M€

Green Regional Aircraft

Leaders: Alenia & EADS CASA
174 M€

Green Rotorcraft

Leaders: Eurocopter & AgustaWestland
160 M€

Clean Sky Technology Evaluator

31 M€

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H.Schwarze, 18/04/2012
The SFWA Leadership
SFWA-ITD counts 37 beneficiaries, i.e. leaders and partners with their affiliates (Jan 2011)

- **8 SFWA ITD Leaders**
  - Airbus Operations
  - Saab AB
  - Dassault Aviation
  - EADS-Casa
  - Fraunhofer-Gesellschaft e.V.
  - Rolls-Royce
  - Safran Group
  - Thales Group

- **7 SFWA Associate partners**
  - Aernnova Aerospace
  - DLR
  - INCAS-Cluster
  - Netherlands-Cluster
  - Onera
  - QinetiQ
  - RUAG Switzerland Ltd

H.Schwarze, 18/04/2012
Organisational Structure
Smart Fixed Wing Aircraft ITD

SFWA-ITD
Airbus / SAAB

WP 1 Lead: Dassault
Smart Wing Technology

WP1.1 Lead: Airbus
Flow Control

WP1.2 Lead: Airbus
Load Control

WP1.3 Lead: NL-Cluster
Integrated Flow & Load Control Systems

WP 2 Lead: Saab
New Configuration

WP2.1 Lead: Airbus
Integration of Smart Wing into OAD

WP2.2 Lead: Dassault
Integration of Other Smart Components into OAD

WP2.3 Lead: Airbus
Interfaces & Technology Assessment

WP 3 Lead: Airbus
Flight Demonstration

WP3.1 Lead: Airbus
High Speed Smart Wing Flight Demonstrator

WP3.2 Lead: Dassault
Low Speed Smart Wing Flight Demonstrator

WP3.3 Lead: Airbus
Innovative Engine Demo. Flying Test Bed

WP3.4 Lead: Airbus
Long Term Technology Flight Demonstrator

WP3.5 Lead: Dassault
Innovative Empennage Large Demonstrator

WP3.6 Lead: Airbus
ALEAP Flight Test

H. Schwarze, 18/04/2012
The aircraft concepts represent a “virtual” aircraft environment for maturing SFWA technologies. The concepts are:

- High Speed Demonstrator Passive (HSDP)
- Low Speed Demonstrator (LSD)
- Short Range Aircraft Concept (SRA)
- Low Sweep Bizjet Concept (LSBJ)
- High Speed Demonstrator Active (HSDA)
- Long Range Aircraft Concept (LRA)
- High Sweep Bizjet Concept (HSBJ)
- CROR Engine Demo FTB
For bundling aircraft concept related technologies nine Technology Streams have been defined:

- Natural Laminar Flow (NLF)
- Hybrid Laminar Flow (HLFC)
- Innovative Control Surfaces (ICS)
- Fluidic Flow Control (FFC)
- Load Control Functions and architectures (LCFA)
- Buffet Control (BC)
- CROR Engine Integration (CROR-EI)
- Integration of innovative turbofan engines to bizjets (IITE)
- Advanced Flight Test Instrumentation
The Technology Streams define requirements & collect the respective RTD results from the Workpackages.
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Mature technologies to achieve ACARE ambitious targets

→ 50% cut in CO2 emissions

Aircraft manufacturers 20-25%

Engine manufacturers 15-20%

Operations 5-10%

Air Traffic Management

Technologies are key towards ACARE targets, but can only deploy their benefits through smart integration

ACARE: Advisory Council for Aeronautics Research in Europe

H.Schwarze, 18/04/2012
Key Smart Fixed Wing Aircraft technologies
Technology Streams Integration and Demonstration

Input interfacing with:
- SAGE ITD – CROR engine
- SGO – Systems for Green Operation

Smart Wing Technologies
- Technology Development
- Technology Integration
- Large Scale Flight Demonstration
  - Natural Laminar Flow (NLF)
  - Hybrid Laminar Flow (HLF)
  - Active and passive load control
  - Novel enabling materials
  - Innovative manufacturing scheme

Innovative Powerplant Integration
- Technology Integration
- Large Scale Flight Demonstration
  - Impact of airframe flow field on Propeller design (acoustic, aerodynamic, vibration)
  - Impact of open rotor configuration on airframe (Certification capabilities, structure, vibrations...)
  - Innovative empennage design

Output providing data to:
- TE– SFWA technologies for a Green ATS

H.Schwarze, 18/04/2012
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1. High Speed Flight Demonstrator

**Objective:** Large scale flight test of passive and active flow and loads control solutions on all new innovative wing concepts to validate low drag solutions at representative Mach and Reynolds Numbers. Envisaged to be used at least in two major phases of the project.

