M.Eng Project or Undergrad Research Internship (CUSRA/USRA/COOP): **Parametric Aerospace Design Tools**

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This project at the Aircraft Systems Lab aims to compare the capabilities of parametric design tools for aerospace concept design, which have the potential to streamline the design process and create interactive environments for an improved exploration of novel configurations and architectures.
Timeframe: Summer 2025

Background

The aerospace industry is pursuing more efficient, eco-friendly aircraft designs. This process begins at the conceptual stage, where designers can freely explore novel configurations and system architectures. This flexibility involves evaluating a wide range of geometric alternatives with drastic implications for aerodynamic performance, thermal management, system safety, and propulsion. Rapid iteration and assessment help understand competing objectives such as weight, drag, heat dissipation, and manufacturability.

Parametric and knowledge-based engineering (KBE) design tools play a major role at this stage by providing the flexibility to define, modify, generate, and evaluate geometries based on key design variables [1, 2]. Additionally, these tools expedite the integration of multidisciplinary analysis and optimization (MDAO) workflows to find optimal designs in problems including several interacting disciplines.

As novel architectures like blended wing bodies and hybrid-electric propulsion emerge, conceptual design tools must handle more complex subsystem integrations and analyses. Traditional CAD tools are often inadequate for tasks like thermal management in more electric aircraft or the aerodynamic optimization of unconventional geometries, which require tighter integration between geometric modeling and physics-based simulations. Software tools like the Engineering Sketch Pad (ESP)[1] [3] and ParaPy [4], address these needs by enabling automated geometry creation, rule-based design, and direct interfaces to simulation and analysis environments.

Objectives

This project aims to compare ESP/CAPS and ParaPy for creating parametric models and integrating them with analysis tools. It will evaluate their strengths, weaknesses, and overall suitability for conceptual aircraft system design, considering ease of use, flexibility, scalability, and support for automated workflows.

The project also seeks to develop a parametric modeling tool for case studies in aircraft systems, such as avionics or actuation, using ESP/CAPS or ParaPy to generate geometry models and integrate them into multidisciplinary workflows. An optional goal is to incorporate some of the Aircraft System Lab's existing tools to assess compatibility with ongoing research.

Qualifications

- **Programming skills:** Knowledge of object-oriented programming and Python.
- **CAD modeling:** Solid understanding of the principles of computer-assisted design (CAD) and its main operations, such as lofts, extrusions, and revolutions.
- **Engineering design and optimization:** Familiarity with the engineering design process and some notions of optimization.

Additionally, experience with ESP/CAPS or ParaPy, familiarity with MDAO concepts and tools, knowledge of aircraft systems, and understanding of version control tools like Git are desired but optional qualifications.

How to Apply

Qualified and highly motivated candidates are invited to send their application by **February 14, 2025**[2], via email to Dr. Susan Liscouët-Hanke (susan.liscouet-hanke@concordia.ca) and Santiago Valencia Ibáñez (santiago.valenciaibanez@mail.concordia.ca) using the subject "**Parametric Aerospace Design Tools**" with the following elements:

- Email with your motivation and relevant experience
- A complete up-to-date CV
- Up-to-date transcript or overall grade of your current and/or past program
- Sample of writing skills (e.g., publication, term paper, project report)

Please refer to the Aircraft System Lab's statement on equity, diversity, and inclusion, posted here.

[1] As well as the associated Computational Aerospace Prototype Synthesis (CAPS) program.
[2] This date applies to ENGR 412 candidates.

References

[1] Sanchez, F., Liscouët-Hanke, S., and Tfaily, A., "Improving aircraft conceptual design through parametric CAD modellers – A case study for thermal analysis of aircraft systems," *Computers in Industry*, Vol. 130, September 2021, pp. 103467. doi:10.1016/j.compind.2021.103467.

[2] La Rocca, G., "Knowledge based engineering: Between AI and CAD. Review of a language based technology to support engineering design," *Advanced Engineering Informatics*, Vol. 26, No. 2, April 2012, pp. 159–179. doi:10.1016/j.aei.2012.02.002.

[3] Dannenhoffer, J., "An Overview of the Engineering Sketch Pad," *AIAA SciTech 2024 Forum*, American Institute of Aeronautics and Astronautics, Jan. 2024, pp. 1–15. doi:10.2514/6.2024-1315.

[4] ParaPy BV, "The ParaPy Platform," https://parapy.nl/features/. Accessed 2024-11-30.