CENTRELINE

ConcEpt validatioN sTudy foR fusElage wake-filLIng propulsioN intEgration

D5.05

CENTRELINE TECHNOLOGY TRANSFER WORKSHOP

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CENTRELINE TECHNOLOGY TRANSFER WORKSHOP

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Abstract: Deliverable 5.05 summarizes the output of the CENTRELINE technology transfer workshop held on June 4th, 2019 at AIRBUS in Ottobrunn (Germany) as well as additional technology transfer activities at the 24th International Society for Air Breathing Engines (ISABE) Conference (Australia) and the 9th European Aeronautics Science Network International (EASN) Conference (Greece). The workshop and conference sessions provided technology transfer to key innovation stakeholders inside the consortium and aerospace community to promote and assess future industrial uptake and development needs.

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Glossary

Abbreviation / acronym	Description
CFD	Computational Fluid Dynamics
EASN	European Aeronautics Science Network
EC	European Commission
EU	European Union
ICAO	International Civil Aviation Organization
ISABE	International Society for Air Breathing Engines
PFC	Propulsive Fuselage Concept
TRL	Technology Readiness Level

1 Concept Note of the Workshops

The Propulsive Fuselage Concept investigated in CENTRELINE is aiming TLR 3–4 at the end of the project. During the project, the proof-of-concept for the propulsion-airframe integration is demonstrated through numerical and experimental investigation. Given this TRL level, it is evident that further industry and academic research will be required to drive the concept to a full-scale demonstration and subsequent application in commercial aircraft programmes. Therefore, the future exploitation of CENTRELINE results is promoted already during the project by providing obtained key insights and requirements as possible starting points for future technology maturation activities. As such, a dedicated technology transfer workshop with invited participants from industry partners as well as two public technical sessions as part of international aerospace conferences were held. The technology transfer workshop took place at AIRBUS in Ottobrunn, Germany. It targeted key innovation stakeholders to promote and assess future industrial uptake and development needs. In this way, the CENTRELINE propulsive fuselage concept gets widely known inside the industry engineering departments, which will be a prerequisite for internal take-up. In turn, through this proactive technology transfer approach, product development engineers provided valuable feedback from a product development and market perspective.

2 Workshop Reports

2.1 CENTRELINE Technology Transfer Workshop, AIRBUS Ottobrunn

The technology transfer workshop, the first event in the series of knowledge transfer activities, was organised by Bauhaus Luftfahrt, ARTTIC and AIRBUS, and held on June 4th, 2019 at AIRBUS in Ottobrunn, Germany (agenda see annex). The workshop targeted at a transfer of the gained knowledge on CENTRELINE's novel propulsion technology to the engineering departments of the CENTRELINE industry partners. The full-day workshop with 27 participants from MTU, Siemens, AIRBUS, Bauhaus Luftfahrt as well as all CENTRELINE partners was divided in two parts: a presentation section by each partner followed by an interactive workshop on further the PFC technology development needs.

Figure 1: Technology transfer workshop at AIRBUS, Ottobrunn

Figure 2: Arne Seitz at the technology transfer workshop at AIRBUS, Ottobrunn

During the presentation section (see Figure 1 and Figure 2), the status of the different CENTRELINE project tasks was presented to serve as a basis for the interactive workshop. An overview of the assessed aircraft concept and aero-structural design aspects with a focus on the structural design of fuselage and fuselage fan was given. Furthermore, results from the aerodynamic optimization of the fuselage-propulsor design through wind tunnel experiments and CFD simulations as well as from the optimization of the fan through fan rig tests were presented. Selected aspects of the turbo-electric drive train architecture, main engine and electric generator integration and performance assessment were explained. The CENTRELINE consortium concluded with a summary of first results from an overall aircraft design integration.

The succeeding interactive workshop (see Figure 3 and Figure 4) focused on the technology roadmap for three selected technology bricks, namely needs for the technology roadmap of the overall aircraft design integration, the aerodynamic integration of the fuselage fan propulsor and the turbo-electric power train. Discussions took place in three different focus groups. During the workshop, the participating experts had the opportunity to give input to the compilation of the technology road map towards increasing the technology readiness level (TRL) and in-depth discussions on specific technical aspects.

Figure 4: Technology transfer workshop at AIRBUS, Ottobrunn

Figure 3: Technology transfer workshop at AIRBUS, Ottobrunn

Within all three groups, topics were identified, which are crucial to drive the investigated technologies to a higher TRL. Furthermore, it was discussed, which actions will have to be taken to drive the technologies to these TRL. The moderators of the three groups had prepared technology roadmaps cards for selected topics, which were filled out during the group discussions in the course of the workshop.

