Preliminary Airplane Design using SURFACES

Snorri Gudmundsson
Assistant Professor of Aerospace Engineering
Embry-Riddle Aeronautical University

Course Description:
This course provides a comprehensive look at SURFACES and how to design or evaluate aircraft using the program. The course begins with a simple introduction to the Vortex-Lattice Method. Then the user will be trained in proper construction of models, beginning with a simple wing-HT-VT configuration to a realistic modeling of an actual airplane that incorporates extended landing gear, ailerons, rudder, elevator, and high-lift devices. Additionally, the incorporation of power effects due to jets or propellers will be demonstrated. Users will be trained in creating a model using a standard three-view image. Students will be trained in troubleshooting incorrect paneling and other mistakes that may result in inaccurate results (do's and don'ts). Available construction tools, such as "point align", "vector break", "parametric curves", "surface split", "model repair", "point linking" and others will be demonstrated. The user will be trained in preparing a viable first CG envelope and how to extract moments and products of inertia from the model. Other topics include the use of control surfaces, static and dynamic stability, determination of stability derivatives, drag analysis, use of the Virtual Wind Tunnel. Simulation of aeroelastic deformation, load analysis, and dynamic simulation. Special design topics will be covered; how to design a winglet with SURFACES, as well as how to design canards and three surface aircraft. Introduction to asymmetric aircraft design will be given and how to evaluate capabilities of aircraft with battle-damage. Evaluation of the design's certifiability will be introduced as well. The participant will be awarded with a diploma at the end of the course.

Intended Audience:
Aircraft designers, engineers, and technical managers, who seek an introduction to rapid aircraft design methods. Background in math is required.

Course Duration and Price: 24 hours of instruction over 3 days (Monday through Wednesday). $2400.00 USD per participant (course only).

Instruction Method:
Participants must bring own laptops along with a proof of a valid SURFACES license. The student is expected to create all models in sync with the instructor. Each participant will be provided with a paper copy of course material as well as a free upgrade to the latest version of SURFACES. Casual classroom setting. Coffee, tea, and cold beverages will be provided.

Tentative Class Schedule[1]:

Day 1	8:30am	Introduction to the Vortex-Lattice Method.
	9:30am	Validation examples. Advantages and shortcomings of the method. SURFACES as a multi-disciplinary tool (aerodynamics, S&C, loads).
	10:30am	Introduction to Constraint Analysis. Creation of a simple model using the sample "MyFirstAirplane".
	12:00pm	Lunch.
	1:00pm	Creation of a cranked wing, HT, and VT from scratch. Model repair. Setup of geometric relationships. Various model creation tools.
	2:00pm	Practice session.
	3:00pm	Incorporation of control surfaces. Fuselage creation.
	4:00pm	Creation of an airplane from a 3-view image.
	5:00pm	End of Day 1.

[1] Note that this schedule is tentative and ultimately depends on the abilities of the student.

Day 2	8:30am	Estimation of aircraft component weight. Incorporation of inertia into model. Determination of CG, moments and products of inertia. Study of CG movement and component arrangement.
	9:30am	Running the model. Solution troubleshooting. Do's and Don'ts. Solver parameters. Handling of large deflection control surfaces.
	10:30am	Control of flight condition, determination of stick fixed neutral point. Preliminary assessment of stick-free neutral point.
	12:00pm	Lunch.
	1:00pm	Trimming at a flight condition. Crash course in performance analysis. Simplified and Adjusted drag modeling. Drag models that feature "drag buckets." Determination of a flight envelope. Selection of conditions inside the flight envelope.
	2:00pm	Determination of static and dynamic stability derivatives. Determination of control surface deflection derivatives.
	3:00pm	Determination of required angle of incidence for a wing and HT. Design for gentle stall characteristics.
	4:00pm	Running the Virtual Wind Tunnel. Surface tuning. Setup of drag analysis. Automated skin friction analysis.
	5:00pm	End of Day 2

Day 3	8:30am	Design of canard aircraft using SURFACES. Pros and cons of the configuration.
	9:30am	Design of three-surface aircraft using SURFACES. Pros and cons of the configuration.
	10:30am	Evaluation of the certifiability of a new design using SURFACES.
	12:00pm	Lunch.
	1:00pm	Design of asymmetric aircraft using SURFACES. Pros and cons of the configuration.
	2:00pm	Survivability and resilience of military aircraft with battle damage (partial wing, HT, or VT).
	4:00pm	Discussion. Course evaluation FAQ. Conclusion of Course: Diploma Awarded.
	4:30pm	End of Day 3