Swedish Aerospace Research Center – a National Research Network

Directors:
Dan Henningson, KTH/LiU
Tomas Grönstedt, Chalmers
Ardeshir Hannefi, KTH
Petter Krus, LiU

What is SARC?

SARC is a national aeronautical research centre hosted by LiU and funded by Innovair, one of the first Vinnova's strategic innovation programmes.

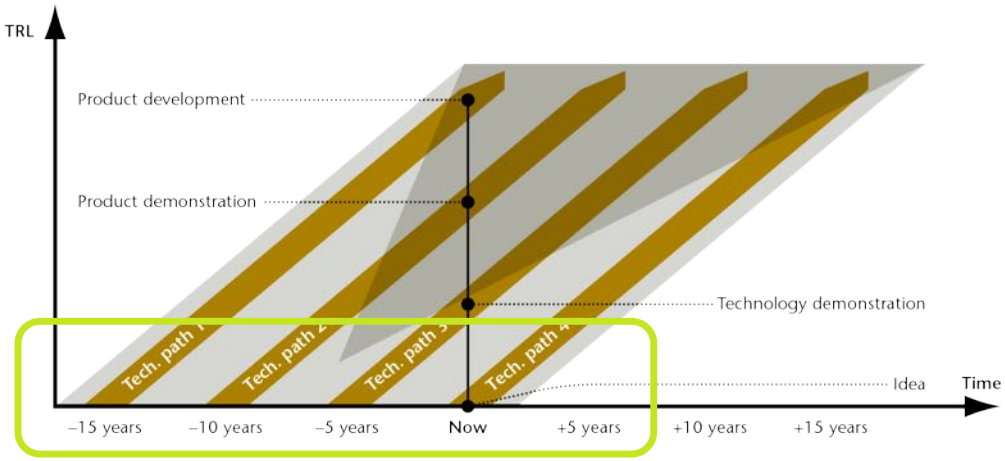
Why SARC?

Recommendations in National Research and Innovation Agendas 2013 and 2016:

- 2013: “Strengthen the research networks”
- 2016: “We propose to fund a strategic research programme for aeronautics at TRL 1–2 ...”

Background

- Increased international competition requires a more articulate process to ensure Sweden's competitiveness.
- A smooth running innovation system, from early research, through demonstrators to products.
- There is an increased need for research at low TRL levels at universities.



The vision of SARC

To be the leading Network of Aeronautics researchers in Sweden, fostering collaboration among researchers and graduate students, influencing aeronautics policy and facilitate funding for fundamental aeronautics research.

The goals of SARC

- Facilitating collaboration between researchers in aeronautics through graduate schools, annual conferences and workshops
- Being a strong player internationally, positioning SARC in the EU Framework Program and other international research initiatives,
- Facilitating aeronautical research cooperation with Brazil, Great Britain, Germany and, in the long run, France and the United States,
- Facilitating competence in the aeronautics sector, including strategic aspects of graduate and undergraduate education.
- Having a clear communicable view on environmental aspect of aviation, aligned with the ACARE 2050 goals.

