Digital Design Network+
Case Study 1 Individual Report Template

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Institution	University of Strathclyde
Team	Team 2
Focus	Better, Faster,
Design Process	Specification Development, Conceptualisation, Embodiment
Tools Used	Lens.org + PATENTSCOPE (data); CLIP + FAISS + PyTorch (search); OpenAI (design insight); Flask + Python (app); Vizcom + Quicksurface + SolidWorks (CAD pipeline)
Links	This was all run on machine locally and in PowerPoint gifs.

Executive Summary

This project explores how artificial intelligence (AI) and patent data can be integrated into the digital design workflow to accelerate early-stage and embodiment CAD concept development for drone systems. A web-based prototype tool was developed in which a designer provides a visual prompt (sketch, CAD model view, or photograph). This image is processed to retrieve a gallery of patent figures drawn from over 1300 vertical take-off drone patents and ranked by visual similarity using AI-based embeddings. Results can be adjusted to favour convergence (close matches) or divergence (novel alternatives), supporting different design intents. Each result is enriched with contextual indicators, including patent "alpha" (strength based on factors such as geographic protection, scientific citations, and commercial linkage), legal status (pending, active, lapsed), and the full abstract. For selected patents, an LLM-driven analysis extracts key design intent for CAD, including salient geometry and functional parameters. The workflow extends downstream through rapid 2D-to-3D model generation, enabling initial CAD geometry to be derived from patent images and refined using reverse engineering tools (e.g. Quicksurface) into parameterised models.

Overall, the work demonstrates a pathway for embedding patents and technical literature into the front end of the digital thread, supporting requirements capture, concept generation, and design embodiment, while enabling more exploratory and informed design processes.

Problem

Digital design workflows, particularly in aerospace and UAV development, rely heavily on internal knowledge, prior designs, and structured requirements processes. Meanwhile, a vast external knowledge base exists in patents and technical literature that remains largely disconnected from the design process. This gap is increasingly significant given the rapid growth of UAV-related intellectual property, with the B64U classification alone accounting for around 40,000 inventions in five years, linked to approximately 19,000 technical publications. Platforms such as Lens.org are beginning to connect these sources and provide developer access, but their integration into design workflows remains limited.

As a result, drone specification development, early-stage concept generation, and embodiment design are often time-intensive, constrained by prior experience, and limited in their exploration of existing solutions. The design intent embedded within patents is rarely utilised, despite containing rich geometric, functional, and system-level information. In practice, patents are difficult to search and interpret efficiently for design inspiration, are not aligned with CAD workflows, and are seldom integrated into digital engineering toolchains. This creates a clear gap where valuable prior art is underutilised in concept development, ultimately slowing innovation and reducing design diversity.

