Digital Design Network+
Case Study 1 Individual Report Template

Name	Jie Yuan
Email	j.yuan@soton.ac.uk
Institution	University of Southampton
Team	Team 1
Focus	Better, Faster, With Less
Design Process	Develop an agentic AI workflow to automate and accelerate the design process
Tools Used	LLM
Links	https://www.southampton.ac.uk/people/62gh2r/doctor-jie-yuan https://scholar.google.com/citations?user=1uyWN3oAAAAJ&hl=en

Executive Summary

This work presents an Agentic AI-driven framework for accelerated aircraft design and optimisation, addressing the growing complexity of multidisciplinary aerospace design. Traditional modelling workflows rely heavily on manual setup, expert-driven simulation campaigns, and iterative tuning, which limits scalability and slows down design exploration.

The proposed solution introduces a multi-agent large language model (LLM) framework capable of autonomously formulating problems, orchestrating simulations, and iteratively refining designs. By integrating reasoning, planning, and tool-use capabilities, the framework transforms static simulation pipelines into self-directed, adaptive digital design ecosystems, significantly enhancing efficiency and decision-making in early-stage aircraft design.

Problem

Drone design is a complex process involving many interacting disciplines, such as aerodynamics, structures, and performance. Current workflows require engineers to manually set up models, choose simulation parameters, and run optimisation studies. This is time-consuming, requires specialist expertise, and limits the ability to explore large design spaces. As a result, the process is not scalable enough for increasingly complex, modern aircraft design challenges.

Digital Design Solution

The solution is a multi-agent AI framework that can manage the entire design process. It starts by translating a design goal into variables and constraints, then different AI agents collaborate to build models, run simulations, and optimise the design. The system can analyse results and iteratively improve the design using past information. This creates a continuous, automated design loop that reduces the need for manual intervention.

How it makes Digital Design Better, Faster and/or With Less

- **Better:** The system can explore more design options and consider multiple physics interactions at once, leading to higher-quality and more robust designs.

- **Faster:** Automation of model setup, simulation, and optimisation significantly reduces the time required for each design iteration.

- **With Less:** It reduces the reliance on expert input and avoids unnecessary high-cost simulations by using efficient modelling strategies.

Reflection

This approach demonstrates strong potential to transform digital design by making it more autonomous and scalable. However, challenges remain, including integrating different engineering tools, managing data across models, and ensuring that results are reliable and trustworthy. There is also a need to develop skills and workflows that support the adoption of AI in engineering practice. Future work should focus on improving model efficiency, handling uncertainty, and enabling wider industry adoption.

References

Martins, J.R.R.A., & Lambe, A.B. (2013). *Multidisciplinary Design Optimization: A Survey of Architectures*. AIAA Journal, 51(9), 2049–2075.

Peherstorfer, B., Willcox, K., & Gunzburger, M. (2018). *Survey of Multifidelity Methods in Uncertainty Propagation, Inference, and Optimization*.

Xi, Z., Chen, W., Guo, X., et al. (2023). *The Rise and Potential of Large Language Model Based Agents: A Survey*. **arXiv preprint arXiv:2309.07864**.

Appendix

Flowchart of the LLM based aircraft design