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Institution	Loughborough University
Team	2
Focus	Better, Faster, With Less
Design Process	I was targeting to investigate in more detail the design process used by the AMRC to develop the design workflow for Challenge 1
Tools Used	Qualitative Interview and NVivo
Links	10.17028/rd.lboro.32002710

Executive Summary

This study explores the AMRC team's experience in creating a digital design workflow, focusing on the challenges faced, necessary skills, project timeline, and tools employed. Through semi-structured interviews, the research uncovers how AMRC engineers developed the drone's digital workflow. The interview reveals the development process, insights into the challenges encountered, the required skills, the project duration, the team composition, and the tools used. Key findings are summarised in terms of team skills and backgrounds, project length, reasons behind the project, development difficulties, ideal process, and adoption barriers.

Problem

This project aimed to uncover the design problems and challenges that the AMRC design team faced in developing a digital design workflow for a vertical take-off drone.

Digital Design Solution

The analysis has highlighted six main themes, namely: team skills and backgrounds, project length, reasons for the project, development challenges, ideal process, and adoption challenges.

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

Team skills and backgrounds. Digital Design seems to be facilitated by systems engineering (Better), a fundamental skill for developing system-level models. The other three relevant skills that emerge from the team background are programming, CAD and simulation.

Project length. The project had an exploratory and iterative nature. The overall time required to develop the digital design workflow (Faster) could be optimised and reduced through the experience curve and the development of dedicated tools that enable it.

Reasons behind the project. The rationale for developing the workflow was to explore the concept of the digital thread and understand the capabilities of current CAD technologies (With Less).

Development challenges. The first challenge the team faced was finding a digital tool capable of developing the workflow. The second was identifying the right point of contact with the software provider. Since the software provider was a large organisation, it was difficult to identify the right

person with the necessary expertise to support workflow development. The third challenge was the lack of tutorials and learning materials. Since the team has adopted a range of cutting-edge tools from different packages, learning materials and tutorials are not yet available. The fourth point is that not all tools are yet mature enough to be implemented in practice. Overall, these points indicate the need to develop learning materials and customer support to help users understand how to adopt and integrate the required digital tools (Better and Faster).

Ideal process. Based on their experience, the interviewees proposed an ideal process for developing a digital design workflow. The process has the following stages (Better and Faster): (1) facilitate stakeholder engagement; (2) capture user requirements; (3) perform system-level modelling; (4) create a concept – skeletal modelling; (5) run simulations; and (6) develop a detailed design.

Adoption barriers. The participants highlighted four adoption challenges: the inertia of large organisations, the need to align supply chains with the same software or platform, the high licence costs for SMEs, and the effectiveness of system-level modelling only for complex products. This underscores the importance of adoption research and initiatives not only to achieve better, faster, and less digital design but also to facilitate the implementation of digital design workflow.

Reflections

Team's skills and backgrounds

The team's skills and backgrounds are reviewed to identify the expertise required to develop and implement a digital design workflow. Table 1 summarises the interviewees' education, work experience, skill set, and prior experience with digital design workflows.

Table 1 AMRC team's skills and background

	Ross	Daniel	Rob
<i>Education</i>	UG degree in Product Design and Technology with a year in industry, 2006-2010	UG degree in Aerospace Engineering with a year in industry, 2008-2013	UG degree in game software development
<i>Previous job</i>	Product designer	Mechanical designer	Training technician in VR lab
<i>AMRC role</i>	Mechanical designer	Product engineer	Project engineer for software
<i>Skills</i>	CAD	Mechanical simulation Topology Optimisation Design for AM	Electronics VR Control systems Programming GitHub Treating everything as sort of an object and a class
<i>Experience in digital design workflows</i>	No previous background or experience in digital workflows	Digital thread interest: maintain the chain of information	Never done digital design workflows before

To note, the team has a range of skills covering computer-aided design, simulation, and programming. All the participants have minimal or no experience in digital design workflows.

Project length

The project started in April 2023 and lasted until April 2025. The first year had nothing to do with the digital thread; it was devoted instead to defining the drone concept and the elements of detailed design. The second year was devoted to exploring and developing the digital workflow. The period from April 2024 to October/November 2024 was devoted to fact-finding, i.e., determining which software to use and how to approach the workflow development.

“We didn't know what we didn't know”

The three project members committed 40% to 50% of their working time over 2 years. This results in a total of 1.5 years of engineering time.

Given that year 1 was not devoted to the workflow and the period from April 2024 to October 2024 was used for fact-checking, the workflow's actual development took roughly 4 months.

