Eureka

Discovering Innovation in Everyday Spaces

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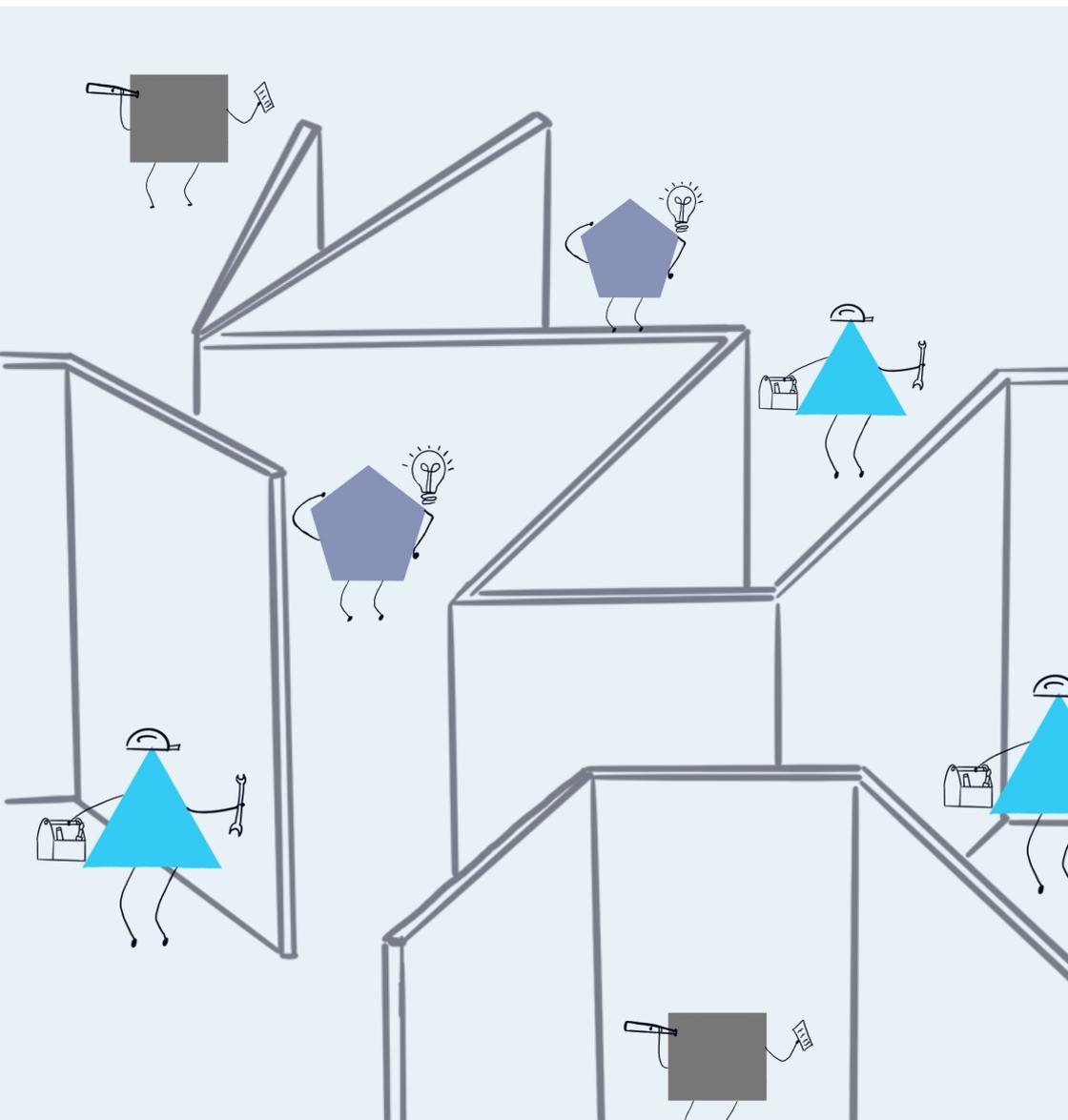
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I was eight when I first sat in an aircraft; the fact that a metal tube can float up in the air fascinated me, and it still does today. That childhood wonder evolved into a deeper appreciation for aviation's complexity, not only the technology but also the human systems that make flight possible.

My journey came full circle when my first internship brought me to Air India's engine shop, where I worked alongside the skilled technicians who make flights possible.

Now, as I complete my thesis, I find myself returning to where it all began, but this time as a designer seeking to amplify the voices of those who make flight possible. I am shifting my focus from the mechanical intricacies of engines to the human systems that drive innovation itself.

acknowledgements

To my chair, Euiyoung Kim, who agreed to take me on as a graduate student even before I fully knew what my project would become. Thank you for bringing your critical lens to this work, your encouraging words and for consistently checking in on my well-being, beyond the research.

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To my friends, for the countless discussions, brutally honest feedback, and always being available for a chat. Your perspective kept me grounded.

To my parents and sister, who encouraged me from thousands of miles away and patiently listened as I sometimes rambled endlessly about the project. Your unwavering support carried me through every challenge. Thank you, mummy, papa and Aaru.

Finally, I extend my heartfelt gratitude to the Foundation Justus & Louise van Effen and TU Delft for believing in the potential of students like me from around the world.

dedication

I've always been driven to make the invisible visible. In the case of this thesis, that meant amplifying voices that are too often unheard in innovation processes.

To the maintenance technicians who generously shared their valuable insights and time, who welcomed my questions with openness, and who provided candid feedback about their experiences. Thank you, sincerely.

I hope this work represents a meaningful step toward recognising you as the co-creators and essential partners you've always been in the innovation process.

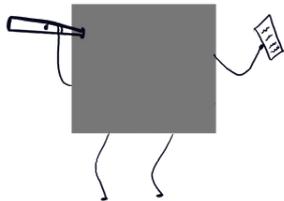**"Everyone you meet knows something you don't."** *Bill Nye*

how to read this book

meet the characters
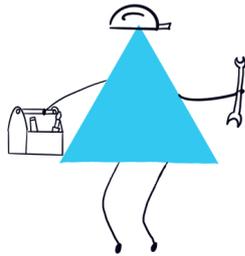
Maintenance Technician
The people who use emerging technologies every day at work and know the operations inside and out are both responsible for using new technology and experts in understanding how it fits into their workplace.

Management and Innovation Experts (KLM)
The people who find the right technologies to encourage innovation and ensure the workplace keeps improving through new tech solutions.

Innovation experts (outside KLM)
...to avoid fixation and biases

External specialists who have deep knowledge about building innovation culture and driving change in different types of organizations, providing fresh perspectives to avoid biases.

"These are the quotes"

These are the key insights

These are the reflections during the process.

a summary

This research addressed a critical gap in understanding how to engage maintenance technicians with emerging technologies to foster innovation within organisations. Through qualitative research methods with maintenance technicians, innovation managers, and external experts, the study identified three fundamental tensions: Innovation versus Integration (balancing innovation spaces with integration into existing workflows), Efficiency versus Exploration (providing clear practical benefits while enabling autonomous discovery), and Constraints versus Co-creation (working within operational limitations while enabling meaningful participation in innovation processes).

Three technology engagement concepts emerged from the research: Tech Triage, a facilitated workshop approach using problem cards from technicians paired with technology solutions to enable collaborative problem-solving; Mech, an AI chatbot trained on organizational innovation resources to help technicians navigate complex organizational structures and access relevant technologies; and Eureka, a spatial innovation intervention that transformed everyday workplace environments into technology discovery spaces. Following stakeholder evaluation using desirability, viability, and feasibility criteria and how each concept navigated the three tensions, Eureka was selected for development and validation due to its alignment with existing workflows, minimal behaviour change requirements, and leveraging of existing infrastructure. Eureka navigated the identified tensions through "structured serendipity," bringing emerging technologies directly into breakrooms where technicians naturally gathered. It featured functional technologies for hands-on testing, peer testimonial videos, autonomous exploration, and clear pathways to deeper engagement.

Testing Eureka at KLM demonstrated strong engagement across behavioural (139 technician visits over four days), cognitive (92% actively tried to understand technology functionality, 88% recognised clear work advantages), and affective dimensions (overwhelmingly positive emotional responses dominated by fascination rather than resistance).

The research provided theoretical implications, including spatial prototyping for innovative spaces, navigating paradoxes through design to foster dynamic decision making, and the integration of personal passions in professional identities as a critical adoption mechanism. Practical implications included the following recommendations: integrating demonstration areas into operational environments rather than segregating innovation spaces, designing peer-to-peer technology transfer systems that leverage natural champions, redesigning organisational layouts to eliminate innovation barriers through spatial prototyping approaches, and creating holistic technology ecosystems that bridge personal and professional contexts.

These findings contributed actionable strategies for creating more effective innovation ecosystems in aviation maintenance and comparable contexts. They also advance theoretical understanding of user engagement in highly regulated environments where safety requirements, operational constraints, and technical complexity amplify both barriers and enablers to technology adoption.

There are three main deliverables from this thesis:
- A validated concept to foster innovation, Eureka, that KLM and other organisations can implement
- A strategic roadmap to implement Eureka across the organisation
- Theoretical and Practical implications for the industry and academia to foster innovation, especially in safety-critical maintenance environments.

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the approach

This research employed a four-phase approach to activate maintenance technicians' engagement with emerging technologies. It is described below.

1

Maintenance technicians are expected to engage with emerging technologies in their work, but they must do so within **a specific context.**

Phase 1
Background research & context setting: It was important to understand the importance of innovation in aviation maintenance, KLM's current innovation ecosystem, stakeholders involved and the project brief.

2

Fostering innovation in a large organisation involves multiple stakeholders beyond maintenance technicians, making it essential to **understand their diverse perspectives.**

Phase 2
Generative Research & Problem Framing: I conducted **semi-structured interviews** with technicians, management, and external experts to understand the barriers to technology engagement, organisational dynamics, and best practices. **Creative facilitation** sessions with continuous improvement leads and black belts explored innovation goals and the challenges of implementation. **Site visits** revealed successful approaches to fostering an innovation culture.

3

Three tensions need to be navigated to activate engagement. These tensions became the foundation for concept development.

Phase 3
Concept Design & Validation: I developed multiple design concepts through Research through Design methodology (RtD), evaluated how each navigated the identified tensions, and then assessed them against DVF (desirability, viability, and feasibility) criteria to select the best option.

4

Engagement was measured through the selected concept, Eureka, across three dimensions (behavioral, cognitive, and affective) to validate its effectiveness, but I still needed to explore how Eureka fits into KLM's long-term innovation strategy.

Phase 4
Impact & Strategic Planning: To assess broader impact, I developed a strategic roadmap and mapped contributions to KLM, academia, and stakeholders outside the organisation. Finally, I identified both theoretical and practical implications for academia and organisations.

1
Background Research & Context Setting

This step was like piecing together a puzzle based on various data sources, clearly defining the goals of the project (which changed drastically during this stage), and understanding innovation in aviation maintenance. I found myself constantly revisiting my assumptions about what innovation meant in practice versus theory.

What readers can expect: This chapter provides an overview of the aviation industry's innovation challenges, KLM's innovation ecosystem and the project brief. The literature review covers barriers to innovation implementation, the role of emerging technologies in aviation maintenance, and the role of design in innovation-fostering practices.

Key takeaways

- Innovation implementation often fails due to poor engagement with end-users.
- KLM's current innovation maturity numbers are very low.
- The innovation ecosystem's current activities fail to engage technicians effectively.

1.1 introduction

Innovation has become a corporate buzzword, where over 80% of executives list it as their top priority (McKinsey, 2022). Innovation is defined in one of two ways: "(1) the introduction of something new, or (2) a new idea, method, or device" (Merriam-Webster, 2025). Within the aviation industry in particular, rapid advancements in aircraft design and production techniques outpace existing Maintenance, Repair and Overhaul (MRO) capabilities, making the development of adaptive, digital, and sustainable tools necessary (Stamoulis, 2022).

While emerging technologies hold great innovation potential, a disconnect in technology development and workforce engagement exists (Gomez-Beldarrain et al., 2024). Technology developers tend to be in corporate offices or universities, while end users who manage these technologies in their workflows are in operational settings (Lyon et al., 2020). To aid successful technology implementation, therefore, it is necessary to understand and engage the views of the maintenance technicians since they possess unique views on day-to-day reality, workflow limitations, and realistic implementation concerns, which technology developers overlook (Tucker et al., 2008; Deloitte, 2023; SkillRise, 2020). As frontline technology implementers whose adoption decisions ultimately determine implementation success (Oliver Wyman, 2022), maintenance technicians represent a particularly important stakeholder group. They face unprecedented workforce shortages, with Boeing projecting a need for 716,000 technicians over the next 20 years globally (Boeing, 2023), and they require evolving skill sets that combine traditional mechanical expertise with technological competencies (Avionics International, 2022).

Despite substantial investments in innovation hubs and emerging technologies such as drones, robotics, 3D printing, and augmented reality, many organisations struggle with limited engagement and adoption among maintenance technicians. This disconnect goes beyond a knowledge deficit, but it undermines the innovation ecosystem's effectiveness (Eastwood et al., 2017; Rogers, 2003; Venkatesh & Davis, 2000). Research suggests that innovation initiatives fail to progress beyond the concept phase due to implementation barriers (Klitsie, 2021; Cooper, 2019).

The aviation sector's post-pandemic recovery has heightened the urgency of this challenge (Younis et al., 2023). Kim et al. (2022) and Reuschl et al. (2022) demonstrate how COVID-19 exposed vulnerabilities in operational structures and accelerated digital transformation initiatives. Organizations implemented digital initiatives to enhance operational efficiency and increase labour productivity through automation and mechanisation, making the ability to effectively integrate emerging technologies into maintenance workflows critical to competitive advantage and operational resilience (Stolk, 2024). Yet, the implementation of these technologies remains hampered by the incompatibility of automation solutions with existing workflows, multistakeholder environments, and the need for strategies on automation adoption (Gomez-Beldarrain et al., 2025).

There is a gap between who develop technologies and people who use them.

Although these organisational-level challenges have been extensively studied, a void exists in understanding how to engage the maintenance technicians who are the end-users of these technologies. It is their daily practices that ultimately determine whether technological innovations succeed or fail in practice (Rogers, 2003; Venkatesh & Davis, 2000). Furthermore, maintenance technicians cannot simply be mandated to adopt technologies; their active engagement is essential because they are the ones who must integrate these tools into complex, time-sensitive workflows where ineffective technology use directly impacts operational efficiency (Olaganathan, 2024).

1.1.2 Project Brief

This study was conducted at KLM Royal Dutch Airlines, providing a real-world context for investigating innovation engagement challenges in aviation maintenance. It is conducted with and for the MRO Lab (one of the technology hubs under KLM Engineering and Maintenance (E&M)), elaborated upon in section 1.1.3. As a frontrunner in adapting innovations within maintenance activities, the MRO Lab recognises the need to enhance its innovation capabilities and create an effective ecosystem that encourages cross-functional teamwork. The primary objective is to investigate how we can activate maintenance technicians' engagement with emerging technologies to foster innovation, focusing on understanding current awareness levels, interaction patterns, and identifying effective triggers for technology engagement. The project aims to bridge the gap between technology development and frontline implementation by creating strategies that support collaborative innovation. The specific research questions outlined are based on the client brief.

The research has one main question, followed by four sub-questions. These questions move from understanding the context, awareness levels, to developing actionable solutions, identifying triggers and interventions.

RQ: How can we activate maintenance technicians' engagement with emerging technologies to foster innovation?

RQ1: What are the current levels of awareness among maintenance technicians regarding emerging technologies, and what factors influence their access to information about technological developments in their work environment?

RQ2: How do maintenance technicians perceive and interact with emerging technologies in their current workflows?

RQ3: What are the key benchmarks for fostering innovation in organisations?

RQ4: What triggers can we test to engage maintenance technicians with emerging technologies, and how can they effectively interact with them?