Vinnova's decision: 12 MSEK

VINNOVA

Beslutsdatum	Diarienummer
2018-01-24	2018-00063

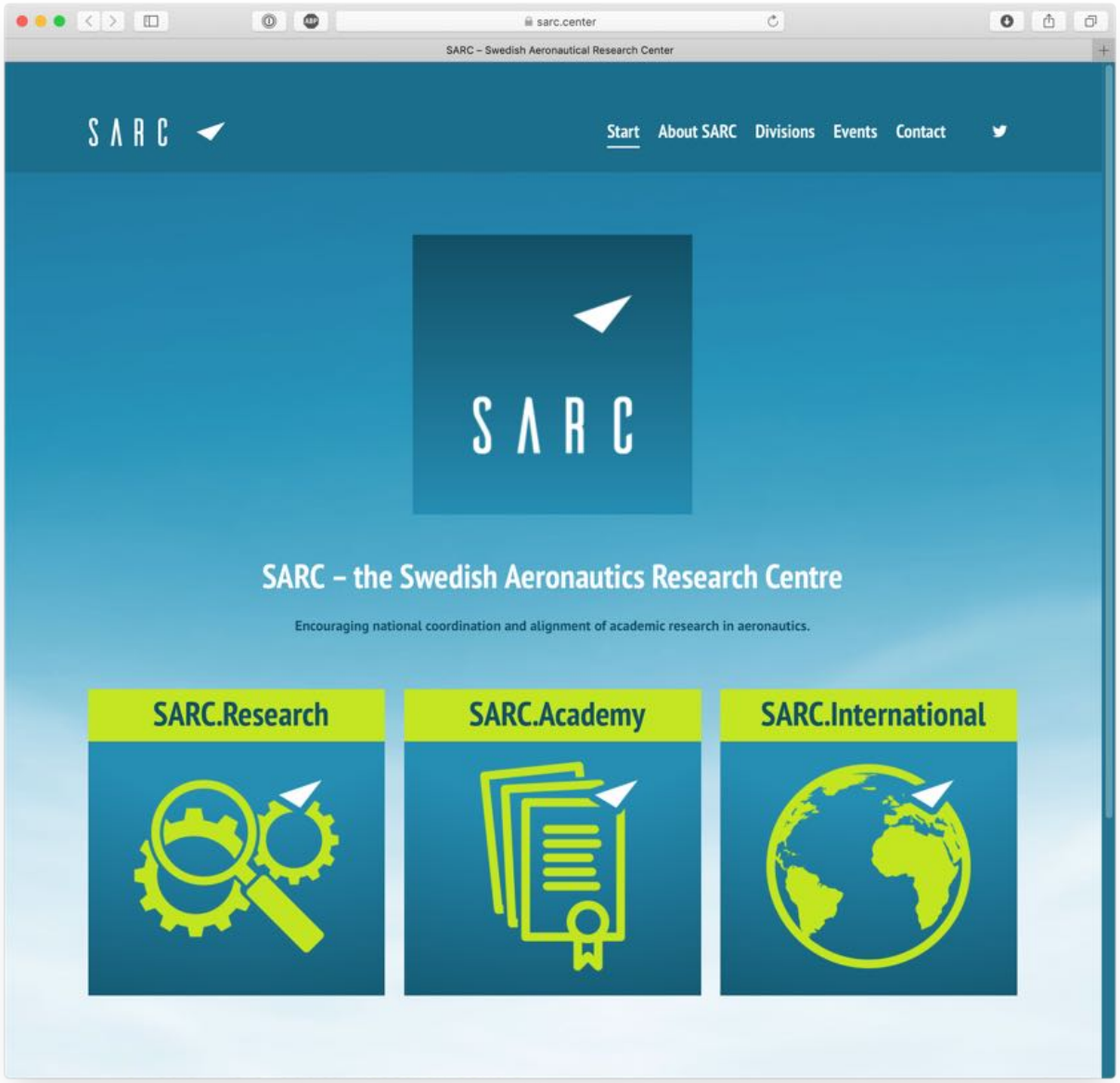
BESLUT OM BIDRAG

Diarienummer:	2018-00063
Projekttitel:	Flygtekniskt Forskningscentra
Koordinator:	Linköpings universitet Institutionen för ekonomisk och industriell utveckling Hus A, Campus Valla 58183 LINKÖPING
Organisationsnummer:	202100-3096
Firmatecknare/prefekt:	Per-Olof Brehmer
Projektledare:	Petter Krus Linköpings universitet Institutionen för ekonomisk och industriell utveckling
Vinnovas handläggare:	Ebba Lindegren
Vinnovas administratör:	Lena Dalsmyr
Startdatum-Slutdatum:	2018-02-01 - 2021-12-31

Er ansökan om bidrag har beviljats

Tack för er ansökan om bidrag inom utlysningen "Enskilda projekt - SIP Innovair 2018". Vi har beslutat att bevilja er ansökan.

sarc.center


sarc.center
SARC – Swedish Aeronautical Research Center
SARC
Start
About SARC
Divisions
Events
Contact
SARC
SARC – the Swedish Aeronautics Research Centre
Encouraging national coordination and alignment of academic research in aeronautics.
SARC.Research
SARC.Academy
SARC.International

SARC Activities

SARC.Research

- Collaborative project, annual meetings

SARC.Academy

- PhD courses: Aircraft Conceptual Design, Aircraft actuation Systems, Sustainable Aviation, Engineering Design Optimisation, etc

SARC.International

- SARC-BARINet Aeronautics Workshop, SBAW2020, Nov 2020
- Multi-Level Design Workshop, May 2021
- SARC-BARINet Aeronautics Workshop, SBAW2021, 18-19 Nov 2021
- SARC-BARINet Competition

The Pandemic has had a severe impact on networking activities

The Pandemic ha, however, in some ways even facilitated international collaboration since on-line work means that distance has not been a factor during the pandemic

Steering Board, Advisory and Management Group

- ***Steering Board***
  - Anders Blom, Innovair, Chariman
  - Thomas Ireman, Saab
  - Henrik Runnemalm, GKN
  - Mats-Olof Ohlsson, FMV
  - Angela Hillemyr, Chalmers
  - Peter Värbrand, LiU
- ***International Advisory Group***
  - **Chris Atkin, City College, Chariman**
  - **Emilia Villani, ITA**
  - **Mirko Hornung, TU Munchen**
  - **Guillermo Paniagua, Purdue Univ.**
  - **Dieter Peitsch, TU Berlin**
- ***Management Group***
  - Petter Krus, LiU, Director
  - Tomas Grönstedt, Chalmers, Deputy Director
  - Dan Henningson, KTH/LiU, Deputy Director
  - Ardeshir Hanifi KTH, SARC.Academy director
  - Ingo Staack, LiU
  - Marta-Lena Antti, LTU
  - Anna Öhrwall-Rönnbäck, LTU

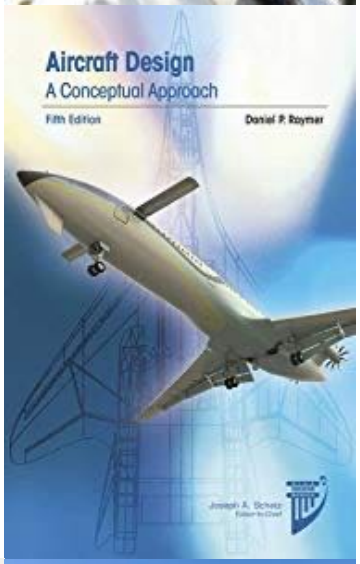
Initial activities

In 2018 the center starts and the first years are planned:

- Linköping Univeristy established the National Centre and appointed the Board and Directors in May 2018
- Kick-off meeting 18–19 June, 2018 at LiU
- Graduate schools and other activities start spring 2019
- Annual meeting 2–3 May, 2019 in Lidingö with ITA participation

SARC.Academy kick-off

- Fundamental course in Aeronautics for all NFFP PhD students.
- Daniel P Raymer. *Aircraft Design a Conceptual Approach*
  - *Create understanding for relations at system level. This is important in order to understand how individual projects relate to top level requirements.*
  - *Creates a network among PhD students, both nationally and also internationally.*
  - *Given in Florianopolis in Brazil, March 18-22 2019.*



SARC.Academy kick-off

Debattartiklar i DN om grönt flyg

"Vätgas är flygets framtid – nu måste Sverige satsa"

Svenska högskolor och svensk industri har inlett forskning kring tekniken för vätgasdrivna flygplan. Andra europeiska länder och flygföretaget Airbus planerar också för vätgasflyg. Sverige behöver nu snabbt öka satsningar och också det internationella samarbetet, skriver **fem flygforskare**.

"Mellanlandning kan halvera utsläppen från Thailandsresa"

I debatten om flyget har det globala perspektivet glömts bort. Risken är att Sveriges bästa möjligheter att minska flygets klimatpåverkan hamnar i skuggan. Det finns nämligen mycket att göra som kan ge effekt redan på kort sikt: vi kan flyga på lägre höjd vid ogynnsamt väder och vi kan välja mindre flygplan och i stället mellanlanda, skriver **fem flygforskare.**

Sustainability for Aerospace Applications (4 hp)

SARC

LULEÅ UNIVERSITY OF TECHNOLOGY

Target group

- PhD candidates and postdocs conducting research in
  - the Swedish Aerospace Research Center (SARC)
  - the Graduate School of Space Technology
- Aerospace engineers, active in research & development and research & innovation (R&D/R&I) projects

Course content

The course gives an overview of United Nations Development Program's (UNDP's) Sustainable Development Goals (SDGs), and tools to assess and develop towards increased sustainability for aerospace applications research and development and innovation (R&D, R&I) projects. It consists of:

- Lectures (online) on sustainability and eco-design, by academic researchers and representatives from aerospace companies to cover current progress (state-of-art and state-of-practice).
- Individual assignment, based on the UNDP SDG assessment tool: https://sdgimpactassessmenttool.org/
- Workshops (online, with break-out sessions) to discuss the individual assessment, and innovative and creative workshop to investigate further improvements.