To note, the first year devoted to defining the drone concept and the elements of detailed design might have been fundamental to understanding how to design the drone and provided key information for the development of system-level and concept-skeletal modelling.

Reasons for the project

The interviewees mentioned that one of the project's goals was to understand the concept of the digital thread.

According to one interviewee,

“The Digital Thread concept has been around for quite a long time, but nobody knew what it meant.”

A vertical take-off UAV was deemed an appropriate case for exploring the implementation of a digital thread due to its complexity and requirements across aerodynamics, electronics, propulsion, and manufacturing.

The aim of the project was to create a drone template so that anyone could adjust the design without specialised expertise.

Development challenges

Initially, the team compared 3 different CAD software providers before choosing the platform to use. The process of understanding which software to use took 6 months.

The chosen software package is organised into “roles”; the project team bought many more “roles” than needed to explore different tools. In total, this amounted to around £400,000 pounds in licensing fees.

At the beginning, the team was fatigued to find the right support concurrently with understanding the type of support they needed to progress the project:

“There's not a single point of contact, a single person to deal with all elements of this...So finding the right people and being put into contact with other people as we

kind of progressively were figuring out what we needed was kind of part of the time, the problem”

They also highlighted the pioneering nature of the approach and tools used, which made it difficult to find people with relevant experience and expertise.

“This is all very new. It's very difficult to set up. No one's really an expert in all of it.”

The depth of the tutorials and learning materials was also mentioned as a barrier to implementation:

“we got we got more information by looking through this and going, I don't understand that, and then speaking to our [software vendor] content and saying, I need someone who's got expertise in this area to answer all the questions we now have, and that would give us more answers than endlessly going through these online tutorials.”

The interviewees stressed several times the importance of system engineering, which played a major role in helping them model the drone from a higher level. This skill was not considered at the outset but became prominent as the project progressed. The team felt the need for specific training in system engineering to complete the project.

Ideal process

Towards the end of the interview, the team proposed an ideal process to develop a digital design workflow. The process is as follows:

1. **Facilitate stakeholder engagement.**
2. **Capture user requirements.**
3. **Develop the System-level modelling.**
4. **Create Concept – skeletal modelling.**
5. **Run simulations.**
6. **Develop the detailed design.**

Adoption barriers

A significant part of the interview was devoted to discussing the barriers that slow the adoption and implementation of digital design workflows. The inertia in large engineering organisations, such as established routines and reliance on manual design, poses challenges. Additionally, there is a need to synchronise supply chains with a software platform, which can be costly for SMEs. High costs also arise from software licences and the need to ensure compatibility and integration with other platforms. Furthermore, the maturity level of the software platform and the effectiveness of systems engineering for simple projects are critical factors.

Appendix

Transcript

The interview transcripts are available at 10.17028/rd.lboro.32002710.

Interview Protocol for how to develop a digital design workflow

The interview will focus on the experience of developing the workflow, the challenges encountered, the required skills, the timeframe, and the tools used.

A semi-structured interview process will analyse the design process adopted by AMRC engineers in developing a digital design workflow. The interviews will focus on fulfilling the following objectives.

1. Uncover the process used to develop the digital design workflow.
2. Provide insights on the challenges encountered,
3. Identify the skills required to develop the workflow.
4. Define the timeframe and staff involved,
5. Explain the tools adopted.

To achieve the above objectives, the interview will be conducted in two sections.

1. **Introduction:** This section will focus on knowing the interviewee, their educational background, their job role and professional experience, their interest and experience in digital workflows.

Questions:

- Please could you take me through your educational background?
- Please could you take me through your professional experience and job role?
- What was your previous experience in creating digital design workflows?

2. **UAV digital design workflow:** In this section, we will explore the interviewee experience and process in developing the digital design workflow case study.

Questions:

- How did you start to work on this project?
- What was your task?
- Which tools did you use?
- What have been the challenges?
- How did you solve them?
- How long did it take?
- Which data did you use?
- Did you need any specific training?
- Are you satisfied with the outcome?
- What would you improve?
- How do they automate all the tools and link them together?
- Are all parts automated, or are there some manual processes?
- Do you see any benefits in automating this process with AI and reducing human engineering involvement?
- How were the design parameters (spans, chords, duct diameter, etc) developed?
- Have these been validated theoretically? I have seen an earlier AMRC test drone flight; the current design has not been reported as airborne in the media - is that the case or intention?
- There is an article online reporting the use of recycled carbon fibre - do you have any material properties for this?
- Is there any registered IP (patents, designs) for the current design?

The interviewees will be advised to bring to the interview any notes, artefacts, documents, etc. that will help them narrate their experience of developing the workflow.