1.1.3 About KLM

KLM Royal Dutch Airlines, a key entity within the Air France-KLM Group and is the Netherlands' premier airline. Within KLM, various subdivisions drive its operations and strategic goals. Figure 1 shows the organisational structure at KLM. One of these subdivisions is KLM E&M, which is crucial for ensuring optimal aircraft performance through its various business units. These business units include Engine Services, Component Services, Engineering, Airframe and supporting units such as Innovation Hubs and Engineering. The Innovation Hubs include the Technology Hub, MRO Lab, Makerspace and the E&M Repair Lab.
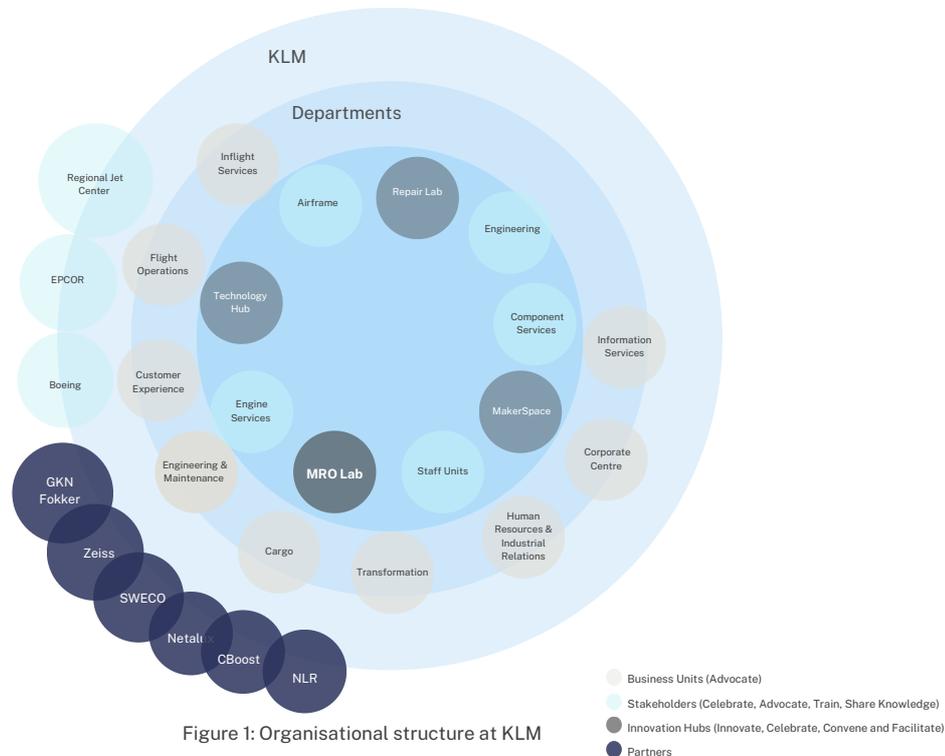
Figure 1: Organisational structure at KLM

- Business Units (Advocate)
- Stakeholders (Celebrate, Advocate, Train, Share Knowledge)
- Innovation Hubs (Innovate, Celebrate, Convene and Facilitate)
- Partners

In response to ongoing financial pressures, KLM launched the Back on Track initiative aimed at enhancing operational efficiency. This strategy involves increasing labour productivity by at least 5% by 2025 through the implementation of automation, mechanisation, and measures to reduce absenteeism. These efforts are designed to address challenges such as rising operational costs and staffing shortages (KLM Annual Report, 2024). This approach allows the airline to focus resources on critical areas while navigating the post-pandemic recovery landscape. In alignment with these organisational changes, it is advancing its innovation roadmap by leveraging data-driven and autonomous operations. The development of predictive maintenance tools, thereby optimises aircraft availability and reduces operational disruptions (Stolk, 2024).

While KLM is one of Europe's leading airlines, the global aviation landscape is highly competitive. Furthermore, it is driven by sustainability pressures, tight profit margins, and rapid technological advancements.

KLM recognised the need for continuous improvement and cross-departmental alignment, and it has made innovation a core strategic objective. As a part of this, KLM established the KLM E&M Innovation Ecosystem, comprising four innovation hubs (KLM Innovation Ecosystem Masterplan, 2024)

An Innovation Ecosystem is defined as the evolving set of actors, activities, and artefacts, and the institutions and relations that are important for the innovative performance of an actor or population of actors (Granstrand & Holgersson, 2020). The innovation landscape has become more complex and fragmented, with innovations being geographically dispersed and harder to classify (Edwards-Schachter, 2018). Hoffecker (2019) identified eight key roles of actors that must be present in Innovation Ecosystems: Innovate, Connect, Celebrate, Train, Advocate, Fund, Convene and Facilitate, and Share Knowledge. Figure 1 classifies the various departments at KLM into these eight roles. KLM's innovation approach involves multiple interconnected roles. The MRO Lab focuses on developing innovations. Innovation Hubs serve dual purposes by celebrating successes and providing necessary training. Management supports the entire process through advocacy and funding, and the broader ecosystem ensures knowledge flows effectively between all these components.

The mission of the ecosystem is,
"To offer a safe environment that empowers people with the right resources to bring innovative ideas into reality."
And the vision is to
"To establish a self-sustaining innovation culture to position KLM E&M at the forefront of the MRO industry."
It consists of four innovation hubs (KLM Innovation Ecosystem Masterplan, 2024):

- **MRO Lab:** Focuses on adaptive innovations for aircraft maintenance challenges, targeting short-term implementations under 5 years. This study focuses on the MRO Lab. Figure 2 illustrates the application of MRO Lab technologies in the aircraft hangar, while Figure 3 presents current MRO Lab projects and their respective development stages. These figures aim to provide a visualisation of technologies in the maintenance operations.

- **Technology Hub:** Provides a centralised overview of trends and projects, focusing on long-term innovations over 5 years.
- **ES Makerspace:** Dedicated to prototyping and employee-driven innovation using 3D printing techniques.
- **Repair Lab:** Specialises in advanced repair techniques using the latest tooling and equipment.

Hub leads oversee daily operations and coordinate activities. The ecosystem facilitates networking through activities focusing on inspire, engage, and educate:

- **Inspirational Sessions:** Educate on the latest technologies from external companies
- **Spark Meetups:** Platform for brainstorming innovative ideas and challenges
- **"Bosdagen" Team Building Days:** Foster collaboration and provide updates.
- **Innovation Stories:** Inspire employees by showcasing key innovators
- **Tech Studio:** Planned as a central hub for all innovations (not yet established). Previously, KLM's Digital Studio (2016) delivered transformative products which are widely used within the organisation.
- **Shared Innovation Platform:** Digital environment for collaboration, knowledge sharing, and cross-departmental teamwork to break down silos.
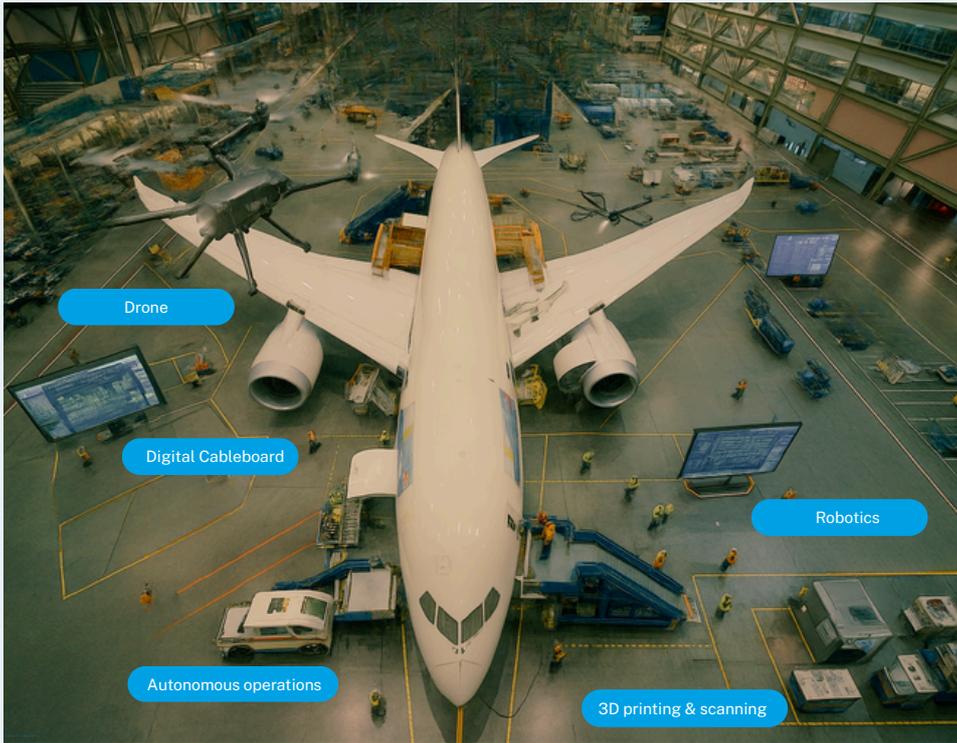
Figure 2: Technologies from the MRO Lab in use in the aircraft hangar (AI generated image)

Ongoing projects in the MRO Lab

ideation

3D printing & scanning

concept & proposition

NeRF Technology   project brightsky   robotics

advanced innovation   OR & mathematics
ecosystem

proof of concept

digital cableboard

experimentation

implementation & Improvement

drone   autonomous operations
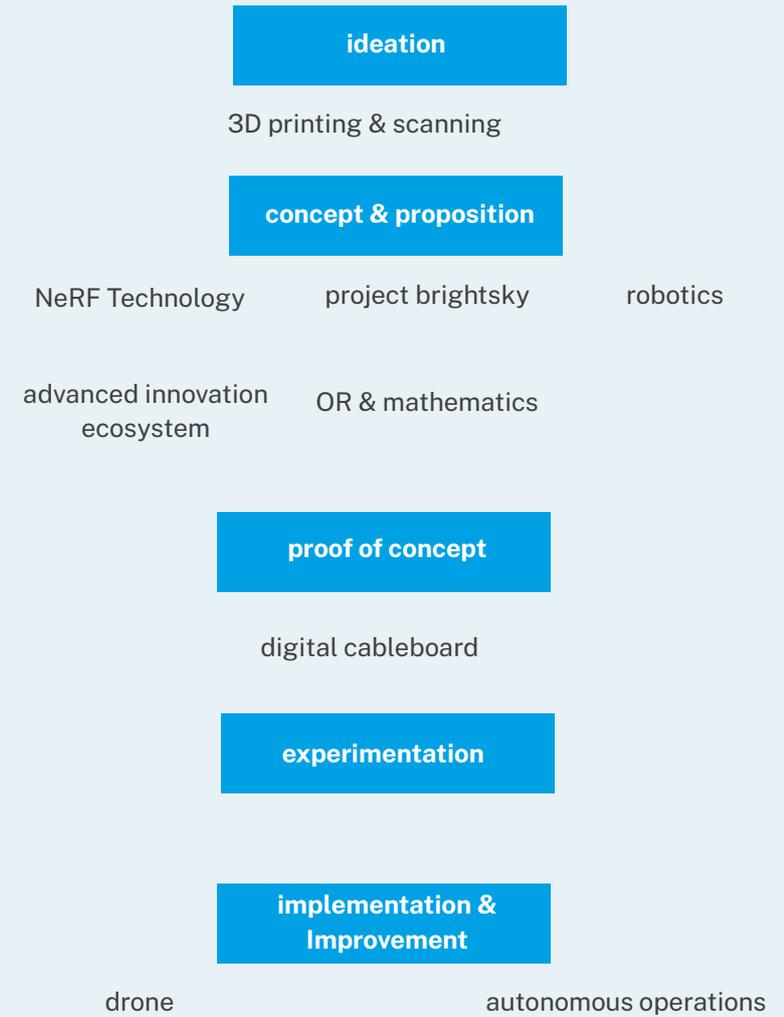
Figure 3: Ongoing projects at the MRO Lab and their current stages (MRO Lab Projects, 2025)

Following the analysis of KLM's current context, understanding the innovation landscape required mapping key stakeholders and assessing innovation maturity levels. Figure 4 illustrates the stakeholder map their perspectives are analysed in Chapter 2.

The maturity assessment was conducted by KLM's Program Manager from the MRO Lab in collaboration with stakeholders across KLM E&M business units (Engine Services, Component Services, and Airframe).

This assessment used an innovation maturity model, which is a structured framework measuring organisational capabilities across progressive stages from initial to optimised performance. The research applied Blommerde and Lynch's (2016) Service Innovation Capability Maturity Matrix (SICMM), which features five levels (Initial, Managed, Defined, Measured, and Optimising) covering user involvement, knowledge management, strategising, and networking.

It was chosen for three reasons: it aligns with MRO Lab's existing assessment methodologies, provides multidimensional measurement beyond binary indicators, and creates clear developmental pathways for systematic capability enhancement (Inków, 2019). Inków's (2019) review of 27 models demonstrates that these frameworks both diagnose current capabilities and provide actionable roadmaps toward higher maturity levels. Based on this assessment, the strategy scored 2/5 across all units, indicating innovation is mentioned occasionally but remains a sporadic, reactive activity rather than a strategic priority. Governance scored 1/5 universally, showing no formal innovation management or defined roles. Culture and mindset averaged 2/5, with limited innovation promotion and basic training programs.
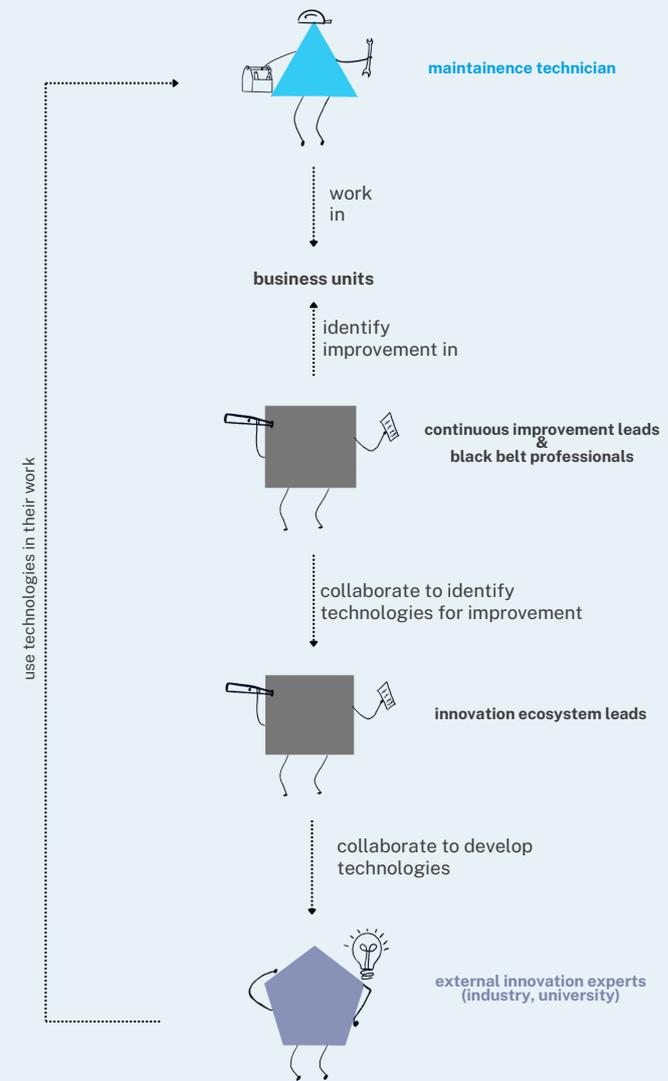
Figure 4: Stakeholder Map (KLM Innovation Ecosystem Masterplan, 2024)

KPI and performance measurement scored 1/5, with inconsistent innovation targets and limited measurement systems. Resources and tools averaged 2/5, indicating some innovative tools exist but are applied in limited ways, with only 1% budget allocation and basic project management tools (Maturity Model, KLM). Figure 5 shows a graph of KLM's current innovation maturity number.