On overall aircraft level, necessary actions to increase TRL for specific technical topics were discussed. Specific topics included:

- Operational aspects of a PFC, including maintenance, repair and overhaul
- Structural integration of a fuselage fan
- Internal (cabin) noise, including aspects of noise source, transmission and perceived annoyance
- One (main) engine inoperative case
- Auxiliary Power Unit integration

It was found by the experts that for the fuselage fan propulsor aerodynamic design the basic design approaches and processes would not differ radically from existing aircraft designs. As such, the TRL increase measurements should follow already established paths of calculation, simulation, rig testing etc., which are currently in place.

The main concern regarding de-risking the PFC would be to map all possible failure modes and find a means to mitigate them at an early stage of the conceptual design. The technical discussion dealt with aspects such as:

- Impact of the fuselage fan on aircraft stability
- Noise of the fuselage fan
- Fuselage fan certification
- Fuselage fan failure modes

The turbo-electric power train group identified steps for a safety analysis of the system with increasing TRL. A succeeding technical discussion focused on aspects of a design concept for the generator cooling.

2.2 CENTRELINE session at EASN, Athens, Greece

At the 9th EASN International Conference on Innovation in Aviation and Space, held in September 2019 in Athens, Greece, a CENTRELINE session "R&D Research in the Field of Aeronautics and Air Transport" took place. The conference hosted 450 attendees in ~70 sessions with over 360 technical presentations (http://easnconference.eu/2019/home).

The CENTRELINE session was well-attended with approximately 40 persons. The session was chaired by Fabian Peter (Bauhaus Luftfahrt) and consisted of the following presentations (see also Annex):

- Arne Seitz: Recent Advances In Fuselage Wake-Filling Propulsion Integration
- Arne Seitz: Optimality Considerations For Propulsive Fuselage Power Savings
- Fabian Peter: Specification of the CENTRELINE reference aircraft and power plant systems
- Biagio Della Corte: Experimental and Computational Analysis of Model Support Interference in Low Speed Wind Tunnel Testing of Fuselage Boundary Layer Ingestion
- Stefan Biser: Sizing of hybrid-electric propulsion system

The plenum received the presentations well and the questions asked aimed at more detailed information of the technical contents that were answered by the respective presenters.

2.3 CENTRELINE session at ISABE, Canberra, Australia

As part of the technology transfer activities, the CENTRELINE consortium chaired two sessions at the 24th ISABE Conference in September 2019 in Canberra, Australia. The theme of the conference was "Disrupting Distance with Advanced Propulsion Technologies".

The first session was attended by 10–15 participants, the second session by 40–90 participants, respectively. In total, six presentations were held, covering many propulsion related aspects assessed in the project (see Annex). The presentations were well received by the resident stakeholders and led to answers on specific technical details, which were answered by the presenters.

3 Dissemination

All three technology transfer activities contributed to a knowledge transfer of CENTRELINE's synergistic propulsion-airframe integration to industry engineers, the scientific community and technology planners. The first workshop of this series at AIRBUS in Ottobrunn was not public and addressed to staff of engineering departments of CENTRELINE industry partners to increase in-house awareness of the technology. The industry partners promoted the workshop within their companies.

The following two sessions at EASN and ISABE conference were announced through social media channels and the dissemination activities of the conferences. In September 2019, the CENTRELINE Twitter channel gained seven new followers and 5,604 Tweet impressions due to the public events at conferences (see Figure 5–Figure 6). At ISABE conference the CENTRELINE roll-up was presented (Figure 7).

Figure 5: Tweet during EASN conference.

Figure 6: Tweet during ISABE conference.

Figure 7: CENTRELINE roll-up

4 Annex

AGENDA

CENTRELINE Technology Transfer Workshop

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723242.

