SARC / SC2C.Aero 5-Day Conceptual Aircraft Design Course with Daniel P. Raymer

2019-03-18-22 (17-23)

1. Outline

Welcome to the first SARC.Academy course in collaboration with SC2C.Aero. We collected in this information some important facts you should know when preparing your travel to Florianópolis, Santa Catarina, Brazil.

You can find information about **SARC – Swedish Aeronautical Research Center** at www.sarc.center and about **SC2C.Aero – Santa Catarina's Center of Convergence for Aerospace Technologies** at http://sc2c.ufsc.br/

2. Program

Day	Time	Program
Sunday, 17th	17:00 – 18:00	SARC presentation (Dan Henningson) SARC.Academy information (Ingo Staack) SARC-SC2C.Aero Collaboration & Opportunities (Petter Krus & Victor De Negri)
	19:00 – 21:00	Reception
Monday – Friday		**Course lectures** (see own lecture plan below)
Thursday, 22th	19:00 – 22:00	**Dinner**
Friday, 22th	15:00 – 18:00	**Visit to the Federal University of Santa Catarina and CERTI Foundation**. Visitation to laboratories at UFSC and CERTI Thereafter: free evening.
Saturday, 23t **(Swedish participants only)**	10:00-11:30	**Future Collaboration and Research Planning:** open discussion Session lead by Prof. Petter Krus and the SARC.research team. Take this opportunity to find like-minded researcher/Ph.D. students to broaden your research and expertise horizon!
	11:30 – 12:30	Presentation and WP planning of the **SARC collaborative Ph.D. project** (Tomas Grönstedt)
	14:00 – 18:30	**Social Event by endorsement:** Excursion by bus through local beaches **OR** Marine cruise on the Florianopolis bay

3. Organization, Travelling and Venue

Travelling

Travelling must be individually organized by the participants. We recommend highly to attend the introduction on Sunday before course start and, for the Swedish participants, the closing session on Saturday after the course.

Venue

The course will be given at the Jurerê Beach Village Hotel, Florianópolis. A contingency of discounted rooms is available for the participants. The hotel and course room are directly located on the beautiful Jurerê strand.

Figure 1: Impressions from the Jurerê Beach Village Hotel.

A paradisiac island with 42 preserved beaches, enriched by valued history and culture together with an index of quality of life to envy. So is Florianópolis, the state capital. Within many attractions, the Jurerê beach is one of the most desirable beaches and the heart of Jurerê Beach Village. With calm and crystal-clear sea and white sand, the beach is the perfect setting for any occasion. Its welcoming spaces are ideal for renewing the energy and enjoy the day without worrying. For those who want to get out of the rut, it offers more than just a fine structure.

Accommodation

The hotel provides a 10% discount on the room prices for the course participants. The reservations should be made directly with the hotel using the following booking code (online, mail or tel.):

JURERÊ INTERNACIONAL BOOKING CENTRAL
+55 48 3331.7200 reservas@jurere.com.br
www.jurerebeachvillage.com.br
PROMOCODE: **SARC_SC2C2019**
The reference prices are those at the hotel website.

4. Course Description

Course Schedule

Day	Morning Session	Afternoon Session
Monday	08:30 – 12:00	13:30 – 17:30
Tuesday	08:30 – 12:00	13:30 – 17:30
Wednesday	08:30 – 12:00	13:30 – 17:30
Thursday	08:30 – 12:00	13:30 – 17:30
Friday	08:30 – 12:00	13:30 – 17:30

The course language is English (AE).