Course objectives

- To increase awareness about sustainability issues in the participant's **own and other participants' ongoing R&D/R&I projects**, and
- to improve the participant's ability to address these issues in their own work.

- By raising sustainability issues in the participant's current project, and by reflecting upon them in groups with other course participants, teachers and guest lecturers, the course objective is that the participant achieves deeper insights about sustainability aspects, in order to improve management of and communication about sustainability issues in the current project, the research work, and, especially for industrial participants, in their organizations.
- On completion of the course, the participant should be able to demonstrate (in a short text and in a presentation of the PhD research project) the ability to make relevant sustainability statements about the own research (R&D/R&I) project and be able to discuss the project in relation to UNDP's 2030 sustainability goals.

Participants

- PhD students in the course
  - 7 space field
  - 4 aeronautics field
- Company participants
  - 3 diploma participants
  - + Several participants at each session via ACS and RIT2021

SARC

SARC Collaborative project

CHALMERS UNIVERSITY OF TECHNOLOGY

LINKÖPING UNIVERSITY

KTH VETENSKAP OCH KONST

LULEÅ TEKNISKA UNIVERSITET

Background

What is the collaborative project?

- **Common platform** for applied aviation courses and research
- Evaluate impact of **new technologies** (hydrogen, NLF...)
- **Green** regional air transport in focus
- **Pilot project** for collaborative research

CHALMERS UNIVERSITY OF TECHNOLOGY

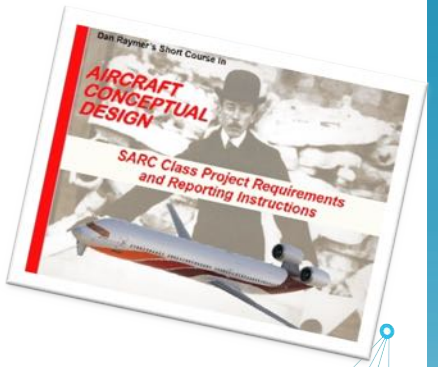
LINKÖPING UNIVERSITY

KTH VETENSKAP OCH KONST

LULEÅ TEKNISKA UNIVERSITET

Distributed work

- TLRs, conceptual design, propulsion →
- Aerodynamics, CFD, laminar-flow wing →
- Systems architecture, sizing, M&S →
- Materials, hydrogen fuel storage →



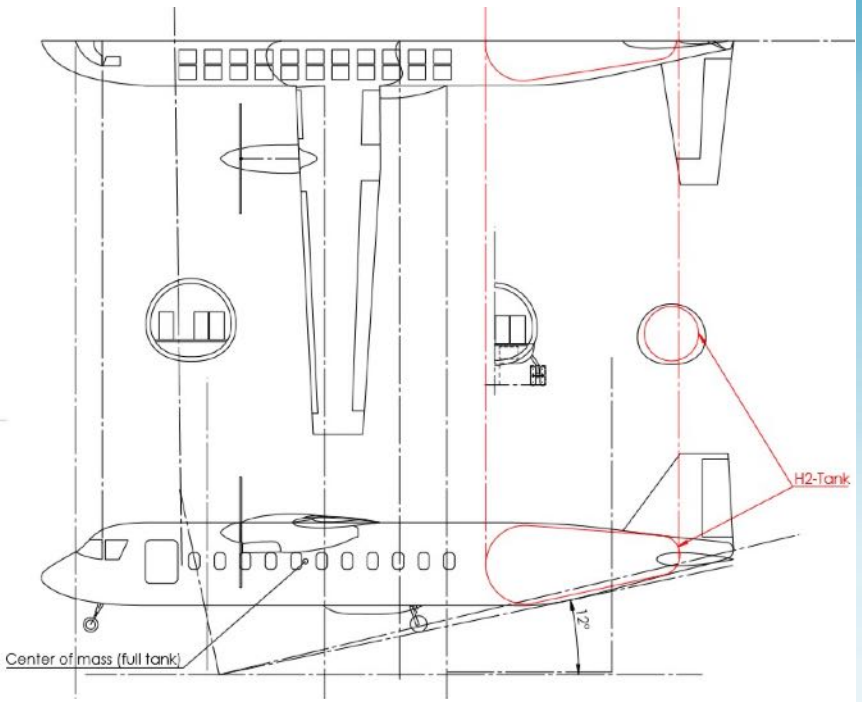
Conceptual aircraft design

- Conceptual design initiated at D. Raymer's course in Brazil
- Basic assumptions to fit tank and TRL (40 pax, regional range...)

Conceptual aircraft design

- Propulsion integration studies completed in PACE
- LH2 design based on ATR-42
- 2-m stretch and cargo capacity reduced to accommodate LH2 tank
- Low-weight, rigid-cell, foam-insulated aluminum tank (17 m^3)

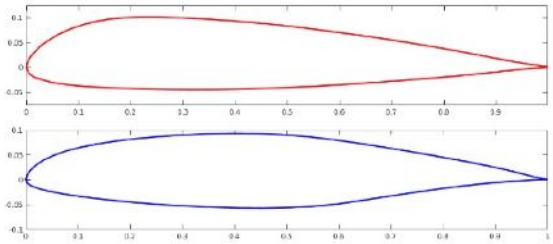
Wing	
Wing Loading (lb/ft^2)	60
Aspect ratio	13.04
Span	25
Cruise Mach	0.45
Weights	
MTOW (kg)	14040
OEW/MTOW	0.597
OEW (kg)	8381.88
Payload (kg)	4000
Propulsion	
Prop Diam (m)	3.57
Prop SLS (lbf)	6696
L/D	16.5
SFC mg/Ns	5.195833
t/W	0.432
Range (km)	2500



Aerodynamics – laminar wing study

Comparison between two airfoils

- ATR airfoil
- NLF(1)-0115[1]



Geometrical parameters and flight condition from preliminary design:

$$M = 0.45 \qquad Re = 6.6 - 11.4 \cdot 10^6$$

Aerodynamic studies were performed with Xfoil[2]

