



Digital Design Network+ Case Study 1 Individual Report

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Team	Group 4
Focus	Better, Faster, With Less
Design Process	Early-stage conceptual design and research workflow in mechanical/aerospace engineering: literature review & knowledge synthesis, research-gap identification, 3-year research-programme planning, automated generation of 3D CAD models, and setup of Multiphysics simulations.
Tools Used	▪ Multi-agent AI system (Python-based LLM agents using the full AI/ML ecosystem: NumPy, SciPy, PyTorch, Pandas, Matplotlib) ▪ IntelliResearch toolbox (core “Virtual PhD Student” platform) ▪ InteliQUBCAD (FreeCAD macro generator) ▪ Integration with commercial CAE tools (ANSYS, Abaqus) and open-source alternatives
Links	• Live demonstration delivered at EPSRC Digital Design Network+ workshop, Glasgow, February 2026 • Full presentation (Presentation_GA3.pptx) available on request • Prototype demo video in preparation (contact g.abdelal@qub.ac.uk)

Executive Summary

IntelliResearch is an AI-powered multi-agent platform that functions as a “Virtual PhD Student”. It automates the most time-intensive early-stage tasks in digital design and research: intelligent literature searching, paper summarisation, research-gap analysis, structured project planning, and direct generation of executable CAD and multiphysics simulation scripts.

Developed and refined with previous EPSRC IAA support, the tool was successfully demonstrated at the EPSRC Digital Design Network+ workshop in Glasgow. Early user testing already shows ~30 % time savings in literature reviews and 80 % user satisfaction. The platform is now being extended through integration with Dr Jiannan Yang’s uncertainty-aware mechanical design tool at the University of York.

Problem

In academic and industrial R&D, researchers typically spend 30–50 % of their time on repetitive, low-value tasks: manually searching and synthesising literature, identifying gaps, drafting research plans, and writing custom scripts for CAD and simulation tools. These bottlenecks slow design iteration, limit creativity, and create a high barrier for early-career researchers and interdisciplinary teams.

Digital Design Solution

IntelliResearch deploys a collaborative team of five specialised AI agents that work together autonomously:

Requirement Analysis Agent – extracts constraints and needs from user text + image input.

Research Agents – perform targeted literature search and produce concise, structured summaries.

Coding Agent – generates ready-to-run Python macros (FreeCAD for CAD; ANSYS/Abaqus scripts for multiphysics).

Execution Agent – runs the generated code in the target environment.

Debugging Agents – perform up to three iterative correction cycles.

The user simply inputs a research topic or design requirement (e.g., “Multiphysics analysis of a wildfire-response drone”). The system then returns:

A full literature-review report

Identified research gaps

A complete 3-year research programme with work packages and tasks

Generated 3D CAD geometry (InteliQUBCAD)

Ready-to-execute Multiphysics simulation scripts.

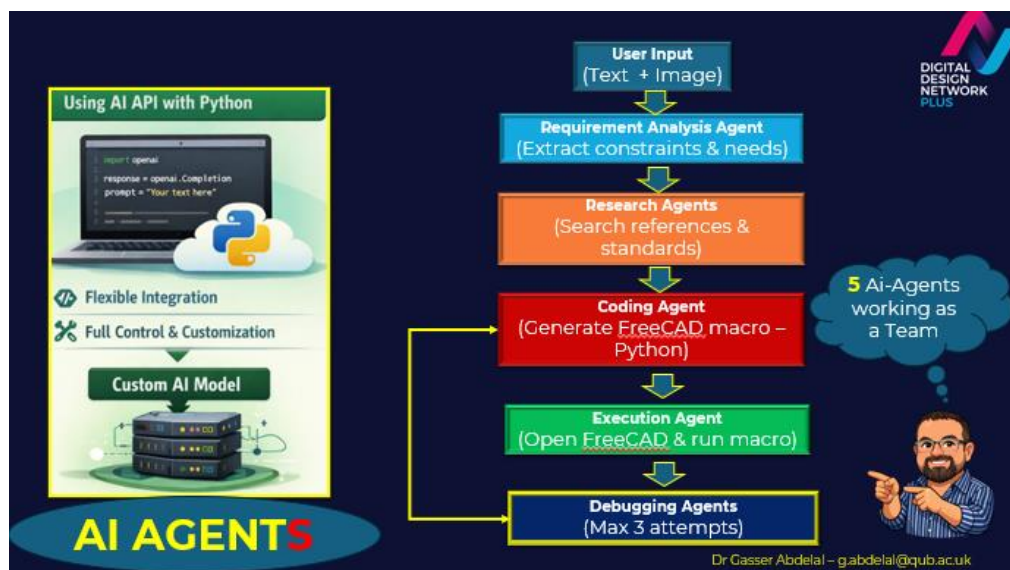


Figure 1 – “5 AI-Agents working as a Team” workflow diagram.