Course Outline

Lecture	Topic
1	**INTRODUCTION:** Overview of the design process, requirements definition, end products of design.
2	**QUICK DESIGN & SIZING TECHNIQUES:** Methods to quickly determine aircraft weight and size required to meet mission requirements, rapid aero/weights/propulsion methods, design trade studies.
3	**WING/TAIL GEOMETRY SELECTION:** Selection of wing geometry and tail arrangement.
4	**THRUST-TO-WEIGHT AND WING LOADING, INITIAL SIZING:** Initial selection of wing loading and thrust-to-weight (or horsepower-to-weight) ratio to satisfy requirements such as stall speed, climb rate, and maneuverability. Refined estimation of takeoff weight and determination of fuselage, wing, and tail sizes.
5	**CONFIGURATION LAYOUT AND LOFT:** Design layout of a credible aircraft configuration arrangement including external geometry, conic lofting, flat-wrap development, smoothness verification, cross-section definition, and internal layout. Design layout of wings and tails including airfoil interpolation, trapezoidal and non-trapezoidal geometries, wing location guidelines.
6	**AERO & STRUCTURES CONSIDERATIONS:** Design guidance and rules-of-thumb for creation of configuration layouts with good aerodynamics and structural arrangement.
7	**SPECIAL CONSIDERATIONS:** Design impacts of observability (radar, IR, visual, and aural), vulnerability, producibility, and maintainability.
8	**SYSTEMS INTEGRATION:** Design integration of landing gear, hydraulics, electrics, pneumatics, and avionics.
9	**PAYLOAD, PASSENGERS, & CREW:** Design layout of the crew station, passenger compartment, cargo bays, and weapons integration.
10	**PROPULSION INTEGRATION:** Jet engine integration including engine selection, engine scaling, engine location considerations, inlet geometry and location, and nozzle geometry. Propeller engine integration including engine selection and location, cowling, and propeller sizing. Aircraft fuel system considerations.
11	**AERODYNAMIC ANALYSIS:** Methods for estimating the aerodynamic lift and drag from low subsonic through supersonic speeds, including the component drag build up method, the leading edge suction method, and the Sears-Haack wave drag method. Introduction to Computational Fluid Dynamics (CFD).
12	**STABILITY AND CONTROL ANALYSIS:** Methods for determining if the design satisfies essential stability and control requirements including trim, nosewheel liftoff, static stability, departure susceptibility, and spin recovery.
13	**PROPULSION ANALYSIS:** Methods for calculation of the installed net propulsive force for jet or propeller-driven aircraft, including installation corrections, inlet drag, nozzle drag, and propeller thrust.
14	**LOADS, STRUCTURES AND WEIGHTS:** Aircraft loads, aerospace materials and properties. Introduction to the Finite Element

	Method (FEM). Estimation of aircraft weights and mass moments using statistical models and corrections for advanced materials.
15	**PERFORMANCE ANALYSIS:** Performance analysis methods for level flight, climb, glide, takeoff, landing, and maneuver. Energy maneuverability methods for combat analysis and minimum time/fuel to climb. Fighter measures of merit including agility and post-stall maneuver.
16	TRADE STUDIES AND COST ANALYSIS: Refined sizing techniques and discussion of industry methods. Sizing matrix and carpet plot optimization techniques, along with Multidisciplinary Optimization (MDO) methods. Use of performance constraint curves to determine the optimal aircraft. Life Cycle Cost analysis using statistical and operational data. Airline economic analysis
17	**COMPUTER-AIDED CONCEPTUAL DESIGN:** Use of CAD in the conceptual design environment, tools for facilitating initial design layout and design iteration. Demonstration of conceptual design CAD and integrated analysis and optimization including MDO methods (RDSwin-Pro).
18	**VTOL, HELICOPTER, AND DERIVATIVE AIRCRAFT DESIGN:** Overview of jet VSTOL design and analysis including concepts and integration issues. Helicopter aerodynamics, performance, controls, design, and sizing techniques. Design considerations for development of derivatives of existing aircraft, including performance, weight, and cost estimation.
19	**INNOVATIVE DESIGN CONCEPTS:** Overview of innovative design concepts including Canard, Flying Wing, Joined-Wing, Blended Wing Body, Unmanned Aircraft (UAV), Asymmetric, and others.
20	**DESIGN EXAMPLES:** Review of prior lessons by a step-by-step design examples from initial requirements and first sketch to completed configuration layout and optimization

Course Examination

The course examination is based on a design project that has to be completed within 2 months after the class. The design task will be described on the last course day. Limited support by the instructor is available during this period. The work will be graded on a 1-100 scale. If the score is high enough to pass the course, you will receive a SARC diploma worth 6HP (grading scale: pass/fail).

Remark: At the end of the day it is the responsible Professor (your supervisor) that decides how that translates into their grading system. E.g. for a high score (a very detailed and extremely good design project work you possibly could get even more than the 6HP).