$C_{L_{2D}}$ and $C_{D_{2D}}$ evaluated at different section

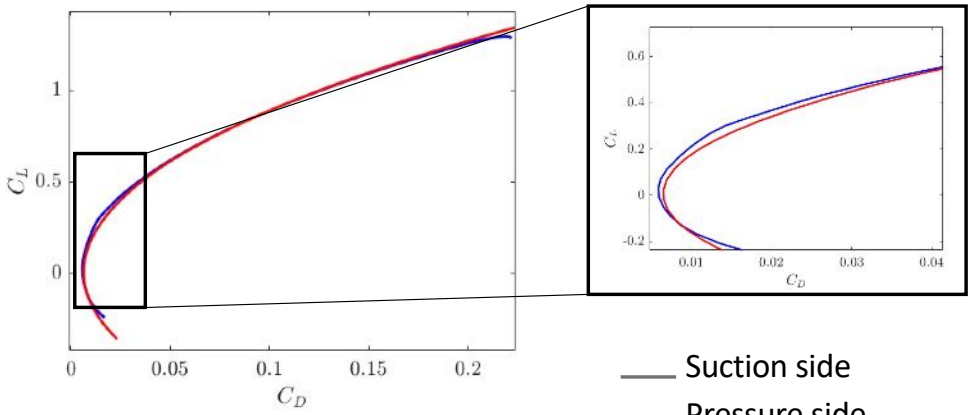
We integrated over the wingspan and added the contribution of the induced drag

We evaluated the transition position at the different angles of attack

[1] Seling M. S. et al. (1995)
[2] https://web.mit.edu/drela/Public/web/xfoil/

Aerodynamics – laminar wing study

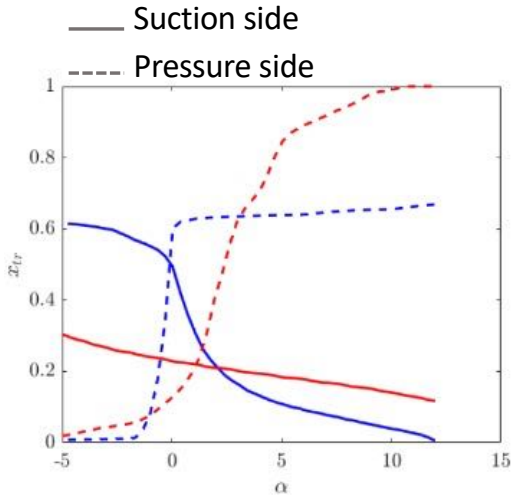
- For low values of lift the total drag is lower for the laminar wing

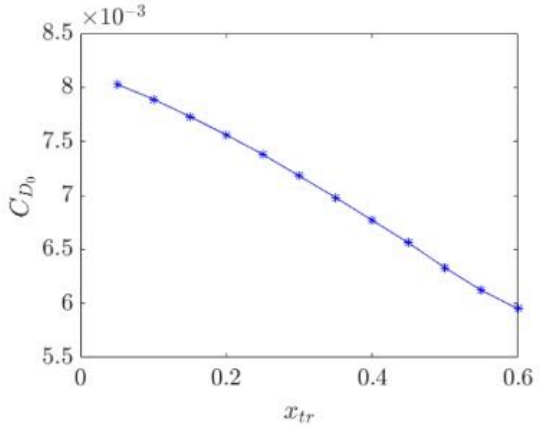


ATR airfoil
NLF(1)-0115

- Lower value of C_{D_0}

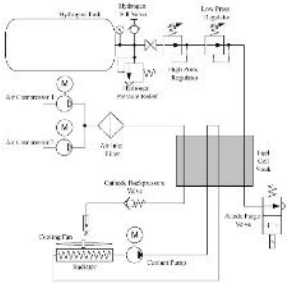
$$C_{D_0} = 0.0065$$
$$C_{D_0} = 0.0060$$

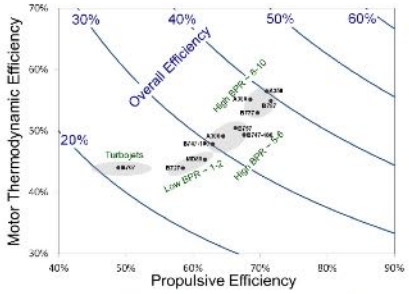


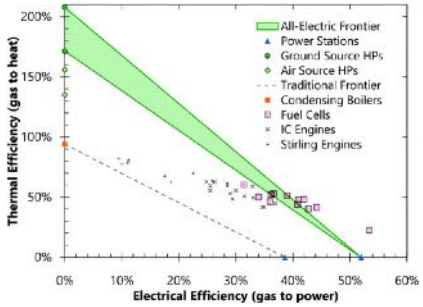


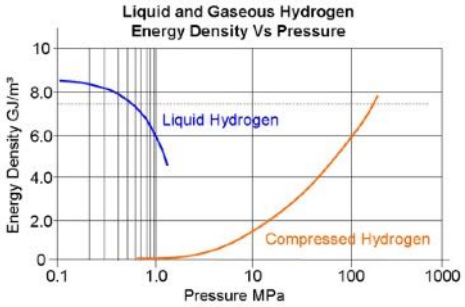
Assessment of architecture and config.

- Map scaling effects and optimum solutions:
  - Mission vs propulsion technology
  - Energy strategy
  - Fuel cell vs burning hydrogen
- Integration of hydrogen storage and distribution system
- Estimation of efficiency levels needed