- **Option 1:** UAV
- **Option 2:** Alpha-Jet
- **Option 3:** Airbus A340 with modified wing

Selected in April 2009

2. Low Speed Flight Demonstrator

**Objective:** Validation flight testing of High Lift solution to support / enable the innovative wing low drag concepts with a full scale demonstrator.

- **Option 1:** Dassault Falcon
- **Option 2:** Airbus A320

Selected End of 2011

3. Innovative Engine Demonstrator Flying Testbed

**Objective:** Demonstrate viability of full scale innovative engine concept in operational condition

Options under investigation

Preferred solution

4. Long Term Technology Flight Demonstrator

**Objective:** Validation of durability and robustness of Smart Wing technologies in operational environment

- **Option 1:** In Service Transport Aircraft
- **Option 2:** Airbus A300 “Beluga”
- **Option 2:** Airbus A320

Selection(s) part of technology roadmap

H.Schwarze, 18/04/2012
Smart Passive Laminar Flow Wing

- Design of an all new natural laminar wing
- Proof of natural laminar wing concept in wind tunnel tests
- Use of novel materials and structural concepts
- Exploitation of structural and system integration together with tight tolerance / high quality manufacturing methods in a large scale ground test demonstrator
- Large scale flight test demonstration of the laminar wing in operational conditions

Port wing
Laminar wing structure concept option 2

Starboard wing
Laminar wing structure concept option 1
**Complexity**

– The panel combines several advanced design principles into an fully integrated solution, co-cured in one step.

– Fulfilling very challenging requirements regarding surface quality

**Test/Trial Panel**

– A test/trial panel manufactured and being used for several purposes, i.e. evaluation design concepts, tooling, surface measurement etc.
December 2010: Measurement of laminarity extension using FLIR IR camera for:

- Qualification of measurement system to be used on A340
- Calibration of transition criteria

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SFWA- ITD integration of the CROR engine concept

Innovative Power-Plant Integration

- Design of innovative CROR blades and pylon
- CROR installation effects: aero, noise, vibrations, handling qualities
- CROR propeller kinematics, study of fragment impact depending on size and propeller and fuselage materials
- Structural technologies for armour and shielding
- Feasibility study of a full scale CROR engine in a Flying Testbed Demonstration (FTB)

H.Schwarze, 18/04/2012
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H.Schwarze, 18/04/2012
Envisioned major activities, achievements and milestones for 2012

- Completion of detailed design activities for the “High Speed demonstrator Passive” (HSDP)
- Completion of the CROR feasibility study.
- Preliminary Design Review for CROR-engine demonstrator Flying Test Bed (CROR demo-FTB)
- Start of manufacturing for the Low Speed Demonstrator Passive
- Conduct of wind tunnel test for low speed handling quality as part of the flight clearance process for the HSDP.
- Conduct of major wind tunnel test to select a CROR engine – blade target design.
Envisioned major activities, achievements and milestones for 2012 (cont.)

- Completion of the smart wing leading edge structural feature demonstrator, preparation for testing
- Conduct of wind tunnel tests with concepts for the integration of innovative engines in Business Jets.
- Wind tunnel tests with 2.5D active flow control high performance high lift concepts for laminar wings.
- In flight testing of surface coatings for laminar wings
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CLEANSKY

is of major importance for European Aeronautics R&T
to fulfil on the ambitious targets of ACARE

The special priority R&T needs for large commercial Aircraft are
covered in SFWA-ITD

• by developing an all new smart low drag wing
• by integration of innovative power plants
• through large, representative flight test demonstration
• engaging a wide range of partners from all over Europe
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## List of Call#12 Topics of SFWA