Digital Design Solution

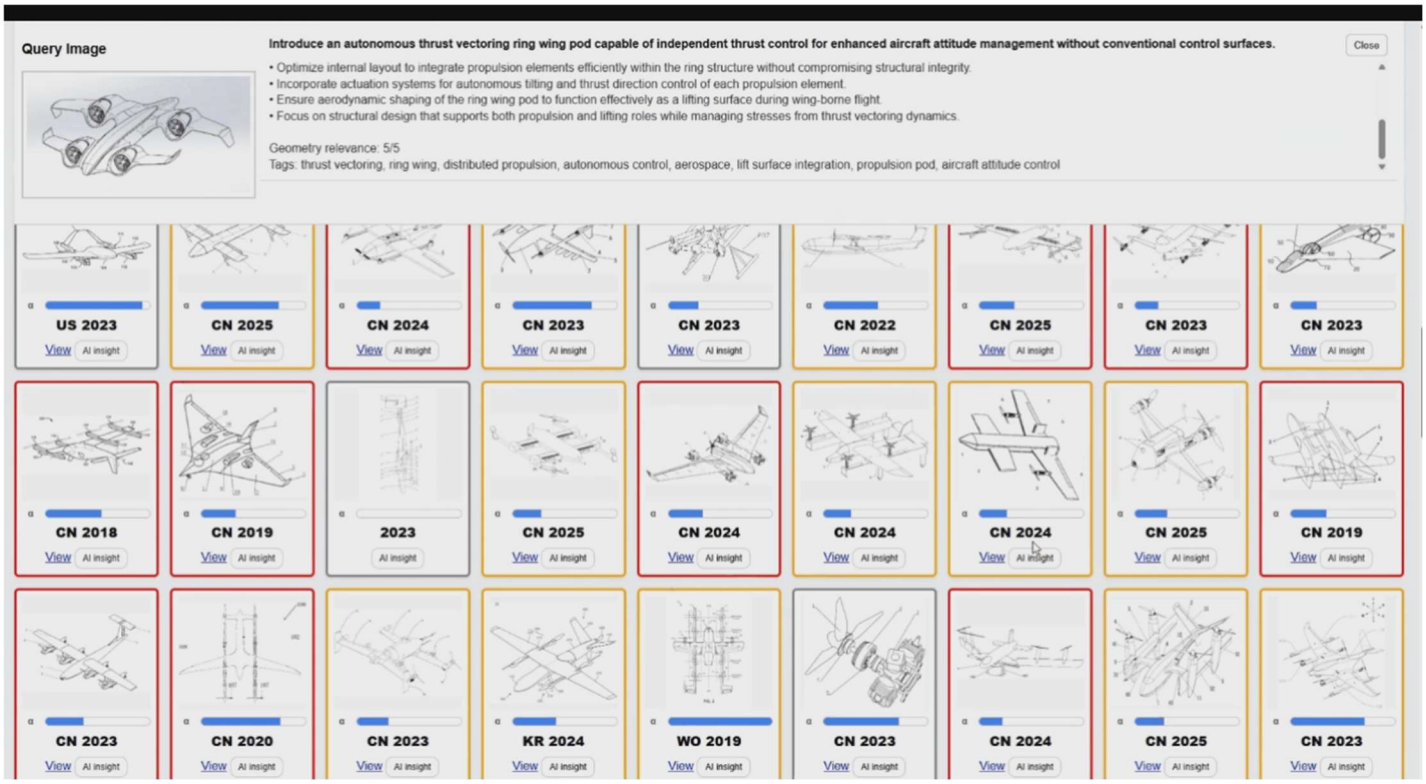
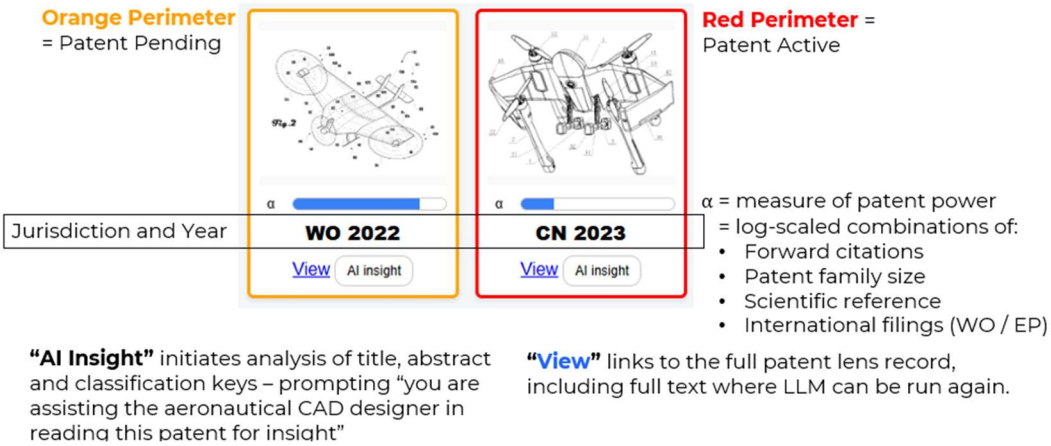
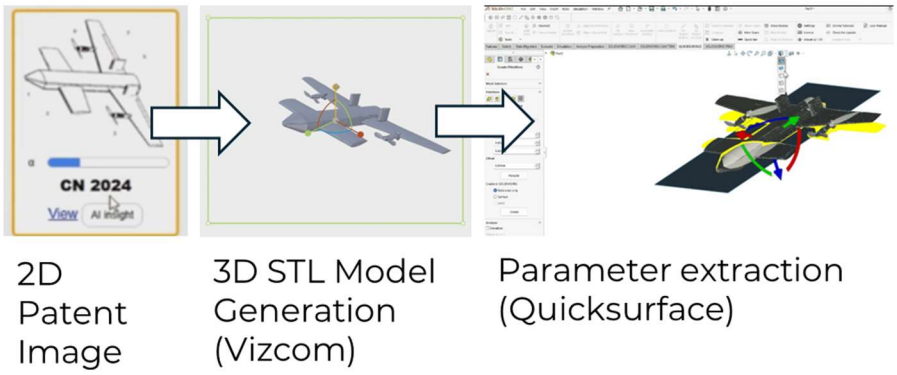