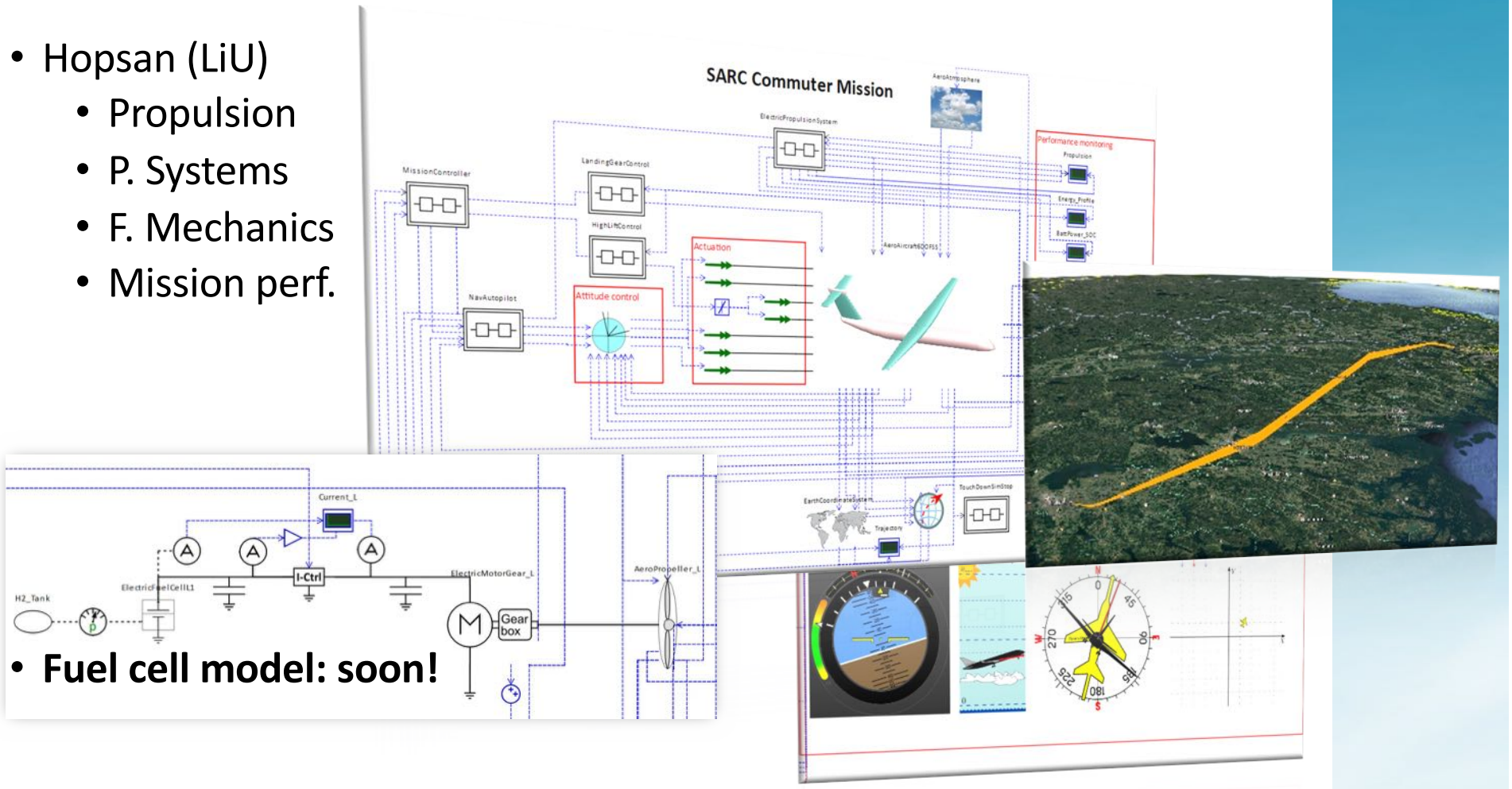






Modelling & Simulation

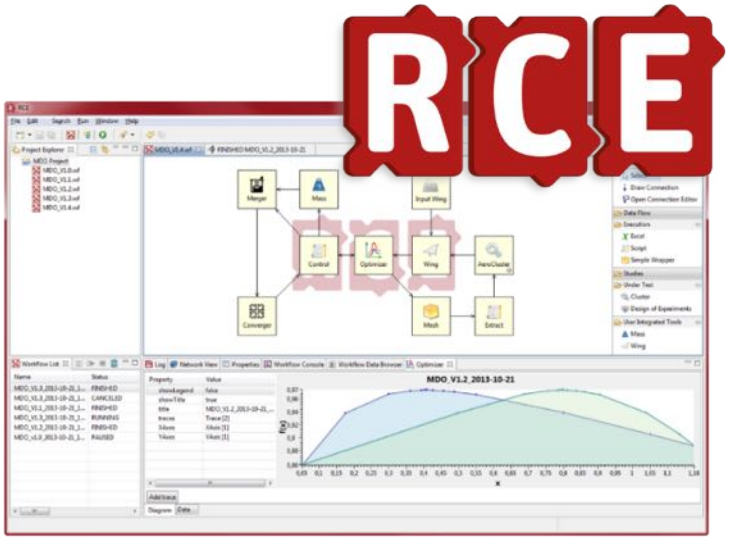
- Hopsan (LiU)
  - Propulsion
  - P. Systems
  - F. Mechanics
  - Mission perf.

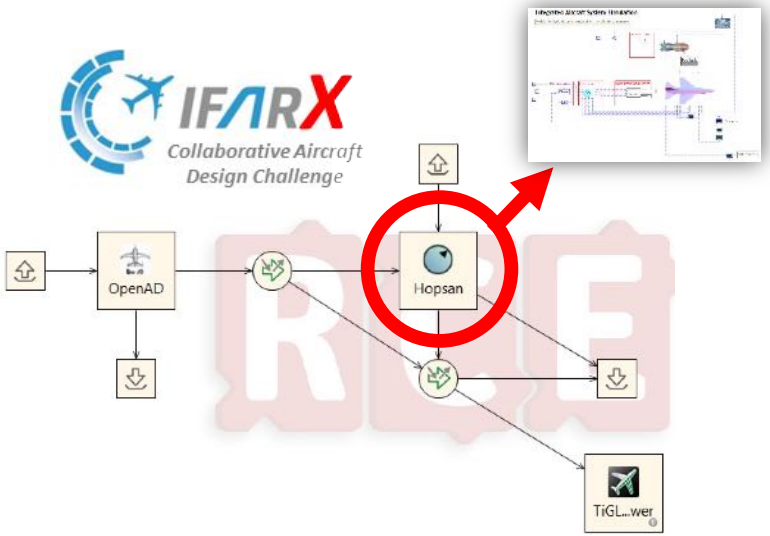


- **Fuel cell model: soon!**

(Distributed) Modelling & Simulation

- Transition to open-source integration platform
  - RCE (Remote Component Environment) is an Open Source, distributed, workflow-driven integration environment
  - Future way to network for aerospace universities?