<table>
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<tr>
<th>Identification</th>
<th>ITD - AREA - TOPIC</th>
<th>topics</th>
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<th>MAX FUND</th>
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<tr>
<td>JTI-CS-SFWA</td>
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<tr>
<td>JTI-CS-SFWA-01</td>
<td>Clean Sky - Smart Fixed Wing Aircraft</td>
<td>9</td>
<td>12,700,000</td>
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<td>JTI-CS-2012-02-SFWA-01-049</td>
<td>Demonstration of the feasibility of an in-flight anti-contamination device for business jets</td>
<td>650,000</td>
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<td>JTI-CS-2012-02-SFWA-01-050</td>
<td>Development and construction of master moulds for riblet application</td>
<td>350,000</td>
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<tr>
<td>JTI-CS-2012-02-SFWA-01-051</td>
<td>New aircraft de-icing concept based on functional coatings coupled with electro-thermal system</td>
<td>400,000</td>
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<td>JTI-CS-2012-02-SFWA-01-052</td>
<td>Innovative aircraft ice protection system – sensing and modelling</td>
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<td>JTI-CS-SFWA-02</td>
<td>Area02 – New Configuration</td>
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<td>Design and manufacturing of baseline low-speed, low-sweep wind tunnel model</td>
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<td>JTI-CS-2012-02-SFWA-02-030</td>
<td>Low speed aeroacoustic test of a large CROR rig in an open jet test section</td>
<td>1,300,000</td>
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<td>JTI-CS-2012-02-SFWA-02-031</td>
<td>Aeroacoustic and aerodynamic wind tunnel tests at low speed for a turbofan model equipped with TPS</td>
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<td>JTI-CS-2012-02-SFWA-02-032</td>
<td>Low speed aeroacoustic test of large CROR aircraft model in an open jet test section</td>
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<td>JTI-CS-SFWA-03</td>
<td>Area03 – Flight Demonstrators</td>
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<td>JTI-CS-2012-02-SFWA-03-010</td>
<td>BLADE wing structural test to derive test data for subsequent validation of GFEM modelling</td>
<td>3,500,000</td>
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H.Schwarze, 18/04/2012
### CfP Topic Number

<table>
<thead>
<tr>
<th>JTI-CS-2012-02-SFWA-01-049</th>
<th><strong>Title</strong></th>
<th><strong>Start Date</strong></th>
<th><strong>End Date</strong></th>
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<tr>
<td></td>
<td><strong>Demonstration of the feasibility of an in-flight anti-contamination device for business jets</strong></td>
<td>Nov 2012</td>
<td>Nov 2014</td>
</tr>
</tbody>
</table>

**Topic description: Budget, Objective headlines**

**Budget: 650,000,-- €**

The device must be capable of cleaning the wing leading edges after take-off when leaving the “insect-zone”, the top limit of which is at around 500m above ground level.

Extra general requirements for the cleaning system are:
- The system must clean up around 5% of the chord wing pressure and suction sides.
- The wing surfaces must not be altered by the introduction of cracks or joints.
- The system must be fully integrated within the aircraft systems and also be hidden when not in use.

Experiments must validate, in the closest to real operational conditions.

H. Schwarze, 18/04/2012
CfP topic number | Title | End date | Start date
---|---|---|---
JTI-CS-2012-2-SFWA-01-050 | Development and construction of master moulds for riblet application | Dec 2013 | Jan 2013

**Topic description: Budget, Objective headlines**

**Budget: 350.000,-- €**

The subject of this CfP topic is the development and construction of a mould for the riblet silicone matrix with a negative structure of the riblets (see Figure 1) used for the application of riblet paint on aircraft external surfaces (fuselage, wing, Horizontal Tail Plane). The expected outcomes of the work are two master moulds (ideally metal shims with a thickness <300μm) with positive riblet geometry to produce a negative riblet structure on the siliconebelt.

H.Schwarze, 18/04/2012
The goal of this CfP topic is to propose and test new concepts based on passive coatings which would minimize run-back icing and optimize the efficiency of electro-thermal systems. This means the development and manufacturing of model coatings and the experimental characterization of these coatings, individually at first and combined with an electro-thermal system in a second instance.

**Topic description: Budget, Objective headlines**

**Budget: 400.000,-- €**

The goal of this CfP topic is to propose and test new concepts based on passive coatings which would minimize run-back icing and optimize the efficiency of electro-thermal systems. This means the development and manufacturing of model coatings and the experimental characterization of these coatings, individually at first and combined with an electro-thermal system in a second instance.
Innovative aircraft ice protection system-sensing and modelling

Budget: **300,000,-- €**

This CfP topic will have 3 main objectives:
- the development of a system architecture model for an active ice protection system;
- the development of innovative sensing options to support the active ice protection strategy;
- an overall aircraft model that demonstrates the effectiveness of the new ice protection system.