Figure 6 shows the current touchpoints that foster engagement within the organisation. The description of the touchpoints is elaborated on page 23. The horizontal axis represents stakeholder involvement, while the vertical axis shows active engagement. Each dot reflects a different initiative, based on how much technicians are involved and how actively they participate.

For example, Innovation Stories are simply shared as a newsletter, so while they reach people, they don't involve much interaction. Spark Meetups and Bosdagen (team-building days) are placed higher on the engagement scale, but it's important to note that these events haven't actually been tailored for technicians yet, which limits their current relevance. Inspirational Sessions are open to everyone, but very few technicians attend these sessions.

These low maturity scores highlight the urgent need for systematic innovation approaches within aviation maintenance. To understand how organisations can advance from reactive to strategic innovation implementation, section 1.2 examines three questions: the need for emerging technologies, the problems with fostering innovation and how organisations can engage technical staff.

Figure 5: KLM's Innovation Maturity Numbers out of 5 (Maturity Model KLM, 2024)

Figure 6: Stakeholder Involvement and Engagement graph

1.2 literature review

This section examines three questions through existing literature. First, the barriers to innovation implementation in organisations, followed by the role of emerging technologies in aviation maintenance, and lastly, effective mechanisms for fostering engag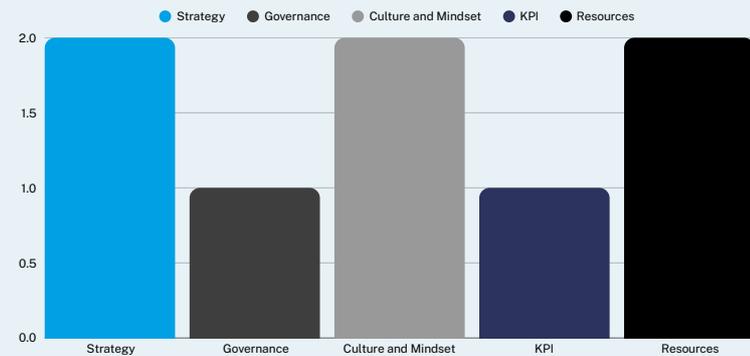ement. These questions guided the literature review to identify knowledge gaps and best practices relevant to KLM's situation.

1.2.1 Why do we need emerging technologies?

The pressure to reduce both downtime and costs while maintaining safety levels within the aviation maintenance sector is especially compelling, as it implements technological innovations (Stamoulis, 2022). Furthermore, Phillips et al. (2010) outlined that predictive maintenance approaches have significant advantages in MRO activities due to their implementation efficiency. Various organisations have successfully implemented these new technologies. Regional Jet Centre's Augmented Reality system, which overlays digital information onto real-world aircraft components to guide technicians through damage assessment procedures, reduced damage assessment time by 40 minutes (Regional Jet Centre, 2025); TaxiBot's half-robotic towing saved 50-65% of fuel during taxiing (van Winkel, 2023); Deep Turnaround's AI-based monitoring detects possible delays 40 minutes before scheduled departure in 30 processes (Royal Schiphol Group, n.d.); and Mainblades' drone program enhances the efficiency of aircraft inspection as well as maintenance personnel safety. Such successes in implementation require understanding the relationship between new technologies and their users.

Gomez-Beldarrain et al. (2023) investigated ways in which essential user requirements can guide the design of significant interactions with autonomous systems. The researchers concluded that prioritising users' needs over just technological potentials generates richer experiences for humans, and the successful integration of technology entails addressing both technical capability and human factors within specific operating contexts.

The MRO Lab at KLM E&M develops emerging technologies to address specific maintenance challenges, including drone systems with Mainblades for safe aircraft inspections, autonomous electric towing vehicles (Mototok) for efficient aircraft movement, and digital screen systems replacing traditional heavy cable assembly boards to improve ergonomics and accuracy, and 3D printing for custom tools, spare parts, and rapid prototyping solutions. However, the current approach often involves the MRO Lab developing technologies and then seeking appropriate problem-solution fits, highlighting the need for better alignment between technology capabilities and actual maintenance technician needs.

1.2.2 What are the problems with fostering innovation?

Innovation initiatives frequently fail to progress beyond the concept phase due to implementation barriers, including limited stakeholder involvement and poor alignment with existing workflows (Klitsie, 2021; Tucker et al., 2008; Cooper, 2019). In a study of innovation implementation in service organisations, Klitsie (2021) identified organisational barriers such as fragmented departmental structures that impede collaboration and process-related barriers like delayed stakeholder involvement that reduce buy-in during implementation phases. Similarly, Gomez-Beldarrain et al. (2024) highlighted a lack of stakeholder consensus and undefined maintenance procedures as obstacles to the adoption of automation at Amsterdam Airport Schiphol. To overcome these obstacles, studies across various industries reveal that technology implementations succeed when organisations involve stakeholders from the beginning and establish clear processes for how change will happen (Eastwood et al., 2017; Lindblom et al., 2017).

To address these implementation challenges, researchers suggest three practical approaches, these include creating physical spaces where different teams can work together on innovations, setting up clear systems that define who is responsible for what during implementation, and ensuring everyone understands the organization's shared goals for technology adoption (Klitsie, 2021; Eastwood et al., 2017; Klein & Knight, 2005).

1.2.3 But how can organisations strategically engage technical staff for better technology adoption?

Research has revealed several effective ways to involve technical staff with new technologies. In aviation, participatory design strategies have been successful in levelling the hierarchy across several levels. By eliminating power disparities that suppress creative exchange, Embraer effectively used the Group Elicitation Method (GEM) to enable cross-functional co-creation in business jet innovation (Torkashvand, 2022). Moreover, experience-based innovation strategies have changed the way aircraft makers see value generation. Using the Vision in Product Design (ViP) methodology at Zodiac Aerospace re-prioritised user experience over engineering specifications, improving cross-departmental collaboration and organisational empathy for end-users (Tsay and de Lille, 2016). Research across disciplines on cultural institutions and agricultural landscapes (Garzotto & Rizzo, 2007; MacMillan & Benton, 2014) shows that creating settings that enable multi-modal user interactions with technology promotes feelings of technological involvement. This is reinforced by Lauff et al. (2018), whose research demonstrates that prototypes facilitate the development of tacit knowledge through building and testing activities. This can enable an embodied understanding of materials, manufacturing processes, and technical aspects that are not possible to replicate through traditional learning methods, such as reading or lectures.

Furthermore, involvement is more successful when technologies are presented as solutions to operational issues rather than purely as innovations. These results suggest that effective technological involvement includes the development of environments to foster emotional attachment to technologies, the design of flexible frameworks for user participation, and the use of context-oriented presentations.

The measurable impact of these user engagement strategies is well-documented. Eastwood et al. (2017) found a 34% increase in adoption rate when users were actively involved as participants in technology development. Likewise, Lindblom et al. (2017) underlined that users were 3.7 times more likely to adopt technologies after witnessing peer role models apply such technologies in relevant settings.

1.2.4 So, where is the gap?

Existing literature has explored general barriers to innovation implementation and some mechanisms for technology engagement. The research has documented organisational-level barriers (siloed departments, decentralised innovation management) and successful case studies of implemented technologies (AR at Regional Jet Centre, TaxiBot at Schiphol, etc), but fails to provide an understanding that specifically addresses how to systematically engage maintenance technicians, the actual end-users, in the innovation process.

In aviation maintainence, this research gap poses a problem, where the voices and experiences of the technicians who are supposed to be the end users of these innovations are largely ignored in favour of organisational factors and technological capabilities in academic literature (Moore & Benbasat, 1991; Olaganathan, 2024; Ward, 2005). This knowledge gap is particularly significant because, despite innovative approaches from adjacent industries (Eastwood et al., 2017), the unique regulatory context of the aviation sector requires specialist approaches to balance technological innovation and operating limitations.

Closing the gap would both contribute to theoretical understanding of how innovation is perceived by maintenance technicians in highly controlled environments and deliver actionable recommendations for technology adoption rates in aviation MRO activities. This suggests that technology achievement requires an understanding of user attitudes, situational conditions, and interwoven social processes (Straub, 2009; Venkatesh et al., 2003).

To conclude, this chapter shows that innovation implementation often fails because technology developers and end-users operate in separate worlds (both literally and metaphorically). KLM's consistently low innovation maturity scores across all dimensions highlight that current strategies don't effectively reach the technicians who play a critical role in using innovations in their work.

Moreover, the challenge isn't purely technological. At its core, it's about making innovation accessible, relevant, and sustainable for those who are aware of operational realities and can identify hidden opportunities in daily operations.

Engaging them not only builds ownership and adoption but also creates a feedback loop that strengthens the broader innovation ecosystem and enhances operational efficiency.

"Strategy doesn't live in a deck, it needs to be translated into everyday behaviours"

Meghan Preiss

We cannot empower people unless we understand how they want to be empowered and what their needs and goals are. This brings us to the next chapter, which focuses on understanding stakeholder perspectives.

2
Generative Research & Problem Framing

On a personal level, I wanted to challenge myself to learn different research methods that I hadn't used before. I tried my best to choose the ones that would be most relevant for answering my research questions, even when they pushed me outside my comfort zone.

What readers can expect: This chapter dives deep into understanding stakeholder perspectives through semi-structured interviews, creative facilitation sessions, and site visits. Based on the qualitative research data, it identifies three tensions that serve as the basis for the concept development.

Research questions answered:
RQ1: What are the current levels of awareness among maintenance technicians regarding emerging technologies, and what factors influence their access to information about technological developments in their work environment?
RQ2: How do maintenance technicians perceive and interact with emerging technologies in their current workflows?
RQ3: What are the benchmarks to foster innovation in organisations?

Key Takeaways:
- Technicians avoid innovation spaces not just due to distance, but because of perceived hierarchical boundaries.
- Personal technology interests significantly influence workplace adoption patterns.
- Technicians see themselves as co-creators in the innovation process.

2.1 semi-structured interviews

2.1.1 Approach

To examine the diverse perspectives of stakeholders in the innovation ecosystem, this research employed a qualitative approach. Semi-structured interviews were conducted with innovation managers, maintenance technicians at KLM, and innovation experts outside of KLM. They were used to create focused discussions around technology engagement and innovation barriers while retaining the flexibility to adapt to participants' individual experiences and responses (Adams, 2015; Patton, 2022). The think-aloud protocol was employed to provide insight into participants' cognitive activity (Charters, 2003). These interviews were conducted by me. Participants were recruited through purposeful and snowball sampling. While interviewing maintenance technician participants, employees often recommended or introduced me to their colleagues, who became additional participants. The participants were selected based on the target criteria of having direct experience working in innovation and/or aircraft maintenance, ensuring representation from both innovation management and operational maintenance perspectives. Table 1 shows the participant numbers (see Appendix G) and roles.

The breakroom where interviews were conducted

2.1.2 Procedure

Semi-structured interviews were conducted online via Microsoft Teams (n = 5) or in person at the participants' workplace (n = 12). Each interview lasted between 45 - 60 minutes. Written consent was obtained from all participants before conducting the interviews, allowing for the audio recording and transcription of the interviews. The full interview guide is found in Appendices A and B. The main questions during the interview followed these themes:

- If employees find emerging technologies necessary
- If employees are aware of the innovation ecosystem
- The best practices to foster innovation
- How do employees perceive and interact with emerging technologies in their workflow
- Employees' preferences to engage with emerging technologies

2.1.3 Data Collection and Analysis

MS Teams was used to record the audio and video in the interviews. The recorded audio was transcribed and coded using thematic analysis on Atlas.ti (Braun & Clarke, 2006). The study was conducted in iterative cycles, with interviews being simultaneously conducted and coded. After each cycle, the data were transcribed, coded, and analysed to identify emerging themes. This iterative process allowed for the refinement of the subsequent interviews based on the codes identified in previous cycles. This data collection and analysis were repeated until data saturation was achieved, meaning no new themes were emerging (Patton, 2002). This was done after 17 participants.

2.1.4 Reflexivity

There could be potential bias from my experiences as a Strategic Product Design student and my personal views. This awareness shaped how I created interview questions and reported participants' responses. Each interview began by informing participants about the study's purpose, what the process involved, and their rights as participants. I ensured anonymity and confidentiality, using all participant quotes anonymously in the results. Since discussing new technologies could be sensitive, I worked to create a respectful and open atmosphere where participants felt comfortable pausing or stopping the interview whenever they needed to.

2.1.5 Results

Line-by-line coding of 13 interview transcripts generated 21 distinct codes, which were systematically organised into five preliminary code groups: Spatial Access Barriers (2 codes), Adoption Enablers and Inhibitors (6 codes), Collaborative Innovation Processes (2 codes), Innovation Environments (6 codes), and Organisational Structure for Innovation (5 codes). For example, the code "Spatial challenges" described how the spatial distance between innovation spaces and work areas creates significant barriers to accessing emerging technologies and impedes meaningful collaboration. All the codes can be found in Appendix C.

Through iterative theme refinement, consolidation of overlapping codes, and pattern identification across interviews, these groups were synthesised into three final themes (Patton, 1990). These are presented in the following pages.

2.1.6 Theme 1: Spatial and Social Access Barriers

Adoption of workplace innovation is limited both through spatial separation and socially driven, perceived boundary perceptions. When considering both aspects, it is apparent that individuals must be sufficiently comfortable with forgoing their work tasks to work on innovation. Technicians expressed aversion to travelling outside their work areas to engage with the office spaces where most of the elements of the innovation ecosystem were located. Participant 8 highlighted the physical distance by stating,

"The makerspace is way too far away. Nobody goes upstairs,"

Participant 9 added, *"...if I go upstairs, I lose time."* Group dynamics amplify spatial challenges. It should be noted that the makerspace is situated on the first floor of the engine services building. Participant 7 noted that technicians *"are like ants, they stay in their work, go home, come back to work",* and "*there is hesitation to approach.*" The yellow lines in Figure 7 show the spatial distance between the workplace of the technicians and the innovation teams. This disengagement was confirmed by the drone pilot (Participant 12): *"We've been testing the drone here for a while; most people (technicians) don't care, they just walk under it."*

Perceived hierarchical boundaries intensified spatial challenges. Participants articulated social stratification:

 "There's a difference. White collar versus blue collar" (P8), with technicians positioning themselves as customers: *"I think I'm the customer, not them. If you want to sell your product, go on the floor"* (P9)*.* While technicians showed curiosity about technologies, they avoided discussing them with management. These barriers highlight how perceived organisational structure and physical layout significantly impact knowledge transfer, suggesting that spatial and social accessibility are critical factors in innovation diffusion.
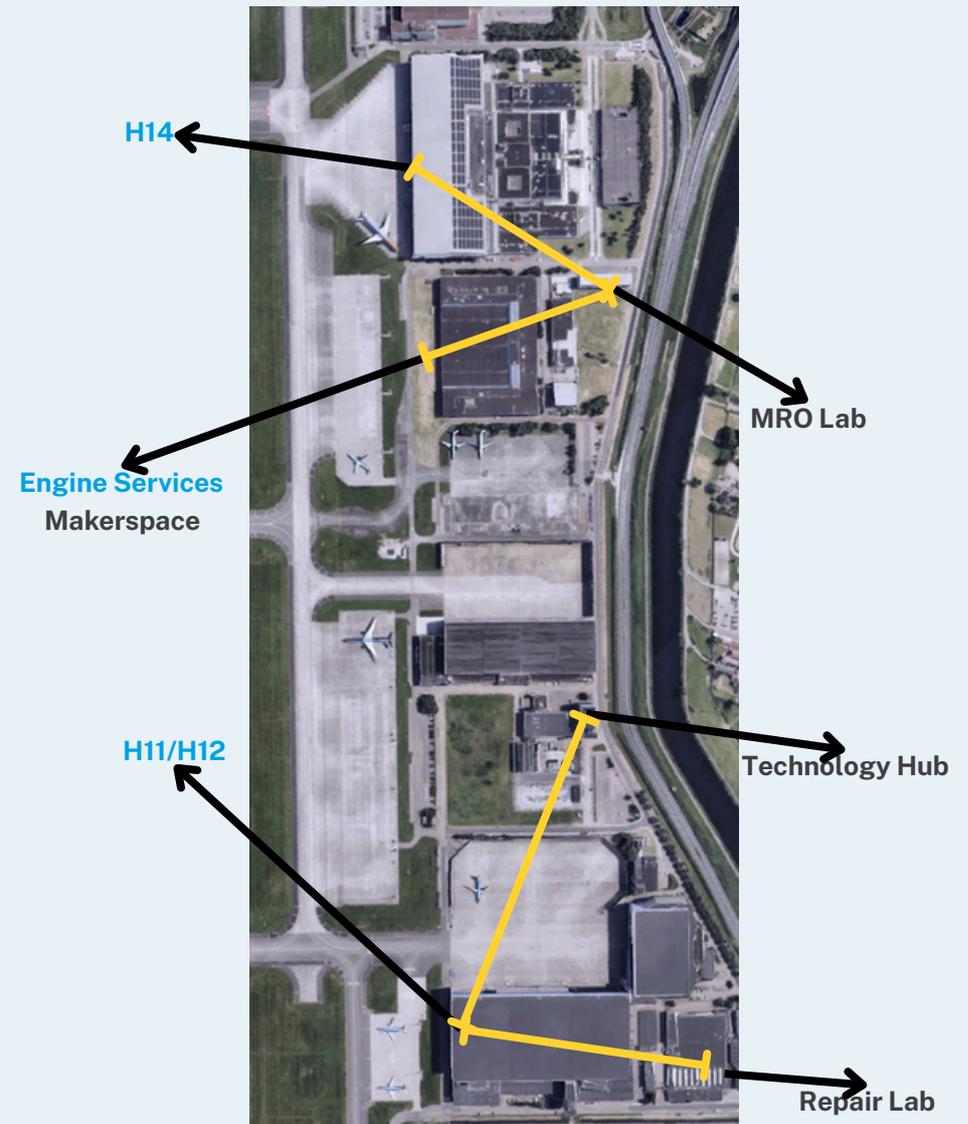

Figure 7: Spatial distance between the workplace of **technicians** and **innovation management personnel** (source: Google Earth)

On the other hand, according to the management, decentralised innovation structures position innovation resources closer to operational contexts, enhancing the relevance and implementation of ideas while addressing both physical and psychological barriers to engagement. P3, a project manager, suggested that *"an open-door policy...good coffee, and regular demonstration events that drew significant attendance"* were key aspects of KLM's Digital Studio that engaged workers. Figure 8 compares the Digital Studio and the operations environment.

Presenting technologies within authentic operational contexts significantly enhances engagement. Participant 5 recalled their experience with the *"innovation train,* where they installed various technologies for showcasing purposes, which *"attracted many conductors and maintenance people because it bridged the gap between technology and its application in trains."* This approach directly connects emerging technologies to familiar work environments, making abstract possibilities concrete and relevant. Similarly, roadshows visiting maintenance locations with augmented reality glasses allowed staff to experience technology in their work context, highlighting the importance of bringing technologies to operational environments rather than expecting staff to seek them out in unfamiliar settings.

Participant 2, another project manager, noted that having *"a dedicated location where everyone can see the work that the innovation ecosystem is doing"* and where everyone is invited could bridge awareness gaps between innovation activities and operational staff. According to external innovation experts (P4 and P5), these environments are characterised by distinct visual elements that signal *"something different is happe*ning" compared to traditional workspaces.

(a)

(b)

Figure 8: Images from the Digital Studio (source: Digital Studio Instagram) (a) and operational environment (b) (source: KLM BRIX)

"A dedicated innovation space is beneficial"

Well-intentioned spatial strategies (like segregated spaces of innovation) inadvertently **reinforce the very hierarchical boundaries that they aim to break.**

"If it's not in the operational environment, it's too far away"
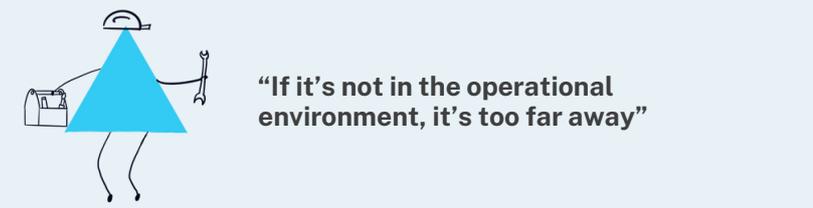
2.1.7 Theme 2: Adoption Enablers and Barriers

Maintenance technicians are affected by a combination of organisational dynamics, contextual factors, and individual interests in adopting new technologies. The sections below showcase the enablers and barriers to technology engagement.

Enablers
Enablers refer to the facilitating factors, conditions or influences that encourage technicians to adopt new technologies.

Personal interests and home technology use greatly impact receptiveness to workplace technology adoption, with users of certain technologies outside the workplace more likely to advocate for their adoption in the workplace. Participants consistently described how their non-work technical interests predisposed them to adopt the same technologies in a professional context. Participant 9 noted,

 "... I already knew it before I came here, because I also do it myself at home. In my free time, I also work on cars, and sometimes I need a moulding or something, so I 3D print it sometimes."

Participant 11 further added, *"I've always been interested in new technology and new ways to improve our department... I'm a technician - I want to know about things. I also work with cars and bicycles, and I follow new mountain bikes."*

Personal interests tend to lead to social connections that ultimately lead to larger adoption, based on the development of relationships out of shared technology interests. Peer influence also has a critical part in technology acceptance, with Participant 8 directly confirming that innovations *"might work better coming from another technician."*

Leadership support further spurs innovation by creating organisational conditions that make legitimate experimentation possible, with participant 5 noting that when they expressed interest in 3D printing solutions, their team leader encouraged them to pursue it independently. *"You just do it, make your drawings, make your prints and everything."* Most technicians see that adapting to technological advancement is vital to survival, demonstrating a sensitivity to how technological incorporation can support and build upon their working lives within a dynamic industry environment.

"If we don't change our workload, then our work will become obsolete... so we need to adapt ... in our group, we need to evolve to the next level of engine mechanics." (P4)

and *"For correct inspection, you can use more AI because the camera sees better than your eyes... When you inspect with your eyes after 40 blades, you become tired. A robot or AI doesn't have that problem."*(P7)

The interviews revealed a strong emphasis on hands-on and demonstration-based introductions in a specific 'working context'. Participant 4 mentioned, *"Seeing is believing"*, and Participant 5 further elaborated, *"We learn from doing"*. This preference for experiential learning extends to their outright rejection of training formats that emphasise heavy documentation or theory. Technicians expressed a preference for intuitive interfaces that*"fit our process"* (P6) or illustrated a clear, relevant working context. Technicians also emphasised formats in which information could be relevant.

"I think the first step is to show the things and goals already accomplished. I don't know if seeing them physically is better than on video. You can see almost everything on video, too. I think videos are pretty good to have"(P4)

However, they were interested in contexts that promoted independent exploration (such as an innovation fair) as well, where they could ascertain things at their leisure, without interruption.

"We want to walk through stuff, and innovation fairs are like that. You can walk, pass by everything. If there is something you do not like, you can walk away."(P5).

On the other hand, according to the management, decentralised innovation structures position innovation resources closer to operational contexts.

The following key enablers were identified: personal technological interests that extend beyond the workplace, peer influence from trusted colleagues, hands-on exploration and leadership support that legitimises experimentation.

Barriers

Beyond the enablers, the study identified barriers that prevent adoption, including information isolation, procedural ambiguity regarding innovation processes and varying information needs for maintenance technicians.

Information isolation is a significant barrier to the organisation's adoption of innovation. Knowledge transfer was particularly challenging because participants often reported having little awareness of technological developments occurring in other departments. When asked if participants are aware of technological developments in other departments, Participant 5 noted, *"Not at all. We have this building, and we know what's happening in this building. What's happening on the other side of the road? We don't know."*
" I don't think there's enough awareness for people like me or the new guys. The new guys are mostly the ones who come up with new ideas - they start working and notice things. I might say, "Yeah, I've been doing it this way for 20 years," and then a new person asks, "Couldn't we do it differently?"...So no, I don't think there's enough awareness. (P4)

Technological adoption within maintenance departments is also significantly hindered by procedural ambiguity regarding innovation engagement protocols. This finding emerged prominently as technicians expressed frustration about the lack of clearly defined pathways for requesting or implementing technological solutions.

Participant 4 added, *"We might think, 'We could have used that.'".* Furthermore, Participant 6 emphasized requiring clearer instructions, *"If I'm interested in a technology, I want to know whom to contact, how to contact them."* Furthermore, when asked about preferred methods of communication, Participant 5 added, *"We need information in a way that we can walk away from it...the posters work quite well, and we all read the communication newsletters".*

Different levels of information needs were also indicated by participant responses, which distinguished between necessary and peripheral knowledge.

"Sometimes, some things are just nice to know, but sometimes I see something and think, 'I need to know that. '.. When I read something in a newsletter, it's nice, but it still feels too far away from me... You always have to go somewhere, and I don't have the time to do that, so I'm not going to." (P6)

Based on these findings, departmental silos heavily constrain organisational knowledge, undermining the potential of cross-functional technology diffusion and constraining the ability of the organisation to leverage internally generated innovations across units of work. Hence, clarity of procedure is critical to technology adoption models within maintenance settings. This requires not just the presence of novel solutions but also open, transparent mechanisms of engagement.

"I think the first step is to show the things and goals already accomplished."
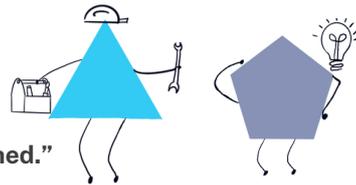
Technicians' desire for autonomous technology **exploration** inadvertently undermines the very **practical benefits** they simultaneously demand.

"We want to walk through stuff...you can walk, pass by everything. If there's something you don't like, you can walk away."

Previous KLM Innovation Fairs that were explorative

2.1.8 Theme 3: From Push to Pull: Co-Creative Innovation

The most effective innovations emerge when end-users become active partners rather than passive recipients in the development process. For effective innovation integration, there must be open paths of communication and substantive technician engagement in the innovation process. The technicians explained that if they were involved in identifying problems and co-creating solutions through transparent protocols, they were most likely to embrace the technology. Furthermore, technicians demonstrated how their direct experience with tools led to practical improvements.

"*For example, the cable boards came from a mechanic who worked with them. The wooden boards were heavy, and he complained they hurt his back. So we came up with the idea to project it on a screen or a table board...would only be able to make useful things if they could talk to the technicians first and understand what the use is in that context*" (P11).

Involving end-users was echoed by management as well, which enhances both solution quality and adoption outcomes. During a baggage robots pilot, Participant 6 spent *"the whole week speaking with baggage handlers, involving them, hearing their views, and understanding their vision on how the technology could help them."* When implementing innovations in operations, *"it's very important to involve those teams because they know how everything works...they need to have been part of the process because they have to accept change."* However, participants noted that due to time-critical operational constraints, it is not easy to engage technicians. Furthermore, this challenge is particularly pronounced for staff working on fixed schedules, unlike office workers who can more easily reschedule their time to participate in innovation events. Participant 8 asserted that developers *"would only be able to make useful things if they could talk to the technicians first and understand what the use is in that context."*

Conversely, Participant 7 described how *"Repair development gets projects from their bosses to create solutions for specific problems, but they don't go to the shop floor,"* resulting in solutions that technicians *"can't work with."*

These findings emphasise that successful technology integration requires meaningful practitioner involvement throughout development, highlighting the critical role of user-centred design in innovation adoption. Participant 1 echoed this view and emphasised the need for the co-creation of solutions.

"Right now, there is a technology push within the organisation; if we create more awareness and engagement, there can be a technology pull, where technicians themselves can co-create solutions with us".

These findings substantiate that to effectively integrate technology into maintenance environments, the maintenance technicians must be involved throughout the development process.

"When I'm busy and I go upstairs, I lose time"
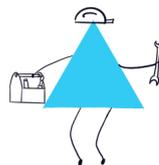
Technicians' aspiration to **co-create solutions** conflicts with the **very operational demands** that make their input most valuable.
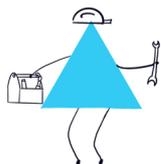
"We might think, 'We could have used that.'"

2.2 creative facilitation

Although qualitative interviews were conducted with technicians, external innovation experts, and innovation ecosystem leads, inputs from continuous improvement and data transformation leads and black belt professionals who support these teams were still missing. These stakeholders serve as intermediaries between maintenance technicians and the broader innovation ecosystem, making their perspectives essential for understanding strategic organisational goals. Table 2 lists the participants of the session (see Appendix G).

Creative facilitation was therefore employed out of curiosity about these stakeholders' viewpoints, using structured collaborative sessions with design thinking techniques to generate insights through group interaction (Sanders & Stappers, 2008). Since the team is large and spread across E&M, conducting one collective workshop also established the shared understanding needed while being practically feasible.

Additionally, the session aimed to understand which target group was considered most organizationally important for the innovation process and what resources should be allocated for fostering innovation within maintenance operations.

The main question of the session was, "How can we inspire aviation professionals about emerging technologies"? The term "aviation professional" was deliberately kept ambiguous during the session, and revealed which groups are perceived as critical for technology engagement and adoption.

The focus of the study was on technicians, but it was important to get a collective perspective of how the management aims to approach innovation in the future, so the proposed concept could help the technicians as well as align with organizational goals.

Facilitating the session

Procedure

The session was conducted in four phases designed to systematically move from problem identification to solution development. The phases move from a divergent phase (phases 1 -2) to a convergent decision-making phase (phases 3-4), allowing participants to first surface underlying assumptions and barriers before collaboratively developing and prioritising actionable solutions (Sanders & Stappers, 2008).

- Phase 1: Evil Ideas and Clustering: Participants generated worst-case scenarios that would discourage innovation, then clustered these by common themes to identify underlying barriers (Hagen et al., 2016).
- Phase 2: Flip Them! Negative ideas were reframed into positive, actionable strategies (Hagen et al., 2016).
- Phase 3: Dot Voting: Participants allocated green dots for feasible ideas and yellow dots for novel concepts to prioritise solutions (McKenzie et al., 2019).
- Phase 4: The 5 Whys Technique: Teams developed rapid prototypes of top-voted ideas to explore practicality and refine solutions (Serrat & Serrat, 2017).

Tools Used:
- Post-its, dots (which were stickers), markers, flip charts
- Reserved session space

Pilot Session: A pilot session was first conducted with TU Delft participants to refine methodology and timing (Malmqvist et al., 2019; Van Teijlingen & Hundley, 2022). This pilot used analogical reasoning and role-playing exercises to test the facilitation approach. The main session was then conducted with actual KLM stakeholders, including continuous improvement and data transformation leads, and black belt professionals who support maintenance operations. The main session improved upon the pilot by using direct aviation context rather than analogical reasoning and involving actual organisational stakeholders rather than role-playing participants.

Figure 9: Setup of the creative facilitation session

Figure 9 shows the setup of the creative facilitation session, and Figures 10 (a) and (b) show the outputs from each stage.

Phase 1: The "Evil Ideas" technique allowed participants to explore hypothetical barriers to innovation without criticising current practices. Five themes emerged: lack of reinforcement (discouraging deviation from established practices), excessive risk aversion (always emphasising problems over possibilities), lack of support (resource constraints and political barriers), lack of awareness (communication gaps about emerging technologies), and implementation complexity (overpromising capabilities while providing inadequate training). This creative distance enabled candid discussion of sensitive organisational challenges.