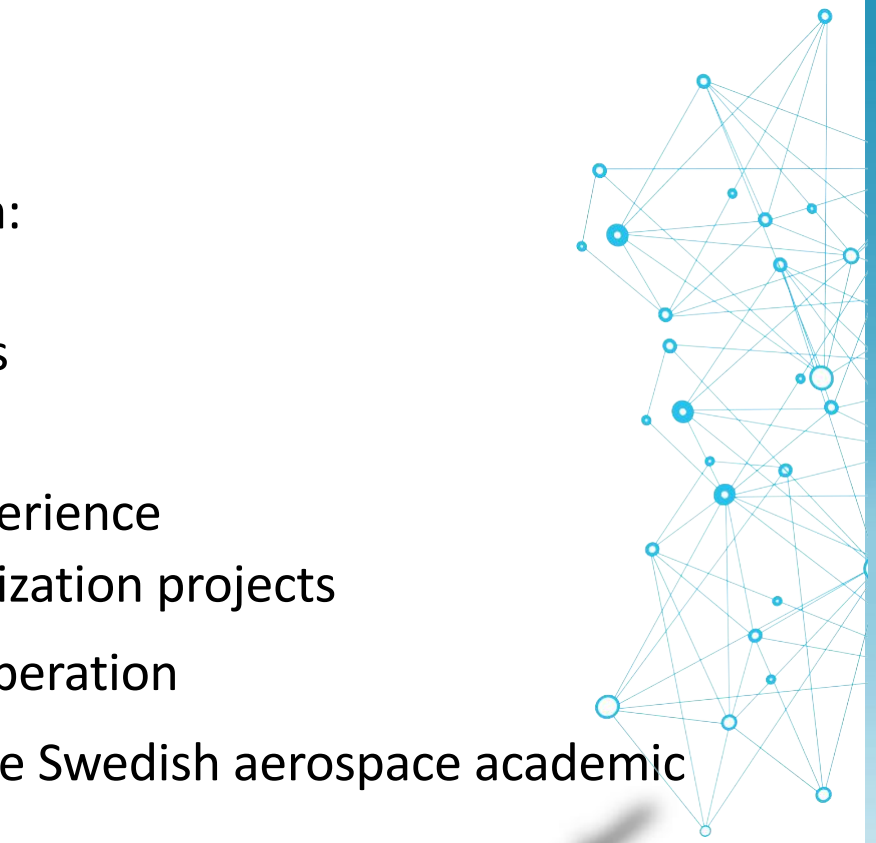
Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Hydrogen fuel system study

- Cryogenic/high-pressure hydrogen storage system:
  - Material selection
  - Weight estimation
  - Identify challenges:
    - TRL
    - Manufacturability (composites)
    - Durability/reliability
    - Safety and integration issues

Expected Output

- **Common ground** for collaboration:
  - "Digital" infrastructure
  - Language, stages and methods
- **Training** for SARC PhD students:
  - Networking and hands-on experience
  - Multi-disciplinary/multi-organization projects
- **Recommendations** for future cooperation
- Strengthen the **dialogue** within the Swedish aerospace academic research and exploit **synergies**
- And, perhaps… a **nice-looking** airplane too!



1st SARC-BARINET

AEROSPACE COMPETITION

COLLABORATIVE UNMANNED AERIAL VEHICLES

Competition Title	Collaborative Unmanned Aerial Vehicle
Themes	Multidisciplinary approach Technologies in the field of *”systems of systems”*
Organization	Open to participants from industry (start-ups) and academia (Doctoral and Research)
Goals	**Simulate** a self-defined mission where 3 or more UAVs **collaborate** towards completion. **Demonstrate** the mission with a single UAV
Evaluation	White paper and video submission Level of innovation; Business case; Engineering achievements; Scientific contribution

Partners and Organizers

- SAAB
- Innovair
- Aerospace Cluster Sweden
- CISB
- SARC
- BARINet

- Sweden
  - KTH Kungliga Tekniska Högskola
  - Chalmers Universitet
  - Linköping Universitet
  - Luleå Tekniska Universitet
- Brazil
  - Istituto Technológico de Aeronáutica
  - Universidade de São Paulo
  - Univesidade Federal de Santa Catarina
  - Universidade Federal de Minas Gerais

Chair: *Raffaello Mariani* (KTH - SE)
Co-Chair: *Glauco Caurin* (University of São Paulo – BR)

Advisory Board - SE

Magnus Ahlström – SAAB
Björn Jonsson – Innovair/FMV
Anders Blom - Innovair
Mats Olofsson - Innovair

Advisor Board - BR

Col. Roberto Follador – EMAER
Daniel Moczydlower – EMBREAR X
Manuel Steidle – CERTI
Ricardo Mangrich - MCTI

Jury Board

Christina Ahremark - Engineer, Development and Future air concepts (Swedish Armed Forces)
Jens Alfredsson - Human Factors / Human Machine Interaction (SAAB)
Fabio Andrade de Almeida – Director of the Institute for Advanced Studies (IEAv) of the FAB – Col Eng
Julio Bolzani - Head of Autonomous Systems (EMBRAER)
Tommy Busk - Aeronautics Strategy Department (SAAB)
Billy Fredriksson – Private Consultant
Anders Gustafsson – Innovair
Gunnar Holmberg - Director Business Development Future Air Systems (SAAB)
Josmar Carreiro Freitas – CMG(T) (Brazilian Navy)
Roland Karlsson - Swedish Society for Aeronautics and Astronautics
Mauricio Pires Malburg da Silveira – CMG(T) Program Manager SisGAAz (Brazilian Navy)
Angelo Naressi - New Business Strategy Manager (EMBRAER)
Mats Olof-Olsson - Engineer, Air Materiel Systems and Aircraft (Swedish Armed Forces)
Jesper Tordelind - Project Manager WASP WARA-PS (Combitech)
Magnus Tormalm - Senior Scientist, Flight Mechanics (FOI)

February 2021

- Competition Announcement

March 2021

- Registation of interest
  - 25+ (including non-eligible)

April 2021

- Team registration
  - 18 teams (SE – 6; BR – 12)
  - 5 companies – 12 univesities – 1 independent

September 2021

- Submission
  - 6 teams: 5 univesities - 1 independent
- Final decision

October 2021

- Award ceremony

Runner-Up

- Team Chalmers (Sweden)
  - Ola Benderius
  - Thomas Grönstedt
  - Xin Zhao
  - Isak Jonsson
  - Carlos Xisto

- Quadcopter, fixed wing, and marine drones for search and rescue

Setup of a triplet of UAVs designed for a rescue mission using autonomous all-weather UAVs. Re-use by surface re-capture. The project will explore multi-role activities by coordinated optical search of person(s) in distress and developing optimal trajectories for search. Mapping out of search area using GPS and recorded trajectories. Optimization of different scenarios for either UAV-to-UAV communication or for UAV-ship-UAV communication.