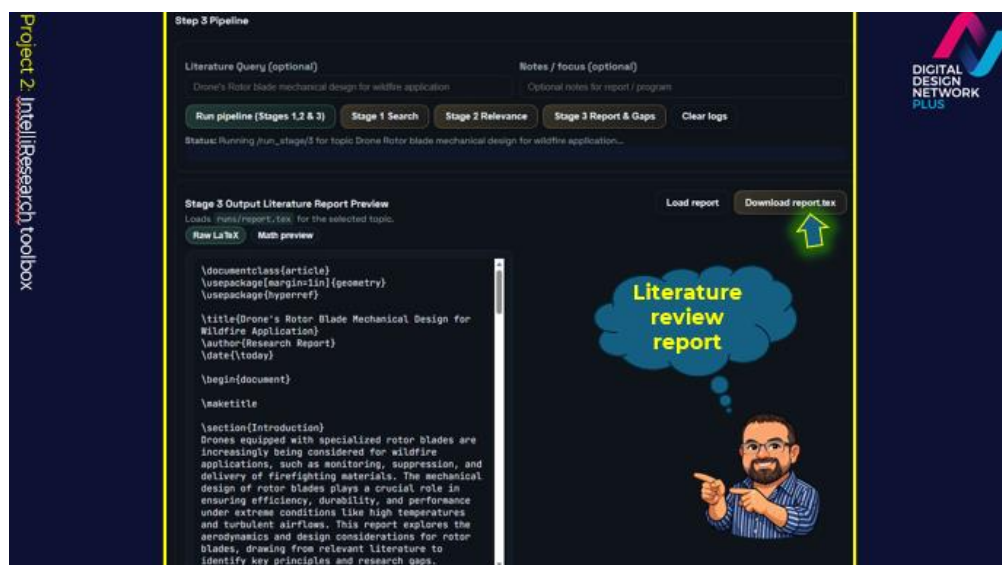


Figure 2 – Example literature-review report output.



Figure 3 – AI-generated 3-year research programme.

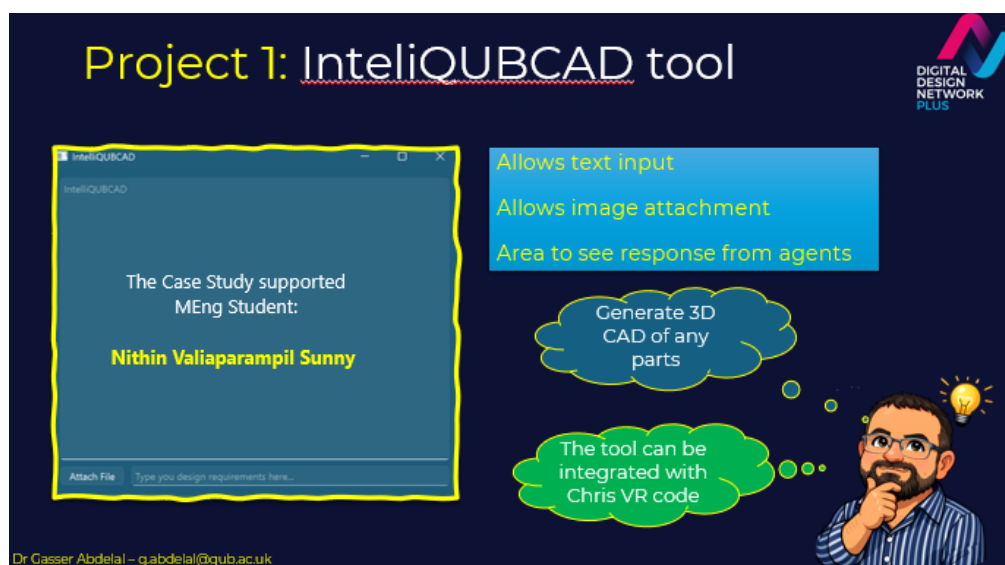


Figure 4 – IntelliQUBCAD interface with drone rotor-blade example.

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

Faster: Early testing demonstrated ~30 % reduction in time spent on literature reviews and planning; CAD and simulation script generation is near-instantaneous instead of hours/days of manual coding.

Better: Multi-agent collaboration with internal review and debugging produces more structured, gap-aware, and technically accurate outputs than single-prompt approaches. Integration with uncertainty-aware tools (planned with University of York) will further improve design robustness.

With Less: Researchers are freed from repetitive tasks, allowing them to focus on high-value creative decision-making. Non-expert users (e.g., MEng students) can now generate complex CAD and multiphysics models without deep Python/CAE scripting knowledge.

Reflections

The Glasgow workshop demonstration confirmed strong demand for tools that genuinely augment rather than replace human expertise. The biggest remaining challenges are: (1) ensuring explainability and trustworthiness of agent decisions, (2) seamless integration with proprietary industrial CAE workflows, and (3) scalable adoption across disciplines.