Phase 2: Building upon the barriers, participants used the 'Flip Them!' method to transform negative scenarios into actionable ideas. Lack of reinforcement became recognition systems, risk aversion evolved into balanced assessment frameworks, insufficient support transformed into dedicated resources, awareness gaps became communication strategies, and implementation complexity shifted toward user-centred approaches. This systematic inversion of barriers generated practical interventions that directly address innovation resistance while maintaining organisational feasibility.

Phase 3: Three strategic directions emerged through dot voting: Communication and Resources: "Continuous communication on failures" and "allocate time and resources for innovation" received the highest priority (5 votes each), revealing recognition that innovation requires both psychological safety and dedicated resources.
Inspiration Mechanisms: "Innovation labs" received balanced support for feasibility and novelty, suggesting the need for multilevel intervention from individual incentives to organisational vision.

Phase 1: Evil Ideas

Phase 2: Flip Them!
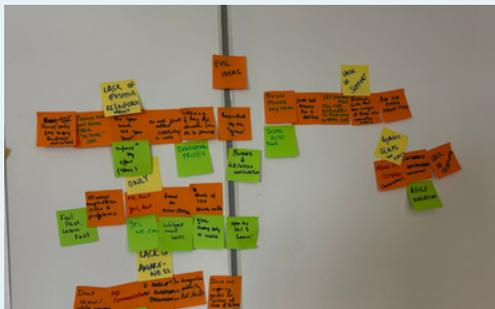
Phase 3: Hits and Dots

Figure 10: (a)Phases of the session

Strategic Alignment: "Set vision and scope" highlighted the tension between providing direction while maintaining exploration space.

Phase 4: Through Rapid Prototyping, two complementary strategies emerged: Ecosystem Development (building community structures and communication channels) and Strategic Alignment (connecting innovation to organisational leaders and business goals). Together, these acknowledge that successful innovation requires both bottom-up engagement and top-down support.

The session demonstrated that engaging employees with emerging technologies isn't something that can be addressed at just one level of the organisation. The need is for solutions that work for individuals (like technicians), teams (such as innovation communities), and the whole organisation (through strategic vision), proving that innovation only succeeds when everyone from top to bottom is working together. Technicians were identified as the first stakeholders to connect with (bottom-up innovation).

Phase 4: Rapid Prototyping
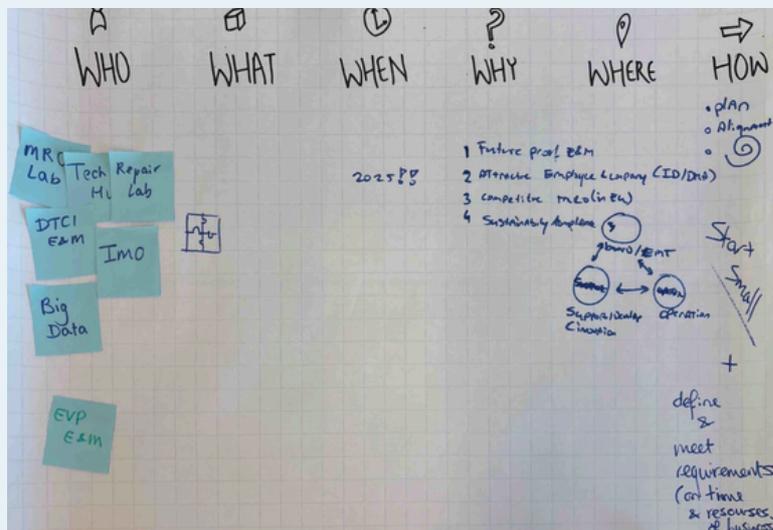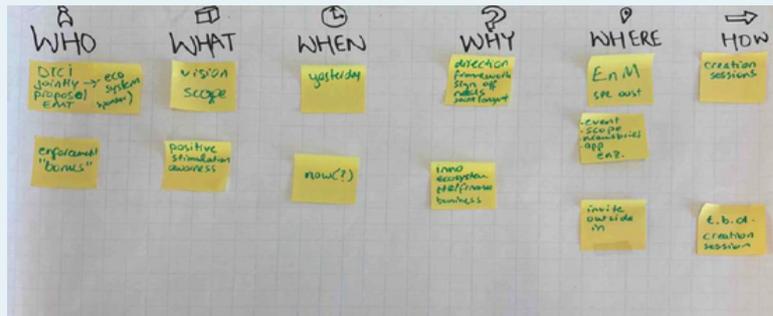
Figure 10: (b)Phases of the session

2.3 site visits

The study employed site visits to understand how innovation ecosystems operate in practice and how different organisations showcase emerging technologies to engage their workforce. As Lawrenz et al. (2003) define, site visits allow researchers with specific expertise to gather information about innovation initiatives through direct experience, providing contextual understanding that remote research methods cannot replicate. This approach was chosen because innovation engagement strategies are highly contextual and embodied in physical spaces, organisational practices, and material artefacts that direct observation alone can fully capture (Orlikowski, 1992). Extending beyond the direct project scope, these visits also helped avoid tunnel vision from focusing solely on one organisation's perspective. Furthermore, they served as inspiration for tacit knowledge embedded in organisational practices such as how spaces are arranged to encourage exploration, how technologies are contextualised for different audiences, and how informal interactions are facilitated that interviews or documentation alone would not reveal (Nelson, 2013).

The visit to NS's Innovation Platform revealed how a major transport organisation operationalises innovation through a centralised hub that inspires innovation concepts, facilitates employee-driven innovation processes, and advises departments on embedding innovation within workflows. The platform showcased key technologies, including 3D printing, AR, and VR, through clear use cases and cross-industry examples, demonstrating how organisations communicate technologies both through physical spaces and regular newsletters (see Figure 11). The second site visit at Microsoft's Innovation Centre displayed emerging technologies integrated into customer-facing environments, demonstrating contextual technology presentation where staff embed innovations within realistic usage scenarios rather than present them as isolated technical demonstrations.
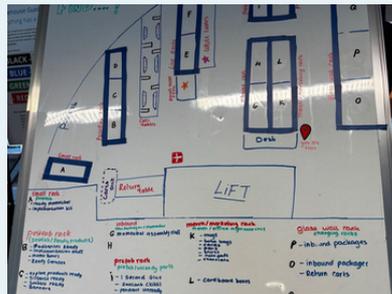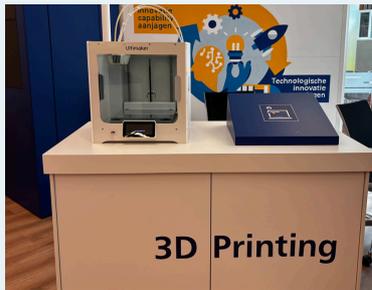
Figure 11: External site visits

The visit to NLR, interviews revealed how hosting shark tank-like competitions, providing funding, and allocating dedicated time for employees to work on their ideas led to the submission of over 100 innovation proposals, demonstrating the effectiveness of structured yet autonomous innovation processes. Vanderlande's approach provided insights into how the introduction of emerging technologies over the years, instead of mandating use immediately, has enabled engineering-focused organisations to balance operational demands with innovation aspirations. A contrast to large organisations was Momo Medical, a healthcare technology startup that demonstrated transparent innovation practices through clear communication protocols, including weekly demo hours that openly showcase successes and failures, and clear displays of team responsibilities to facilitate stakeholder contact.

Site visits were conducted within the organisation (KLM) as well. A notable observation from the Technology Hub was their comparison of TRL (Technology Readiness Levels) and ORL (Operational Readiness Levels), to display their projects. The ORLs include factors like system fit, human factors, organisational culture, and scalability. The Makerspace (closer to the operational floor) showcased 3D printers and tools demonstrating how physical spaces can enable hands-on technology exploration and experimentation. The Digital studio (see Figure 12) utilised artefacts to improve interactions with employees.

Physical Space Design
&
Contextual Technology
Presentation Matters

Figure 12: Internal site visits

2.4 the three tensions

The qualitative research generated a massive amount of data that needed to be organised and analysed systematically. Two complementary approaches were used to make sense of all the insights from technicians, innovation experts, KLM management, and literature, which led to three tensions. A tension is defined as a set of contradictory yet interdependent elements that exist simultaneously, often creating ongoing challenges for organisations (Smith & Lewis, 2011). According to Smith et al., these tensions must be dynamically balanced rather than resolved to achieve sustainable performance. Here, dynamic balance means continuously adjusting between competing resources rather than finding a middle ground.

First, affinity mapping was applied to group related findings together. Affinity mapping is a design research methodology where related insights are clustered thematically to identify patterns and relationships (Beyer & Holtzblatt, 1998; Sanders & Stappers, 2008). This process revealed three clear themes that emerged naturally from the data patterns. These themes were problem-first technology integration, accessibility integration, and peer networks. However, these themes alone weren't enough to start developing concepts because contradictions and competing needs between different stakeholders became apparent. This led to the second approach: using the COM-B model to identify specific tensions between what different stakeholders needed or wanted. The COM-B model (Capability, Opportunity, Motivation - Behaviour) is a framework that helps understand stakeholder behaviour to enable design interventions targeting root causes rather than surface preferences (Michie et al., 2011). This framework helped reveal not just what people said, but why certain barriers existed and how different stakeholder needs sometimes conflicted with each other. This dual approach led to the identification of three tensions.

For example, through affinity mapping, the data showed that technicians consistently emphasised "seeing is believing" and preferred hands-on learning over documentation-heavy training. They also stressed the importance of technologies providing clear, measurable benefits like time savings or improved safety. But when the COM-B analysis was applied, a deeper tension within the technicians themselves emerged: they could evaluate new technologies and the motivation to adopt solutions that would make their work easier, but they wanted to do this exploration in a relaxed, unstructured way that seemed to contradict their demand for practical efficiency.

This led to the identification of the tension, Efficiency Vs Exploration. The entire process can be found in Appendix D. Figure 13 shows the three identified tensions. Understanding these tensions required careful consideration of their nature and implications for design.

Moreover, any final concept needs to work for everyone involved. It has to be something technicians actually want to use (desirable) while also being practical and valuable for the organisation (feasible and viable). The thematic insights showed where to focus, while the COM-B tensions revealed what obstacles needed to be navigated to get there.

These tensions guide concept development in the following section. The concept that best navigates these competing tensions will be selected for validation.
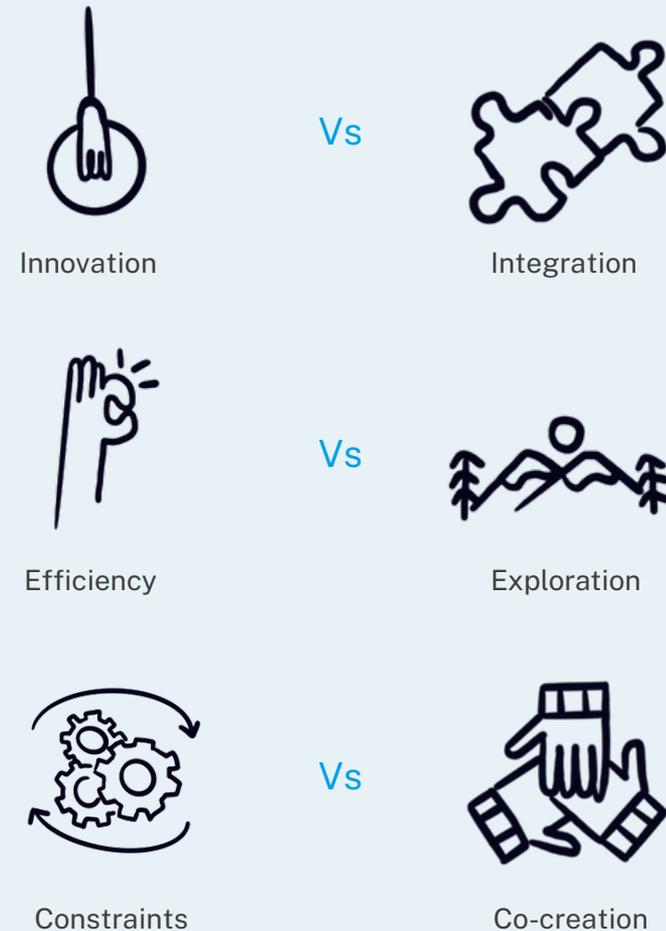
Innovation   Vs   Integration

Efficiency   Vs   Exploration

Constraints   Vs   Co-creation

Figure 13: The three identified tensions

a (mid-term) reflection

Conducting this thesis in a practical environment taught me a fundamental lesson: it's easier to design for **how things should work than for how things really work.** While the project scope evolved significantly, the core focus on empowering maintenance technicians remained constant.

I initially thought I would find an existing technology that KLM wanted to increase engagement with, but instead discovered the MRO Lab was running several promising yet fragmented programs, not all of which had been fully realised: a drone inspection program, exploration of autonomous capabilities for the Mototok system, and a proof-of-concept digital cable board being developed. However, these technologies were implemented in very specific locations by external partners, for instance, Mainblades pilots the drone program with only two trained KLM mechanics, and Mototok has just four licensed operators. Many of these innovations remain in the proof-of-concept stage, seeking broader implementation across Engineering & Maintenance (E&M), particularly for technicians. The lab's mission was to evaluate whether these emerging technologies could benefit technicians more widely and determine scalable implementation strategies.

I have to say, the research caught me off guard in the best possible way. Based on existing literature, I expected that experienced technicians (with over 20 years of experience) would struggle with digital technologies. However, these experienced professionals weren't just open to new technology; they were genuinely excited about anything that might make their demanding jobs a bit easier. Many already use various technologies at home, and they prefer hands-on approaches to learning.

However, a critical gap emerged: technicians were largely unaware of these existing projects and technologies within the innovation ecosystems. This created a multi-faceted challenge that required me to understand the current technological maturity levels, assess their potential for demonstrating value, and identify ways to address underlying tensions. Simultaneously, I gathered benchmarks from other organisations to understand how they foster innovation and explored opportunities for cross-industry collaboration; admittedly extending beyond my direct project scope, but necessary to avoid tunnel vision from focusing solely on one organisation's perspective.

The resulting data volume was substantial and initially overwhelming. To give you an idea, I had ten themes from my interviews, each with its own subthemes and each consisting of every element I heard in the interviews. Clearly, this was not something I could design with or for. Despite multiple rounds of analysis and refinement, I struggled to achieve the right balance of concision and depth, resulting in numerous overlapping themes. While working on the academic paper, I was pushed to think about the tensions emerging through each theme more deeply (thank you, Euiyoung and Katherine), which ultimately led to the three emerging tensions presented earlier. This distillation also allowed for a clearer focus in the next stage of the research.

"If you want to make God laugh, make a plan"

Woody Allen

3
Concept Design & Validation

What readers can expect: This chapter translates research insights into three design concepts. This includes Eureka (spatial innovation intervention), Tech Triage (facilitated workshop approach), and MECH (AI chatbot for navigation). It demonstrates how the identified tensions become design materials rather than barriers. This is followed by stakeholder validation using the triple innovation lenses (desirability, viability, feasibility) and stakeholder validation. The chapter shows how Eureka emerged as the most promising solution through its ability to balance all three tensions simultaneously.

Key takeaways:
- Effective innovation solutions must navigate competing tensions rather than resolve them.
- Stakeholder validation reveals practical implementation constraints early in the design process.
- Spatial intervention can be more effective than digital or procedural solutions.
- Strategy can be translated into operational behaviours through design interventions.

This was quite a fun phase. There was so much qualitative data to work with that we were constantly validating and refining ideas, which kept things moving. What made it especially fun was talking to stakeholders and hearing how they imagined these solutions fitting into their everyday routines. It made the work feel "real" and grounded.

3.1 designing concepts

The ideation process involved brainstorming, how might we questions and iterative feedback with technicians and management, shaped by three core tensions. For example, balancing innovation and integration emphasised embedding new ideas into existing workflows. The insight "seeing is believing" inspired ideas like demo videos, hands-on tool use, and workshops. The section below shows the ideation of the three concepts.