Winner

- Flying U2
  - Kelen Cristiane Teixeira Vivaldini
  - Lidia Gianne Souza da Rocha
  - Kenny Anderson Queiroz Caldas
  - Diego Pavan Soler
  - Igor Araujo Dias Santos
  - Flavio Pires Olivia
  - João Roberto Soares Benevides
  - Pedro Henrique Correa Kim
  - Paulo Victor Galvão Simplício
  - José Ceron Neto

- Multi-UAV Collaborative System for the Identification of Surface Cyanobacterial Blooms and Aquatic Macrophytes

Today Brazilian energy generation companies battle invasive species in their hydroelectric lakes: algae. So, we propose an algae detection, combat, and control system. It consists of: one tethered mini-multicopter; a group of quadrotors; and one boat robot. They cooperate to maximize the aerial robots' flight autonomy and inspection range. All coordination and collaboration between the robots are carried out by a communication system embedded in each mini-multicopter. The boat provides energy, processing power, and mobility on the lake's surface for the flying robot. The mini-multicopter detects the presence of algae in their early life stages on the water surface based on phosphorescence sensors data while flying over the lake. When infestation areas are detected, the mini-multicopter activates a group of quadrotors that are onboard the boat. Then they fly to that infestation area, spread algaecides to control the infestation, land on the water, and wait for the next target area.

SARC

SARC

Start About SARC Divisions Events Contact

Upcoming Events

PhD/industry course: Engineering Design Optimization (EngDesOpt)

PhD Course (2021), 7.5 HEC (7.5 higher education credits) Industrial participants in the aerospace industry (diploma course) Duration November 8th-9th and 22th-23th; December 13th See the detailed schedule in the...

Find out more »

SARC-BARINET Aerospace Workshop, SBAW2021

Preliminary programme: BR SE Day 1, Nov 18 8:30 12:30 Welcome and Introduction 8:30 12:30 Alessandra Holmo CISB Welcome 8:35 12:35 Petter Krus LiU Welcome 8:40 12:40 Emilia Villani ITA...

Find out more »