Date and Location

Date: **June 04, 2019, 9:30 – 15:45 at AIRBUS Ottobrunn**

Agenda

04/06/2019: Technology Transfer Workshop (Consortium and Industry Stakeholders)		
Time	**Item**	**Speaker(s)**
9:30 – 9:45	Welcome and AIRBUS vision on BLI and PFC	Lars Jørgensen
9:45 – 10:00	CENTRELINE project overview and current status	Arne Seitz
10:00 – 10:15	PFC aero-structural design aspects	Bartłomiej Goliszek
10:15 – 10:45	PFC aerodynamic design optimisation and wind tunnel testing	Biagio della Corte
10:45 – 11:15	Fuselage fan design, simulation and testing	Alejandro Castillo Pardo
11:15 – 11:45	*Coffee Break*	
11:45 – 12:00	Turbo-electric power train design	Guido Wortmann
12:00 – 12:15	Design integration of main engines and electric generators	Rasmus Merkler
12:15 – 12:30	Main power plant performance implications	Olivier Petit
12:30 – 12:45	Overall aircraft design integration and performance evaluation	Florian Troeltsch
12: 45 – 13:00	Q & A	All
13:00 – 14:00	*Lunch*	
14:00 – 15:00	Interactive Workshop on PFC Technology Roadmapping: ▪ Overall aircraft design integration ▪ Aerodynamics and propulsors ▪ Turbo-electric power train	All
15:00 – 15:30	Presentation of Working Group results	All
15:30 – 15:45	Summary & Outlook	A.Seitz, L. Jørgensen

AGENDA

CENTRELINE Session at EASN Conference

Date and Location

Date: **September 05, 2019, 14 :00 – 16 :00**

Agenda

Chair : F. Peter, Bauhaus Luftfahrt e.V., Germany

Presentation Title
Seitz, A.: "Recent Advances in Fuselage Wake-Filling Propulsion Integration", 9th EASN International Conference on Innovation in Aviation & Space, Athens, Greece, 3-6 September 2019.
A. Seitz, A.H. Habermann and M. van Sluis, "Optimality Considerations for Propulsive Fuselage Power Savings", 9th EASN International Conference on Innovation in Aviation & Space, Athens, Greece, 3-6 September 2019.
Peter, F.J. Bijewitz, A. Habermann, K. Plötner, F. Troeltsch and A. Seitz, "Specification of the CENTRELINE reference aircraft and power plant systems", 9th EASN International Conference on Innovation in Aviation & Space, Athens, Greece, 3-6 September 2019.
B. Della Corte, A. Perpignan, M. van Sluis, and A. Gangoli Rao, "Experimental and Computational Analysis of Model Support Interference in Low Speed Wind Tunnel Testing of Fuselage Boundary Layer Ingestion", 9th EASN International Conference on Innovation in Aviation & Space, Athens, Greece, 3-6 September 2019.
S. Biser, G. Wortmann, S. Ruppert, M. Filipenko, M. Noe and M Boll, "Automated sizing tool for hybrid-electric propulsion systems", 9th EASN International Conference on Innovation in Aviation & Space, Athens, Greece, 3-6 September 2019.

AGENDA

CENTRELINE Sessions at ISABE Conference

Date and Location

Date: **Session 1: September 24, 2019, 16 :00 – 18 :00**
Session 2: September 25, 2019, 10 :30 – 12 :00

Agenda

Technical Session TuC4 : CENTRELINE 1
Chair : A. Seitz, Bauhaus Luftfahrt e.V., Germany

Presentation Title
F. Troeltsch, J. Bijewitz and A. Seitz, "Design Trade Studies for Turbo-electric Propulsive Fuselage Integration", ISABE-2019-24141, 24th ISABE Conference, Canberra, Australia, 22-27 Sep 2019.
Z. Goraj, M. Kowalski and B. Goliszek, "Optimisation of the loading structure for Propulsive Fuselage Concept", ISABE-2019-24193, 24th ISABE Conference, Canberra, Australia, 22-27 Sep 2019.
B. Della Corte, M. van Sluis, A. Gangoli Rao, L. Orsini and L. L. M. Veldhuis, "Experimental Investigation of the Flow Past an Axisymmetric Body at Low Speed",, 24th ISABE Conference, Canberra, Australia, 22-27 Sep 2019. ISABE-2019-24151

Technical Session WeA4 : CENTRELINE 2
Chair : A. Seitz, Bauhaus Luftfahrt e.V., Germany

Presentation Title
A. Castillo Pardo and C. A. Hall, "Aerodynamics of Boundary Layer Ingesting Fuselage Fans", ISABE-2019-24162, 24th ISABE Conference, Canberra, Australia, 22-27 Sep 2019.
S. Samuelsson, O. Petit, R. Merkler and G. Wortmann,"Adaption of a turbofan engine for high power offtakes for a turbo-electric propulsive fuselage concept", ISABE-2019-24215, 24th ISABE Conference, Canberra, Australia, 22-27 Sep 2019.
R. Merkler, S. Samuelsson and G. Wortmann, "Integration Aspects for Large Generators into Turbofan Engines for a Turbo-electric Propulsive Fuselage Concept", ISABE-2019-24087, 24th ISABE Conference, Canberra, Australia, 22-27 Sep 2019.