3.1.1 eureka (concept 1)

A maintenance technician grabs coffee during their break and notices a 3D-printed tool sitting on the counter, something they're excited to pick up and examine, because as they always say, "seeing is believing." A short video nearby shows a colleague from the engine shop explaining how this same tool cut 20 minutes off a routine inspection. The technician recognises the person in the video, someone they've seen countless times in the shop, not a manager in a suit. A simple QR next to the display says "Want to try this? Email" and "Got ideas to make it better? Leave them here." The whole setup takes maybe two minutes to understand, fits perfectly into a coffee break, and doesn't require walking across the building to some innovation hub. Most importantly, it feels like a discovery rather than a training session, just stumbling across something useful while going about the normal day.

The ideation involved creating sketches alongside 3D printed prototypes of technologies, including drones, digital cable boards, and various 3D printed tools that could be used in the operations. These physical prototypes were combined with videos that demonstrated the clear, tangible benefits of each technology. It was then evaluated against how effectively it addresses each tension.

Balancing Tensions

- **Innovation vs Integration:** Brings technology discovery to breakrooms instead of expecting visits to separate innovation labs
- **Efficiency vs Exploration:** Offers quick interactions showing clear benefits while allowing self-paced exploration during coffee breaks
- **Constraints vs Co-creation:** Provides simple engagement pathways that don't disrupt work schedules or force choices between job duties and innovation

2 A 3D printing station, that showcases a 3D printer, videos showing the benefits.

3 A drone that they can fly and see the benefits of drones.

4 A smart inspection table with cables that can be assembled, videos that show its benefits

1 A maintenance technician enters the breakroom for their coffee break

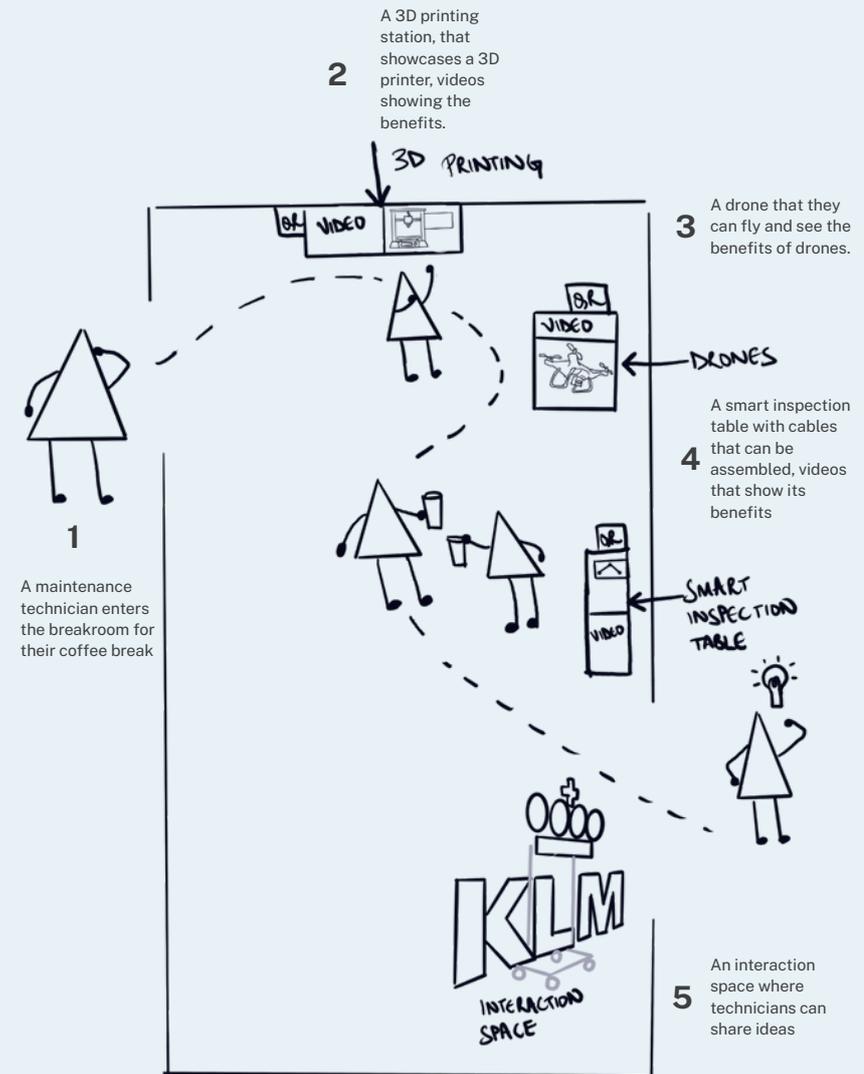**5** An interaction space where technicians can share ideas

Figure 14: Ideation for Eureka

3.1.2 tech triage (concept 2)

A maintenance technician enters the meeting room and discovers something different, not the usual PowerPoint slides, just tables covered with problem cards from technicians. Cards display familiar challenges: "Eye fatigue after inspecting 40+ engine blades," "Back problems from heavy cable assembly boards."
"I submitted something like this," says Maria, recognising her own workplace challenge. The facilitator gestures to solution tables: "These tools might help, but you decide if they work." The room's energy shifts as technicians move between problems and solutions, testing connections: "Could this 3D fixture work for that angle?" "Has anyone used this AR system during inspection?"
By session's end, they're problem-solving together, connecting daily challenges to available technologies. Walking out, one remarks: "They didn't try to sell us anything, just showed tools for problems we face."

The ideation centred on developing card decks that paired real maintenance challenges (problem cards) with corresponding technology solutions (technology cards). Each technology card detailed specific functions and was accompanied by physical prototypes demonstrating potential applications. Figure 15 shows these problem cards. This concept was designed as an interactive workshop format where technicians serve as co-creators, actively identifying which technologies they find most relevant to addressing specific maintenance challenges. It was then evaluated against how effectively it addresses each tension.

Balancing Tensions
- **Innovation vs Integration:** Brings technology exploration into meeting rooms for collaborative problem-solving, though still requires travel from immediate work areas.
- **Efficiency vs Exploration:** Problem cards address real challenges and show efficiency through technician experiences, but the structured workshop format limits free exploration while requiring at least an hour.
- **Constraints vs Co-creation:** Makes technicians problem-owners, but the format doesn't accommodate those who prefer to "walk away".

1

Inviting technicians to a workshop.

2

Problem cards that showcase "real" challenges from technicians.

3

Having peer discussions to identify technological solutions to problems.

4

Technicians rank which technologies can be used to address which problems.
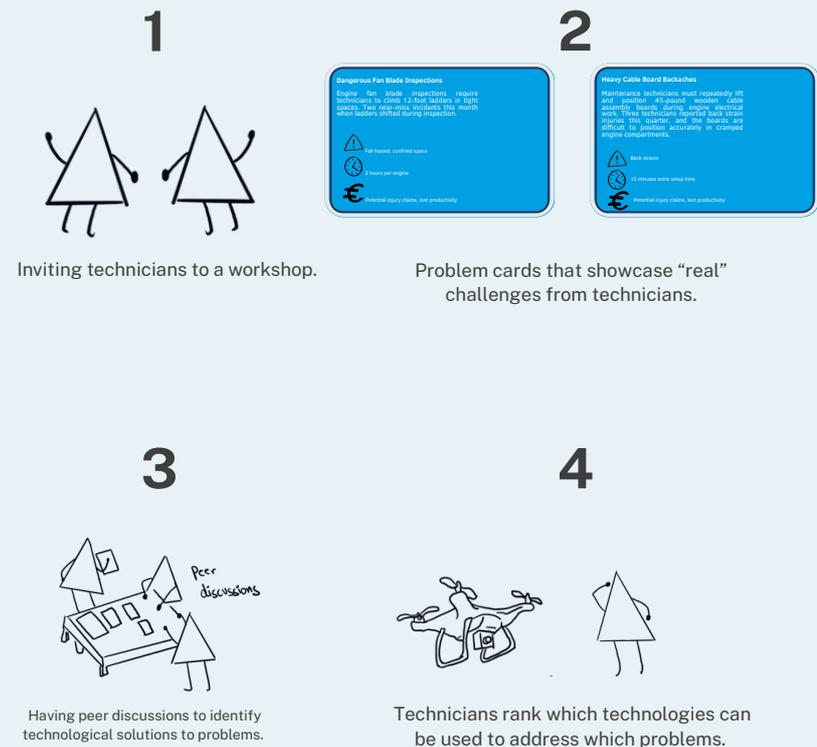
Figure 15: Ideation for tech triage

3.1.3 mech (concept 3)

A maintenance technician, frustrated after a long day of manual inspections, opens the AI assistant on their tablet right in the hangar during their break. Instead of just describing their challenges, they ask: "Who else here has tried that drone inspection system I keep hearing about?" The AI immediately connects them with Marco from Engine Services. They set up a meeting, and Marco walks over with the drone, and the technician gets to fly it themselves, seeing firsthand how it could cut their blade inspection time in half. As they're testing the drone, the AI quietly notes their interest and suggests they join Marco at tomorrow's informal "coffee and drones" session, where other technicians gather to share tips and improvements they've discovered.

The ideation explored a chatbot prototype called "Mech" that was trained on basic MRO Lab information, including available tools and contact details (Figure 16). This concept aimed to help technicians navigate KLM's innovation resources by providing direct access to them and connecting technicians with relevant personnel. However, the prototype faced significant limitations as proprietary company data could not be fully integrated into the system, resulting in constrained conversations that limited the natural flow of interactions during stakeholder testing. It was then evaluated against how effectively it addresses each tension.

Balancing Tensions

- **Innovation vs Integration:** Provides convenient access to innovation information, but it creates another separate channel rather than embedding technologies in a familiar workplace.
- **Efficiency vs Exploration:** Delivers efficient answers to specific questions; this structured interaction conflicts with technicians' preference for autonomous exploration.
- **Constraints vs Co-creation:** Removes constraints like logistical barriers like travel and scheduling, but places the engagement burden entirely on technicians to ask the right questions.

1

a technician has a question about where to find the contact for the 3D printer
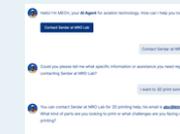
2

it reaches out to mech, the handy chatbot that has been trained specifically on KLM's internal database
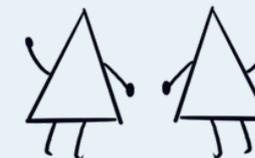
3

the chatbot can help identify resources, directly connecting employees in such a large organisation

Figure 16: Ideation for Mech

3.2 choosing a concept

Beyond analysing how concepts balance tensions, the research required ensuring the selected concept could be realistically implemented and aligned with organisational goals. The study employed the triple innovation lenses (desirability, viability, feasibility) along with future visioning and backcasting because traditional implementation approaches often fail by adopting reactive, present-focused orientations (Robinson, 1990; Holmberg & Robert, 2000). This bridges the gap between probable and preferable futures (Voros, 2003), enabling strategic interventions that deliberately build desired organisational capabilities rather than simply responding to predicted scenarios.

3.2.1 desirability and feasibility checks

Quick sessions were conducted with the stakeholders (technicians and management) to understand which concept was most desirable and feasible. Based on the stakeholder feedback, Eureka emerged as the most desirable and feasible concept for implementation (see quotes on page 79). Desirability and feasibility were prioritised before viability in line with the innovation frameworks (Brown, 2009).

From a desirability perspective, maintenance technicians found Eureka appealing because it requires minimal behaviour change, while program managers appreciated its alignment with existing workflows and organisational structure.

Eureka also scored highest on feasibility because it leveraged existing infrastructure, such as the breakrooms that already exist, requiring only the addition of display materials rather than new systems or processes. Tech Triage scored second in both dimensions, with technicians valuing its problem-solving focus but program managers noting implementation challenges around timing and resource allocation. Mech ranked lowest in feasibility due to concerns about training the AI within 2 months, while technicians preferred hands-on interactions over the AI assistant concept.

eureka

"I think it is important to have an interaction space, ensuring a two way dialogue"

maintainence technician

"A model is too childish, I'd prefer the real thing"

maintainence technician

"This is more a show and tell, will this involve us in an interactive manner?"

maintainence technician

"Yes! This is a good way for me to see it, but I actually want to be able to try it."

maintainence technician

"It aligns with our vision of having a technology pull within the organisation"

program manager

"Since, we already have the existing technology, it would just be a matter of "how" it is presented to the technicians".

program manager

"I think people are using this technology exist within the organisation, but how will you ensure that the information can be translated to us?"

maintainence technician

tech triage

"I don't want to sit through something"

maintainence technician

"I think if you involve us at co-creators at an early step, I'd like that"

maintainence technician

"Where exactly would you do this? Do we need to walk to the office spaces, that's too far away"

maintainence technician

"This means we need someone to facilitate this, it cannot be a one time thing"

program manager

mech

"I think this is helpful, if I know what to look for and currently I don't exactly know that. This can be a later step"

maintainence technician

"This could work as a digital assistant, we can take this up with the big data team"

program manager

"we don't have the data to train this now, but this can be a recommendation for the big data team".

program manager

"Is this even possible?"

maintainence technician

3.2.2 viability check

Based on the desirability and feasibility check, it was clear that Mech could not be implemented and tested within the thesis timeframe. Only two concepts were checked for viability. A unique future vision was created for each concept and mapped using a backcasting approach. It was structured across three horizons on a hypothetical timeline extending to 2030, with an arrow in reverse indicating the present (2025). These are read from right to left, starting with the envisioned future and then tracing backwards to identify the goals and resources required to realise that future. This method also helped clarify which concept was more closely aligned with KLM's strategic goals and long-term direction.

eureka (concept 1)

(an imagined) future

Imagine walking into the Engine Services area in 2030 and hearing technicians discussing how to improve drone inspection protocols, seeing peer-led technology demonstrations happening organically, and witnessing systematic collaboration between operational expertise and innovation development...

Future vision 2030: To transform employee engagement with emerging technologies from passive resistance to active exploration and adoption.

	2025	2028	2030
stakeholders required	MRO Lab and innovation ecosystem leads, continuous improvement leads	Hangar leads, E&M management	KLM management
goal	to explore and engage with technologies, so they can provide insights of core operational challenges	to allow cross-departmental knowledge exchange, can approaches one department be useful to the other?	employees are co-creators and innovation is not restricted to specific departments. The innovation ecosystem gathers challenges from employees, and solutions are co-developed.
resources	identifying natural traffic locations, creating videos and choosing technologies to display	identifying natural traffic locations, creating videos and choosing technologies to display, connecting with an idea collection platform	identifying natural traffic locations, creating videos and choosing technologies to display, connecting with an idea collection platform and hosting Eureka regularly

tech triage (concept 2)

(an imagined) future

Imagine walking into a facilitated session in 2030 and seeing technicians naturally gravitating toward problem cards, having authentic conversations about matching daily challenges with available technologies, and witnessing organic knowledge transfer where maintenance expertise directly informs innovation development priorities...

Future vision 2030: To establish a systematic problem-solving culture where challenges drive innovation, development priorities, and technology adoption decisions.

	2025	2028	2030
stakeholders required	MRO Lab and innovation ecosystem leads, continuous improvement leads, session facilitator	Hangar leads, E&M management, multiple session facilitators	KLM management, multiple session facilitators
goal	to identify and match real operational challenges with available technologies through problem-first workshops and co-creation sessions	to establish systematic challenge collection through the Shared Innovation Platform and allocate time, resources	operational challenges drive innovation priorities and employees systematically co-create solutions with clear business impact
resources	a dedicated location, session facilitator, collecting challenges from technicians and identifying technologies	a dedicated location, session facilitator, collecting challenges from technicians across E&M and identifying technologies through the platform	multiple dedicated locations, session facilitators, collecting challenges from across KLM and identifying technologies through the platform

Eureka was chosen as the final concept to be validated because it makes technology exploration effortless, requires the least resources now and in the future. Unlike Tech Triage, which requires formal meetings that clash with technicians' busy schedules and a dedicated session facilitator, Eureka works through simple nudges (Thaler and Sunstein, 2008). It can start immediately with existing break rooms and grow naturally into a company-wide innovation culture, supporting KLM's productivity goals. Specifically, Eureka directly aligns with KLM's "Innovate with technology" strategic pillar and contributes to the "Back on Track" program's objectives of increasing productivity and cost savings.