« Previous Events

On-line event Nov 18-19

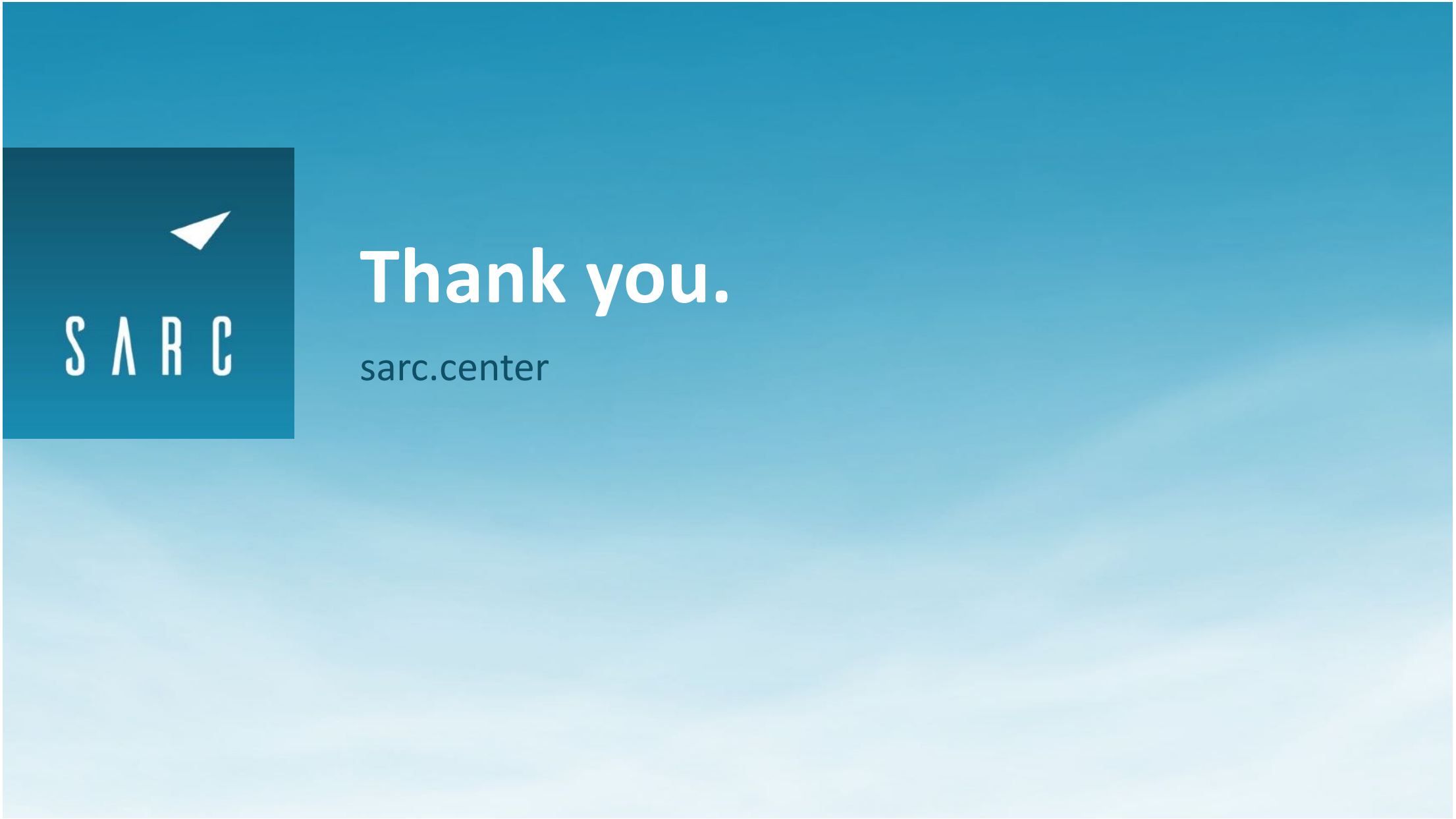
BARINet

SARC

SARC-BARINET Aerospace Workshop, SBAW2021

BR	SE	Person/Chairman	Affiliation	Topic	email
		Day 1, Nov 18			
8:30	12:30	Welcome and Introduction			
8:30	12:30	Alessandra Holmo	CISB	Welcome	alessandra.holmo@cisb.org.br
8:35	12:35	Petter Krus	LiU	Welcome	petter.krus@liu.se
8:40	12:40	Emilia Villani	ITA	Welcome	evillani@ita.br
BR	SE	**Session A- Low Emission**	Fernando Catalano (ITA) and Tomas Grönstedt (Chalmers)		
8:45	12:45				
9:00	13:00	José Faundez Alarcon	KTH	Active control of boundary-layer instabilies	josfa@kth.se
9:05	13:05	Diego Audiffred	ITA		
9:10	13:10	Stefan Wallin	KTH	Dynamics of the deployment of a Krüger high-lift device by numerical simulations within the UHURA H2020 project.	stefanw@mech.kth.se
9:15	13:15	Pedro Bravo Mosqueira	USP	Low fuel burn configuration	
9:20	13:20	Fabiola Costa	Chalmers	Propeller performance and noise prediction	
9:25	13:25	Round table discussion			
9:35	13:35	Daniel Rosell	Chalmers	Military engine performance modelling and	
9:40	13:40	Marcos Vinicius	USP	Distributed electrical propulsion	
9:45	13:45	Oliver Sjögren	Chalmers	Conceptual modelling and design of future	
9:50	13:50	Round table discussion			
10:00	14:20	**Break**			
		Session B - Aeroacoustics	Susann Boij (KTH) & André Cavalieri (ITA)		
10:10	14:10				
10:15	14:15	Gonzalo Montero Villar	CTH	Aeroacoustics modeling for propulsion	
10:25	14:25	Alex Sano	ITA		
10:20	14:20	Mihai Mihaescu	KTH	LES of Supersonic Jets at High Temperatures: Flow and Aeroacoustic attributes	mihai@mech.kth.se
10:25	14:25	Gabriel Gouveia	USP	Slat noise control	
10:30	14:30	Marily Thoma	CTH	Noise and emissions interdependency modelling	
10:35	14:35	Round table discussion			
BR	SE				
10:45	14:45	**Break**			
BR	SE	**Session C - Aerospace Systems**	Victor de Negri, Petter Krus		victor.de.negri@ufsc.br, petter.krus@liu.se
10:55	14:55	Magnus Eek	Saab	System modelling and simulation at Saab	
11:10	15:10	Dimitri Oliveira e Silva	UFSC	Electro hydrostatic actuator	dimitri.oliveira@unifesspa.edu.br
11:15	15:15	Christopher Reichenwallner	LiU	Design perspectives for aircraft actuation systems	christopher.reichwallner@liu.se
11:20	15:20	Artur Tozzi C. Gama	UFSC	Multi-mode actuators	arturcantuaria@gmail.com
11:25	15:25	Ludvig Knöös Franzén	LiU	Ontologies for system of systems	ludvig.knoos.franzen@liu.se
11:30	15:30	Round table discussion			
11:40	15:40	Presentation of SARC-BARINET competition			

BR	SE	**Day 2, Nov 19**			
BR	SE	**Session D -Systems Engineering and SoS**	Emilia Villani, Ingo Staack		
8:30	12:30	Christopher Jouannet	Saab	SoS at Saab	
8:40	12:40	Jorge Lovaco	LiU	Fire fighter system modelling	jorge.lovaco@liu.se
8:45	12:45	Vitor SantAna	UFT	Neuro fuzzy modelling of aerodynamics	vitortsantana94@gmail.com
8:50	12:50	Robert Hallqvist	LiU/Saab	Digital twin	robert.hallqvist@saabgroup.com
8:55	12:55	Round table discussion			
9:05	13:05	Jens Alfredson	Saab	HMI at Saab	Jens.Alfredson@saabgroup.com
9:15	13:15	Karl Kindström Andersson	Saab/LiU/FMS	Design for system of systems	karl.kindstrom-andersson@saabgroup.com
9:20	13:20		USP		
9:25	13:25	Alexandra Oprea	LiU/Saab		alexandra.oprea@liu.se
9:30	13:30	Round table discussion			
BR	SE	**Session E - UAV, Autonomous Systems and AI**	(Roberto Gil da Silva, Fredrik Heintz)		
9:40	13:40	Fredrik Heinz	LiU		fredrik.heintz@liu.se
9:55	13:55	Andrew Sarmento	ITA	Sensor fusion applied to GNS of autonomous sybms	andrew.g.p.sarmento@gmail.com
10:00	14:00	Siwat Suewatanakul	KTH	Hybrid/Electric Unmanned Aerial Vehicles Development at KTH Aeronautics – An Overview	siwat@kth.se
10:05	14:05	Danilo Sartori Alarcon	USP	A Reinforcement Learning Approach for eVTOL	danilo.alarcon@usp.br
10:10	14:10				
10:15	14:15	Round table discussion			
10:25	14:25	Break			
BR	SE	**Session F - Aerospace Structures, Manufacturing and Materials**	Ola Isaksson, Mariano Arbelo		
10:30	14:30	Dan Zenkert	KTH	Shape Morphing Carbon Fibre Composites	danz@kth.se
10:45	14:45	Viktor Sandell	LTU	Defect based fatigue life prediction of additive manufactured titanium alloy	viktor.sandell@ltu.se
10:50	14:50	Dante Krivtzoff De Grandis	ITA		dantekdg@gmail.com
10:55	14:55	Oliva Borgue	Chalmers Luxemburg	Qualification methodology for additive manufacturing space application (aerospace)	borgue@chalmers.se
11:00	15:00	Felipe Ruivo Fuga	ITA		felperuivofuga@gmail.com
11:05	15:05	Vivek Pakkam Gabrial	LTU	Intralaminar cracking in GF/EP laminate composites	vivek.pakkam@ltu.se
11:10	15:10	Round table discussion			
11:20	15:20	Break			
BR	SE	**Session G - Space**	Anna Ohrwall		
11:25	15:25	René Laufer	LTU		
11:40	15:40	Lida			
11:45	15:45	Bernd Weiss	LTU	Re-use of space debris (business)	bernd.weiss@ltu.se
11:50	15:50	Student from Talita	UFSC		
11:55	15:55	Round table discussion			
12:05	16:05	Margot Clauss	LTU	Re-use of space debris (tech)	margot.clauss@ltu.se
12:10	16:10	Christopher student			
12:15	16:15	Didun Collarede	LTU/GKN	Project DYKAM	didunoluwa.oblanade@ltu.se
12:20	16:20	Round table discussion			
12:30	16:30	Closing discussions			


SARC
Thank you.
sarc.center