About the Instructor -Daniel P. Raymer, Ph.D.

The 2010 recipient of the AIAA Aircraft Design Award, Dr. Daniel Raymer is a recognized expert in the areas of Aerospace Vehicle Design and Configuration Layout, Computer-aided Design Methodologies and Design Education. An AIAA Fellow and recipient of the AIAA Summerfield Book award, he was named Rockwell Engineer of the Year for his pioneering work in aircraft computer-aided conceptual design. Dr. Raymer is the author of the best-selling textbook "Aircraft Design: A Conceptual Approach" and the mass-market books “Dan Raymer’s Simplified Aircraft Design for Homebuilders” and “Living in the Future: The Education and Adventures of an Advanced Aircraft Designer.” He regularly teaches his popular five-day Aircraft Conceptual Design Short Course, a two-day Advanced Aircraft Design Short Course, a three-day Short Course in Aircraft Design Management, Requirements Definition, and System Engineering, and a course in Unmanned Air Vehicle (UAV) Design.

Dr. Raymer is President of the design and consulting company, Conceptual Research Corporation, and conducts design studies and consulting for NASA, the USAF Research Lab (WPAFB), DARPA, Composite Engineering Inc., and others. He is a regular Forum Speaker at the EAA AirVenture (Oshkosh). His previous positions include Director-Advanced Design with Lockheed, Director-Future Missions at the Aerojet Propulsion Research Institute, and Project Manager-Engineering at Rockwell North American Aviation. He was Head of Air Vehicle Design for X-31 during the conceptual design phases, and was intimately involved in the actual configuration definition. He also consulted with both RAND and CNA during the JAST/JSF concept development phase.

Dr. Raymer received B.S. and M.S. engineering degrees in Astronautics and Aeronautics from Purdue, an MBA from the University of Southern California, and a Doctorate of Engineering (Ph.D.) from the Swedish Royal Institute of Technology (KTH) in the field of Aircraft Multidisciplinary Design Optimization. He is a recipient of the Purdue University Outstanding Aerospace Engineer Award given to "honor those alumni who have distinguished themselves in the aerospace industry".

Course Material

Basic course material will be supplied free of charge during the course. However, for the design task after the course, the Raymer book (“Aircraft Design: A Conceptual approach”) is of great advantage. No books or discounts available at the course so please purchase the book in advance or after the course on your own!

5. Florianopolis, the Island of Magic and Innovation

Location of SC state

Santa Catarina is a state of Brazil located in the south region. The population is 6.8 million people and the state occupies an area of 95,737 km2 (1.12 % of Brazil's area). Is one of the best states to live in Brazil according to the United Nations, having impressive indexes as Life expectancy of 78 y.o., HDI of 0.774 and GINI index equal to 0.451. The GDP is the 6th highest in Brazil, being 31% from the industry segment.

Campeche Island in Florianópolis

Florianópolis is the capital and second largest city of Santa Catarina state. It is composed of one main island, the Island of Santa Catarina, a continental part and the surrounding small islands. Florianópolis has a warm humid subtropical climate. The seasons of the year are distinct, with a well-defined summer and winter, and a typical mild weather during autumn and spring. Frost occurs occasionally in the winter. Due to the proximity of the sea, the relative humidity is around 80%.

Hercílio Luz Bridge

The city is famous for its natural beauties and life quality – the best among all the Brazilian capitals. It is not for nothing that the capital of Santa Catarina is known as the Island of Magic. There are several beaches spread throughout the island and the continental part. Find other attractions to visit, such as lagoons, the historical center, Azorean districts, Portuguese forts, and the city postcard: the Hercílio Luz Bridge. More information at http://turismo.sc.gov.br/en/cidade/florianopolis/.

Florianópolis' branding of smart city

Furthermore, Florianópolis is known as an innovation cluster with more than 600 technology companies, 2 high quality public universities, 4 venture capital funds, and 2 technology incubators. It is recognized by the Brazilian National Congress as the Brazil's Innovation Capital, besides to be chosen as one of the 10 best cities to work and live in the world (Newsweek), the friendliest city in world (Condé Nest Traveler) and is considered the best Brazilian capital in life quality.