04
about eureka

What readers can expect: This chapter provides an in-depth exploration of Eureka as a spatial innovation intervention that transforms everyday workplace environments into technology discovery spaces. It explains the concept's core principles, what makes a space Eureka, and how it was developed. It addresses each tension through "structured serendipity", featuring peer testimonials through videos, hands-on experiences, and clear pathways to deeper engagement.

Key takeaways:
- Physical space itself can be prototyped and tested like any other design element.
- Authentic peer experiences are more persuasive than management presentations.

I found myself constantly second-guessing the concept, despite positive stakeholder feedback, because something in me resisted the idea that the solution could be "too simple." The only way to truly test this uncertainty was through the validation phase, which ultimately proved quite positive.

4. about eureka

4.1 what is eureka?

Eureka is a spatial innovation intervention that transforms employees' familiar workplace environments into relevant technology discovery spaces by eliminating the barriers that traditional innovation approaches inadvertently create.

4.2 what makes a space eureka?

- **Integration:** Innovations embedded within employees' natural workflow and familiar spaces (break areas, common rooms, transition zones), not segregated innovation labs
- **Exploration:** Enables self-directed exploration, either individually or in groups, during routine activities without mandatory participation or scheduled demonstrations, featuring fellow employees as technology champions through authentic testimonials and peer-led demonstrations of actual usage
- **Efficiency Demonstration:** Features real, functional technologies that can be meaningfully manipulated and tested, showcasing concrete, measurable improvements to daily work challenges through before-and-after scenarios and real-world applications
- **Co-creation Pathways:** Provides explicit next steps from initial curiosity to implementation participation, answering "What's next?"

4.3 how is it different from other spaces

Traditional innovation spaces follow established frameworks like Moultrie et al.'s (2007) five-pillar model, encompassing strategic intention, process of creation, physical space, process of use, and realised intention, which justifies substantial corporate investments in dedicated innovation facilities such as Google's innovation facilities and Apple's campus designs.

Leading organisations have invested heavily in creating sophisticated environments designed for breakthrough thinking, separate from their day-to-day operations. Companies like IDEO developed human-centred design studios (Kelley & Littman, 2001), while tech giants built massive innovation campuses to foster creative collaboration. However, research shows that the vast majority of corporate innovation initiatives fail to achieve their intended transformation, with only 3% of companies qualifying as 'innovation ready' despite 83% prioritising innovation (BCG, 2024). Most critically, many innovation labs become isolated "innovation theatres" focused on displays rather than implementation, evidenced by high-profile closures including Microsoft's Silicon Valley Research Lab and Disney's research lab (Harvard Business Review, 2019). Eureka takes a different approach by bringing innovation directly to employees within their existing workspaces by eliminating spatial, social, and hierarchical barriers while preserving hands-on learning experiences and making practical value immediately apparent through strategic design of everyday spaces.

4.4 why the name eureka?
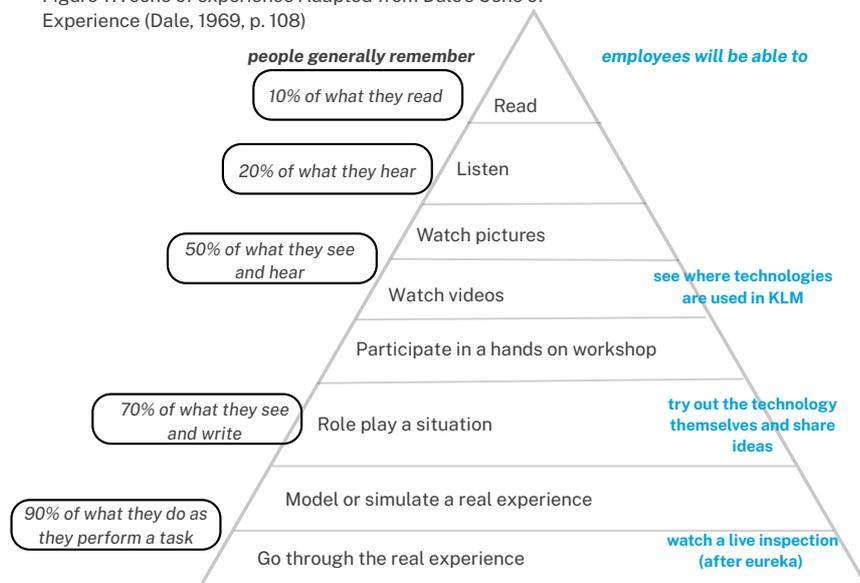
The word Eureka means "I have found it" (in Greek), coming from Archimedes' legendary discovery moment in his bath, where an everyday space and routine activity led to a breakthrough realisation (University College London, n.d.) mirroring how this intervention transforms ordinary workplace spaces into environments where employees can have their own "aha!" moments with emerging technologies

4.5 how was it developed?

The development of Eureka's multi-modal artefacts follows Research through Design's (RtD) iterative knowledge generation process, where design artefacts serve as both research instruments and practical solutions (Zimmerman et al., 2007; Gaver, 2012). The cone of experience was a guiding factor for the artefacts, informing the selection and design of experiential elements that progress from concrete, hands-on experiences to more abstract conceptual understanding (how technology could be used in their work) (Dale, 1969). The systematic evolution from initial prototypes to refined experiential elements demonstrates how RtD enables "learning through making" that responds to empirical insights about technician engagement preferences (Schön, 1983). In the following section, each tension is balanced through a design decision, and the tensions are represented as logos.

Figure 17: cone of experience Adapted from Dale's Cone of Experience (Dale, 1969, p. 108)

people generally remember

employees will be able to

- *10% of what they read* — Read
- *20% of what they hear* — Listen
- Watch pictures
- *50% of what they see and hear* — Watch videos — **see where technologies are used in KLM**
- Participate in a hands on workshop
- *70% of what they see and write* — Role play a situation — **try out the technology themselves and share ideas**
- Model or simulate a real experience
- *90% of what they do as they perform a task* — Go through the real experience — **watch a live inspection (after eureka)**

4.5.1 videos as proof

Efficiency

Technicians consistently emphasised *"seeing is believing,"* making videos essential for technology demonstration. Since people absorb information better through observation than explanation (Bandura, 1977), and safety constraints prevent live demonstrations in operational environments, videos became the primary tool to showcase the efficiency of using emerging technologies. This approach addressed the efficiency-exploration tension by providing concrete proof of practical benefits while still allowing autonomous discovery.. The initial videos simply showed technologies in action, but technicians demanded more: *"Show us the actual difference it makes."* The content evolved to demonstrate clear before-and-after scenarios, highlighting specific problems being solved. Recognising that innovations *"might work better coming from another technician,"* real KLM maintenance staff hosted the videos, sharing authentic experiences with the technologies. While gathering feedback on the concept, fellow technicians naturally gathered and engaged more comfortably when conversations happened in Dutch, prompting the decision to create all content in Dutch to remove potential engagement barriers (Heath & Heath, 2007). KLM's communication lead validated each video, ensuring brand consistency and organisational usability for future applications.

4.5.2 having multiple technologies

Exploration

The research selected three technologies (drones, digital cable boards, and 3D printing) based on their availability and maturity within KLM's existing innovation pipeline.

Rather than prescribing specific solutions, offering multiple technologies allowed technicians to evaluate relevance for themselves while exposing them to new possibilities for their work. This variety accommodated different operational challenges and personal interests: some gravitated toward drones for safer inspections, others focused on ergonomic solutions for heavy cable boards, while those with personal 3D printing experience could connect home and work applications. As technicians noted, *"some things we can use, some we cannot."*

Co-creation

4.5.3 a hands-on experience
When technicians encounter new technology, hands-on interaction creates understanding that traditional demonstrations cannot match. As participants consistently emphasised, *"seeing is believing"* and *"we learn from doing"*. Traditional demonstrations often position technicians as passive observers, watching someone else operate technology while they stand at a distance. In contrast, hands-on experiences allow technicians to test functionalities themselves, discover limitations firsthand, and understand how technologies might integrate into their existing workflows. This hands-on approach positions technicians as potential co-creators who can suggest improvements and modifications based on their direct experience with the demonstrations.

Integration

4.5.4 prototyping a "space"
The idea of "prototyping a space" came from watching maintenance technicians consistently avoid innovation hubs that were supposed to provide them access to ongoing innovations. Instead of treating physical environments as fixed backdrops, this research revealed that space itself can be designed and tested like any other prototype. Technicians avoided going *"upstairs"* to innovation areas not just because of physical distance, but because these spaces embodied a separation between *"white collar"* innovation work and *"blue collar"* operational expertise. This approach builds on Lauff et al.'s (2018) insight that prototypes help people develop hands-on understanding through building and testing. Applied to space design, this means testing how different physical arrangements affect real interactions between people, rather than assuming what will work based on theory alone. There were various spaces present within the organisation that could be chosen for the validation; specifically, the break room was chosen as it was a natural location that the technicians visited during their routine activities. This aligned with the Integration Vs Innovation tension of placing innovation within employees' natural workflow rather than expecting them to seek out separate innovation spaces. On a practical level, it was the location where permission from management was acquired, had at least 4-5 m^2 of space to accommodate multiple technologies and visitors, and included necessary infrastructure such as plug points for the 3D printer and screen. The break room also provided an informal atmosphere conducive to autonomous exploration, allowing technicians to encounter technologies during coffee breaks without disrupting their work schedules or creating the hierarchical barriers associated with formal innovation labs.

A drone that can be flown and VR glasses to view a drone inspection

A digital interaction to try the digital cable board.

3D printed parts that are already being used at KLM and a 3D printer that can be used to print small parts

scan the QR code to see all the videos

Videos were made for each of the technologies to show practical benefits

Figure 18: prototyping eureka (objects and videos)

4.6 how can you build your own Eureka?

Now that we have explored what Eureka consists of and how it was developed, organisations can consider how to create their own Eureka spaces. Several practical questions can guide implementation across the three key tensions, which are shown below.

Innovation vs Integration:
- Are technology touchpoints placed where employees naturally gather rather than expecting people to seek out separate innovation spaces?
- Do these spaces maintain the familiar comfort that encourages spontaneous discovery during routine activities?
- Is the space itself treated as a prototype that can be tested and refined?

Efficiency vs Exploration Balance:
- Are concrete benefits demonstrated through clear before-and-after scenarios while still enabling autonomous discovery?
- Do authentic peer testimonials from real employees feature prominently?
- Are hands-on experiences prioritised to create lasting understanding?

Constraints vs Co-creation:
- Are operational realities like safety and time limitations acknowledged while still enabling meaningful hands-on interaction?
- Are employees treated as collaborative partners who can evaluate technology relevance for themselves?
- Are clear next steps established for interested participants?

5
Validation & Strategic roadmap

This part was pretty tricky to organise, mainly because we did not know exactly when we would get the green light to test, since we were waiting on management approvals. A huge thanks to Serdar for making it happen in the end. Honestly, it was so worth it. Getting real-time feedback was incredibly valuable, not just to validate the concept, but also to see that the themes that had been identified actually resonated with technicians.

What readers can expect: This chapter presents the validation of Eureka through testing with the three-dimensional engagement framework, measuring behavioural, cognitive, and affective responses. It documents the controlled experiment conducted in KLM's breakroom environment over four days. The validation showed concrete evidence of Eureka's effectiveness with 139 technician visits, strong cognitive engagement (92% actively understanding technologies), and overwhelmingly positive emotional responses. This is followed by immediate opportunities, a strategic roadmap which provides an implementation plan on how Eureka can be scaled across the organisation.

Research questions answered:
RQ4: What triggers can we test to engage maintenance technicians with emerging technologies, and how can they effectively interact with them?

Key takeaways:
- Multi-dimensional engagement measurement provides validation of different design interventions.
- Technicians prefer 3D printing technology overwhelmingly (75% relevance rating).
- Informal learning environments generate higher engagement than formal training sessions.
- Natural discovery leads to unexpected ideas of how technologies can be used at work.

5. measuring engagement

Following the development of the concept, engagement measurement became the next critical phase. While engagement is traditionally conceptualised as a long-term behavioural phenomenon that develops and evolves over extended periods (Fredricks et al., 2004), because of the timeframe of the thesis being five months, immediate engagement responses were measured. A three-layered approach was employed (Bijkerk et al., 2023; Perski et al., 2017). This multidimensional approach recognises that engagement is not a simple, one-dimensional construct but rather a complex phenomenon that requires multiple measurement perspectives. Table 3 gives an overview of the engagement metrics.

The first layer, behavioural engagement, relied on direct observation to capture what technicians do when interacting with technology. This approach addresses the social and spatial barriers that emerged during technician interviews, moving beyond surface-level participation to capture genuine technology usage patterns and participation levels that reveal authentic interest rather than mere compliance.

The second layer, cognitive engagement, utilised a survey to assess technicians' internal mental processes, followed by short qualitative interviews about their experience. These measurements focused on technology understanding and work relevance, which is crucial for determining whether technicians can envision practical applications for their everyday tasks (Davis, 1989; Venkatesh et al., 2003). Based on discussions with my company supervisor, this was the most critical engagement layer for KLM.

The measurement focused on two essential questions: which technologies technicians found relevant for their work and how these could solve their daily challenges.

For the third layer, the study used PrEmo's visual character method, which suits technicians who prefer hands-on learning over text-heavy assessments and avoids language barriers (Laurans & Desmet, 2017). Six emotions were selected from PrEmo's 14 options:
Positive emotions that encourage adoption:

- **Satisfaction:** indicates the technology meets functional needs and predicts continued use (Desmet, 2002; Davis et al., 1992)
- **Fascination:** represents sustained attention and exploration drive, key for learning engagement (Desmet & Hekkert, 2007)
- **Admiration:** shows respect for the technology's capabilities and translates positive attitudes into behaviour change (Desmet, 2018; Russell, 2003)
- **Desire:** reflects wanting to use the technology, essential for moving from interest to action (Desmet, 2018)

Negative emotions that create barriers:

- **Contempt:** creates psychological distance and leads to rejection behaviours (Desmet, 2002; Fischer & Roseman, 2007)
- **Boredom:** significantly reduces engagement and signals disinterest (Pekrun et al., 2010)

When technicians show positive emotions, it signals successful engagement and predicts future use. Negative emotions reveal barriers that need addressing before implementation can succeed (Perski et al., 2019). Appendix E shows the survey questions, measurement guide and the PrEmo scale selected to measure engagement.