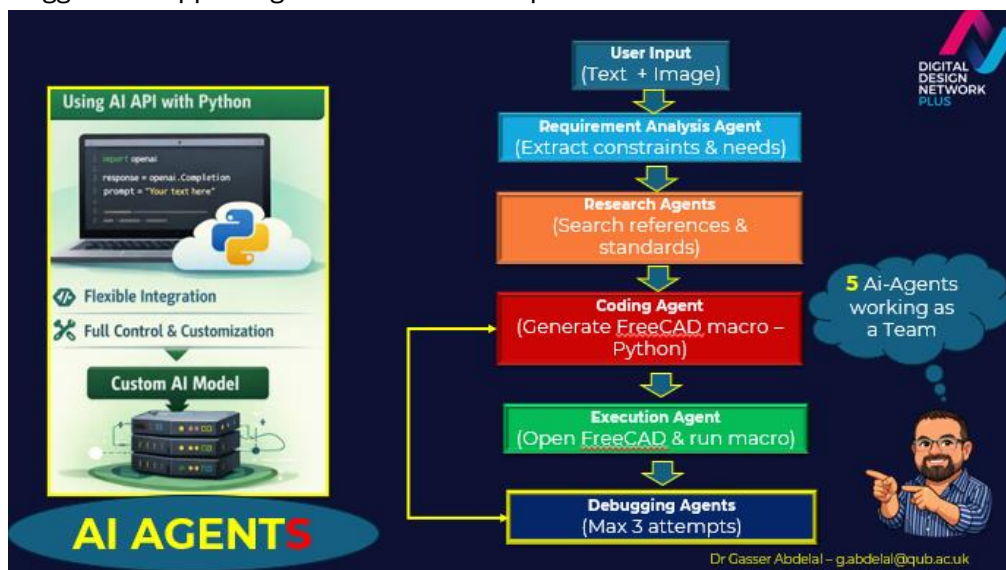
Future R&D should prioritise responsible innovation (bias audits, data privacy, environmental impact of compute) and hybrid human-AI co-creation models. The planned QUB–York integration under EPSRC IAA funding will address uncertainty quantification, creating a genuinely end-to-end digital-design platform. Overall, this work highlights the enormous potential of multi-agent AI to accelerate UK digital-design capability while raising important questions about skills, adoption, and value capture in the research ecosystem..

References

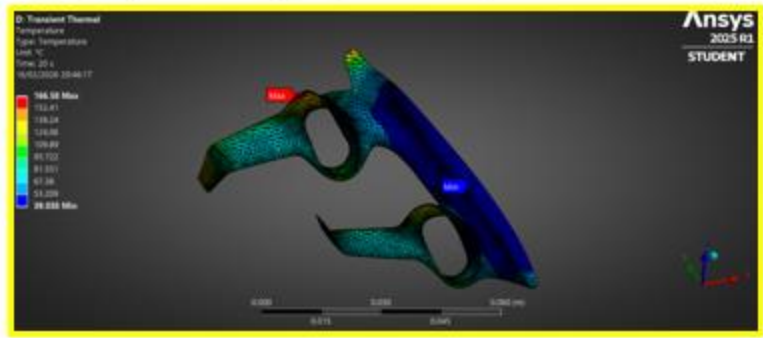
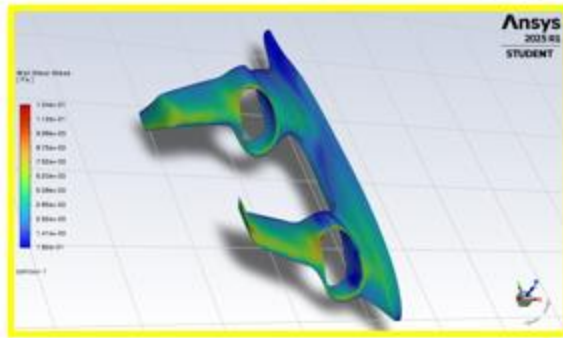
1. Abdelal, G. (2026). Multiphysics R&D using AI Agents. Presentation delivered at EPSRC Digital Design Network+ workshop, Glasgow.
2. EPSRC IAA Impact Report – IntelliResearch Phase 1 (2025). Queen’s University Belfast..

Appendix

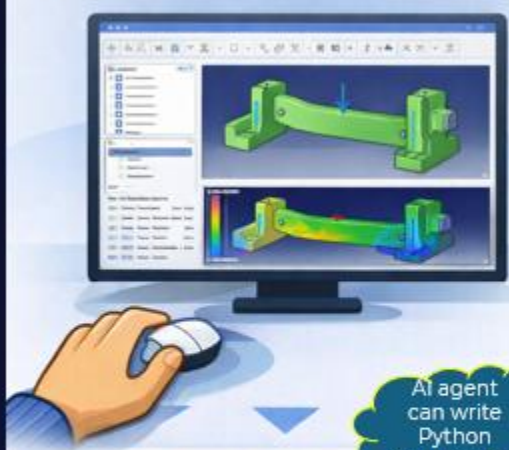
Suggested supporting media for network promotion:



A Multiphysics Simulation Approach for Efficient Modeling of Lightning Strike Tests on Aircraft Structures
 Publisher: IEEE
<https://ieeexplore.ieee.org/document/7880665>



Using GUI for Mechanical Modeling & Simulation



- Drag & Click
- Visual Modeling
- Interactive Analysis

AI agent can write Python commands



Using ABAQUS Python Code



- Write Scripts
- Programmatic Modeling
- Batch Analysis

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