The scope of the work should include applications for both composite and metallic components, NLF and HLFC technologies and a variety of ice protection strategies e.g. electro-thermal, electro-mechanical etc. The final combination of ice protection models and capabilities should be capable of demonstrating a contribution to reduced fuel burn for integrated wing solutions.

The development and the design of actuators for ice removal are excluded from this CfP topic.

Ice removal from leading edge movables and the engine inlets is also excluded.
This topic is devoted to the manufacturing of a large scale half-model for testing in a pressurized low speed wind tunnel (WT). The fuselage will be provided by Dassault-Aviation. It may be modified for this test but should be designed to be returned to its supplied condition for future use on another WT. These modifications should be considered as part of this CFP topic.

Most of the model design will be completed under a previous CFP topic (JTI-CS-2010-3-SFWA-02-007), Some adaptation of the design to the final geometry may nevertheless be necessary as part of this topic.
Budget: 1,300,000,-- €

Clean Sky is investigating the potential of Counter Rotating Open Rotor (CROR); the Smart Fixed Wing Aircraft (SFWA) technology demonstrator there is a dedicated Technology Stream addressing the aerodynamic performance and acoustic signature of such engines. In this framework a low speed aero-acoustic Wind Tunnel (WT) Test has to be conducted with an existing rig.

Specifications of the rig, which is to be equipped with one CROR engine, are as follows:
- Large scale CROR-powered rig;
- 0,85m propeller diameter;
- One 425kW per shaft counter rotating engine (max total 708kW), requiring pressurized air with a maximum mass flow of 12kg/s at 70 bar pressure at turbine entry.
- The model is mounted on a suitable support structure with engine feed and return air.

The applicant shall develop optimised engine feed and return lines (minimized pressure losses) to assure availability of maximum engine power.
This topic is devoted to a low speed, low Reynolds Wind Tunnel Test of a representative large scale powered model. The design of the model is an output of former SFWA studies.

In this challenging WTT, several critical aspects of the shielding empennage technology will be evaluated:
- Aerodynamic interaction of the Horizontal Tail Plane/Vertical Tail Plane (HTP/VTP) with the jet exhaust for critical flight phases such as take-off and landing;
- Acoustic shielding of the engine turbomachinery noise by the empennage;
- Dynamic loads on the Horizontal Tail Plane (HTP) under aircraft stall or engine in reverse mode;
- Ground effect behavior.

The WTT is divided into two main parts: one part is devoted to acoustics measurement with/without TPS (Turbine Powered Simulator) and the other part to aerodynamic behavior of the HTP with TPS running with and without ground effect.

H.Schwarze, 18/04/2012
The applicant shall develop optimised engine feed and return lines (minimized pressure losses) to assure availability of maximum engine power.

The applicant shall test the model in a large low speed WT of their choice. This must be able to cover the following conditions:
- Mach number up to 0.22;
- The tunnel should have an anechoic open test section for Far Field noise evaluation;
- The test section should be larger than 8m of width by 6m of height;
- The model test support shall be acoustically treated and compatible with variable pitch & yawing angles, while keeping the model on the axis of rotation and out of the influence of the shear layer;
- The applicant shall apply both advanced acoustic and steady and unsteady aerodynamic measurement methods.

An innovative approach is requested in setting-up and operating a fast data acquisition system able to record all unsteady pressures and rotating thrust balance data at high sampling rates with at least one day of storage capacity on the facilities’ local data acquisition system.

Specifications of the model, which is to be equipped with two engines, are as follows:
- 5.11m full span;
- Two 170kW per shaft counter rotating engines, one on each side of the fuselage, each requiring pressurized air with a maximum mass flow of 7.2kg/s at 80 bar pressure;
- The model is mounted on a dorsal sting with feed and return air for the two engines;
- The maximum model dead weight is 17,000 N.
Topic description: Budget, Objective headlines

Budget: 3,500,000,-- €

The applicant shall develop an innovative low cost test method for application of up bend only test loads on a fully functional flight test aircraft. The test philosophy is to demonstrate that major components tests can be performed on flight test aircraft. The ability to prove this method could reduce the burden of major component tests for the certification of future aircraft or derivatives. A successful completion of this topic would provide the applicant with expertise and evidence to apply the same innovative test solutions to future production aircraft test packages.

H. Schwarze, 18/04/2012

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Thank you for your attention!

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