Figure 1 overviews a browser-based prototype tool interface developed to integrate patent data into the front end of the digital design workflow. The system enables: User selection of a sketch/CAD/Photo image as a search query; Visual search of patents using image embeddings (CLIP, ViT-B/32, FAISS); Retrieval of visually similar patent figures from a curated UAV dataset (~1,300 patents); Adjustable exploration between convergence (close matches) divergence (novel alternatives). **Appendix 1** overviews the app structure referencing tools, libraries and languages.

Patent records are enriched for selection and analysis as shown more closely in **Figure 2**:



Patent text may have limited geometric data so the demo enabled rapid AI 2D-to-3D model generation from patent images, then reverse engineering into CAD (e.g. Quicksurface), potential linkage to MBSE parameters and requirements. This workflow is shown in **Figure 3**:



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

Team 2 interviews with the AMRC drone team uncovered that developing the design requirements took 3-4 months and the AMRC drone was also based upon a previous project which ran for several years before; time and project experience were required to build the current thread. This project aimed to **Better** the thread by leveraging new, expanded, validated and deeper design knowledge at front-end and embodiment phases from patents through AI visual search. New geometry and design intent/parameters addressing well defined and emerging embodiment challenges is established **Faster** and without reliance on in-house legacy projects.

Reflections

It is somewhat surprising that AI Large Language Models (LLMs) have not yet had a greater impact on patent analysis, a view reinforced through discussions with the UKIPO Chief Analyst. These have clear potential to assist users to navigate the complexity of language and the scale of available patent data (>90 million documents). However, hallucinations and inaccuracies make it difficult to rely on AI alone. To combat this, an offline Retrieval Augmented Generation (RAG) approach was initially considered but proved challenging within the project resource.

Traditional patent search systems focus on identifying “the” single closest match, which is limiting in early-stage less-defined design problems. Efficient exploration of large solution spaces has been difficult with public databases. Visual search (think Google Images) proved effective in narrowing results, and when combined with AI, appears well suited to designers seeking inspiration.

Focusing on UAVs, a rapidly growing patent domain, enabled the development of a meaningful demonstrator. Even so, obtaining sufficient volumes of clean, “clipped” patent images was more difficult than expected. Scaling the approach likely requires greater integration with organisations such as the World, EU or UK IPOs, or open data platforms like Lens.org.

2D-to-3D generation using open-source AI tools has advanced rapidly, creating opportunities to convert image-based data into usable CAD geometry. Combined with established reverse engineering tools such as QuickSurface and Geomagic Design X, there is potential to bridge the gap between unstructured model data and parametric representations initiating the digital thread.

References

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App Structure

DIGITAL DESIGN NETWORK PLUS