Table 3: Engagement Metrics

Engagement Dimension	What to measure	How it was measured	Why is it measured
Behavioral Engagement (What technicians actually do)	Total visitors, Visitor distribution by session, Return visits	Observation and keeping count	Indicates sustained interest and voluntary engagement beyond initial exposure. Multiple visits suggest the technology demonstration has captured ongoing attention.
	Time spent at the exhibition (average session duration in minutes)	Observation	Longer engagement time suggests deeper exploration and genuine interest. Brief visits may indicate polite obligation rather than authentic engagement.
	Type of engagement (Active or Passive) (Operated drone, Used VR glasses, Attempted technology interfaces, Called colleagues over, Asked questions, Took photos/videos, Used inspection tools, Touched interfaces/equipment)	Observation, number of parts printed and number of times the drone is flown	Active engagement (touching, questioning, experimenting) indicates hands-on learning preference identified in research. Passive observation suggests barriers to full participation.
	Intensity of the engagement (Engagement intensity timeline, Zone engagement distribution)	Observation	Measures of depth of interaction were done through superficial browsing vs. focused exploration. High intensity suggests technology has captured attention and overcome initial skepticism.
Cognitive Engagement (What technicians think and understand)	Work relevance (Perceived relevance scales, Goal alignment assessments, Technology credibility ratings)	Survey	This was critical for adoption; technicians need to see clear connections to their daily tasks. Research showed a preference for practical problem-solving over abstract innovation.
	Understanding of the technology (Use of technology to solve a work challenge)	Survey	Measures comprehension and enables technicians to envision implementation and identify potential applications in their workflow.
Affective Engagement (How technicians feel about the experience)	Real time emotional response (Six emotions measured: Satisfaction, Admiration, Contempt, Desire, Fascination, Boredom)	PrEmo Method	Emotions serve as powerful predictors of technology adoption behavior: positive emotions (satisfaction, fascination, admiration, desire) indicate successful engagement and future use likelihood, while negative emotions (contempt, boredom) reveal psychological barriers requiring intervention before implementation success

5.1 initial testing

Setting up the initial testing felt like a controlled experiment. I placed 3D-printed prototypes and videos directly on the technicians' lunch tables during coffee breaks, then observed how they would naturally interact with them.

As shown in the setup images, the prototypes were positioned on their familiar wooden lunch tables in their break room. While several technicians glanced at the displays and a few watched portions of the videos, the results were telling; no one touched or inspected the physical prototypes, despite their stated preference for hands-on learning. This passive engagement reinforced the need for a far more explicit and inviting approach. While some acknowledged that the 3D-printed prototypes effectively communicated the basic concepts, several dismissed them as "childish" and expressed a strong desire to interact with actual technologies rather than simplified representations. What technicians meant by "hands-on" wasn't just being able to touch or inspect objects; they wanted to actively use the technologies themselves, like operating a 3D printer to create their parts, flying a drone, or testing digital interfaces. The clean, organised presentation on their outdoor lunch tables communicated professionalism, but the static nature of the display failed to invite this kind of active participation.

This initial test highlighted a gap: technicians wanted authentic, operational experiences with the technologies, not just physical models to look at.

For the final testing, technologies (3D printer, a drone, and a proof of concept of the digital cable board were added) were added to ensure a hands on experience.

Figure 19: Initial Testing

5.2 validation

The concept was validated through a controlled experiment in the technicians' breakroom, the space chosen because it's where technicians naturally gather during their workday, and it belongs to them rather than to management or innovation teams. Furthermore, it is where management approval was obtained to test the concept, and it was practically feasible due to the presence of plugpoints.

The testing was done over 4 days, from 11:00 - 17:00 (to capture shift changes), where I was present on all days. Formal communication channels were not used; instead, simple brochures were placed near the canteen and across the break rooms with the date and time the experiment was taking place. This informal approach encouraged organic participation instead of creating the pressure of a mandatory demonstration.

I focused on natural observations of how the technicians interacted with the technologies. Only when someone was physically touching equipment or looking around with questions did I approach them. The engagement was richer when technicians could freely ask questions. Figure 20 shows the Eureka setup with three interactive stations: a working 3D printer where technicians could print small parts themselves, accompanied by videos of their colleagues already using this technology; a digital cable board that let them practice mounting cables hands-on with demonstration videos; and a drone they could fly, VR goggles to experience what a drone inspection looks like from the pilot's perspective.

Figure 20: Setup of Eureka
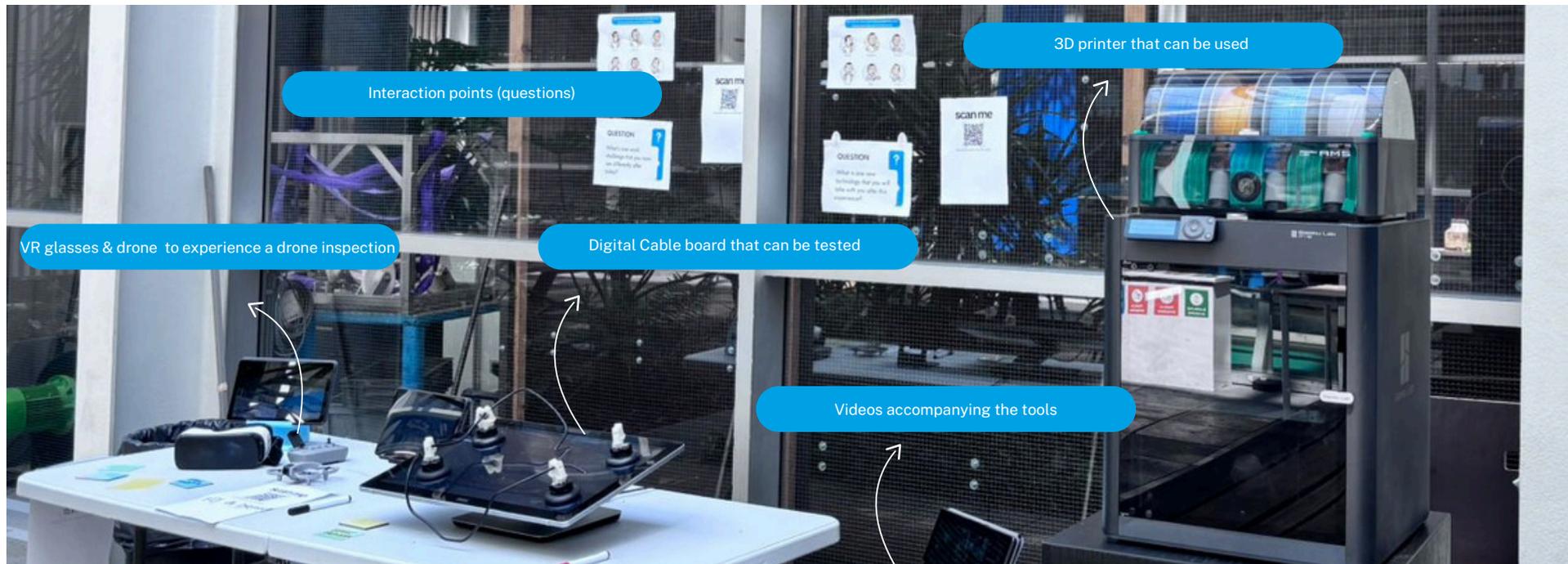
5.2.1 Behavioural Engagement Measurement

Behavioural engagement was systematically measured using a structured observation form (see Appendix E) that was completed through real-time tallies during the four-day validation period. The form tracked multiple engagement dimensions, including visitor counts, interaction types, time spent, and engagement intensity levels across different periods and zones within the exhibition space. A total of 139 technicians visited the Eureka exhibition, which represents approximately 28% of the total number of technicians in Engine Services. However, it's important to consider the context in which the testing took place. I did not have access to the exact number of employees present during each shift, and the exhibition did not run fully during the evening shift. Additionally, the testing period coincided with the holidays, which likely reduced the number of employees on site. Based on shift estimates, there were approximately 180 employees present in the Repair garden (out of a total of 256) and around 170 in MRO (out of 243) at the time of testing. Of those present, 70 individuals from Repair and 69 from MRO participated, representing 39% and 41% of the on-site workforce, respectively.

Alongside the visit and revisit numbers, the depth of the engagement (direct interaction, close observation and peripheral interest was mapped (see Figure 21). Direct interaction refers to moments when technicians actively engage with the technologies, such as 3D printing parts or flying a drone. Close observation refers to those who showed interest by watching demo videos, asking questions, or inspecting the setup and peripheral interest includes those who engaged passively, such as briefly looking while passing by or watching from a distance.

The engagement patterns revealed varied levels of interaction intensity, with visit frequencies ranging from brief encounters to extended exploration sessions, with the average engagement time lasting 10-15 minutes per visit.

Notably, 45 printed parts were produced over the four days, indicating active hands-on engagement with the 3D printing technology rather than passive observation. The highest engagement was observed between 11:00-12:00 (break) and 15:00-16:00 (during shift change). Interestingly, most technicians approached the exhibition in small groups of 2-3 colleagues, suggesting that peer influence and collaborative exploration played important roles in encouraging participation.
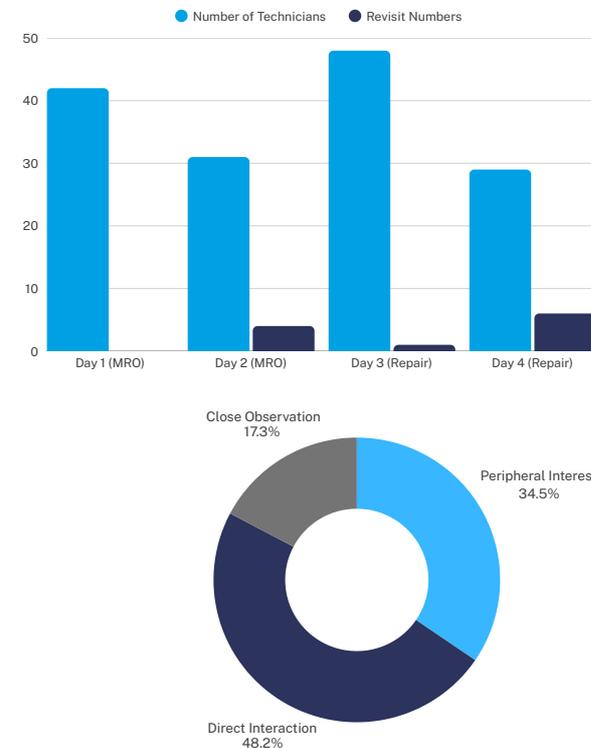

Figure 21: Graphs that measure engagement

5.2.2 Cognitive Engagement

The cognitive engagement measurement utilised a post-interaction survey to assess how technicians mentally processed the technology demonstrations across four key dimensions: relevance perception, active understanding, application thinking, and focused learning. These dimensions follow a natural progression, from technicians first seeing why a technology matters to them, then understanding how it works, thinking about how they could use it in their work, and finally sharing new work requests on how it could aid their work (Davis, 1989; Ellinger, 2005; Andriopoulos & Lewis, 2009). Figure 22 displays the percentage breakdown across these dimensions.

Among the 24 participants, the results demonstrated remarkably strong cognitive engagement, with 92% actively trying to understand how the technologies worked, 88% recognising clear advantages for their work, and 83% finding the technologies relevant to their daily tasks. The data revealed that 3D printing emerged as the overwhelmingly preferred technology, capturing 75% of participants (18 out of 24) who identified it as most relevant to their work, significantly outpacing drones at 17% and digital cable boards at 8%. However, a notable gap emerged between understanding and practical application, as while participants could readily comprehend the technologies, only 79% could envision how to integrate them into their daily work routines. From 24 survey participants, 5 people (21%) shared specific implementation ideas, with 2 additional ideas emerging from informal conversations, totalling 7 concrete suggestions.
While not many technicians wanted to fill out the QR code survey, far richer insights emerged during spontaneous conversations and when technicians discussed the technologies with each other during their demonstrations. These organic interactions helped identify technology experts within the group and revealed how they already used similar technologies at home.

A relevant example of this authentic engagement occurred when a technician saw the 3D printer during his first visit, then returned the next day carrying a replacement part that was over 35 years old, wondering if it could potentially be 3D printed, demonstrating genuine cognitive processing and practical application thinking that extended well beyond the formal demonstration session.

This process also revealed natural technology champions within the organisation, technicians who already used metal 3D printers at home and could immediately envision applications for KLM's plastic printer capabilities. One trained drone pilot approached the station, specifically wanting to observe live inspections and potentially pilot drones for KLM's inspection operations. Beyond the intended demonstrations, technicians discovered unexpected applications. They noticed the 3D-printed iPad stands I had used simply to display information and immediately requested these for their inspection work, showing how hands-on exposure sparks creative problem-solving that goes beyond planned use cases.
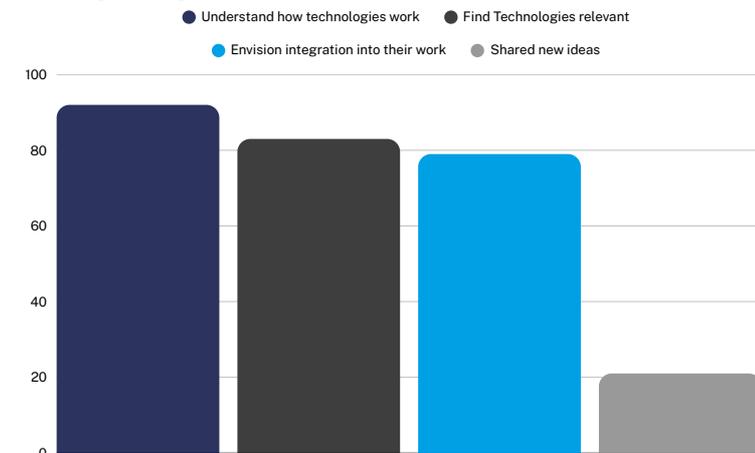
Figure 22: Percentage breakdown across dimensions

"It can certainly be an addition for certain work activities within the shop."

"I would like to watch and/or fly myself"

"You had a nice setup. In the future KLM maybe can get new innovations through the manufacturers ..."

Figure 23: Testing Eureka (quotes by technicians)

"Very nice to see the ongoing tech, hope that in the future new innovations can also be seen. This creates awareness about possibilities...."

5.2.3 Affective Engagement

How did this interaction make you feel? Place your sticker next to the emotion that matches

Boredom Fascination Satisfaction

Admiration Desire Contempt

Figure 24: Using PrEmo to measure affective engagement

As shown in Figure 24, participants were asked to place stickers on the character expressions that best represented their feelings while engaging with the technology demonstrations. However, only technicians who had direct, hands-on interaction with the technologies were asked to complete this emotional assessment, as this approach made it easier to gather qualitative feedback and address any questions they had about their experience in real-time. This nonverbal, sticker-based approach proved particularly effective in the professional maintenance environment, as it bypassed language barriers and social desirability bias that might influence more traditional survey responses.

The results were overwhelmingly positive: 11 technicians placed their stickers on fascination, 2 on satisfaction, and 1 on desire, with no negative emotions selected. While technicians may have been hesitant to provide direct negative feedback through the visual assessment, they were more open to sharing constructive criticism and improvement suggestions during the qualitative interview sessions that followed.

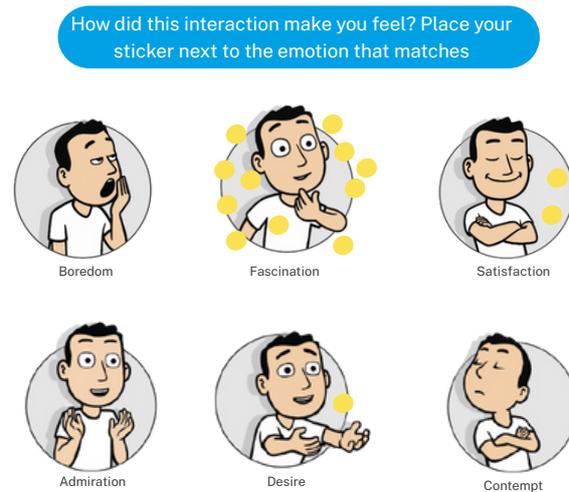Eureka showed that placing technology in a familiar space encouraged natural engagement. Technicians explored freely, asked questions, and connected the tools to their daily work. Their responses revealed strong interest, practical insights, and even new use cases. The experiment confirmed that when innovation is accessible and hands-on, technicians don't just observe, but shape innovation.

Improvements suggested after the validation

Different stakeholders shared distinct preferences in their feedback. Management wanted focused demonstrations featuring single technologies with professional setups, while technicians preferred broader exposure, including examples from industries beyond aviation. Several participants recommended choosing more visible locations and expanding demonstrations to commercial and business units to build organisational awareness. Technicians expressed strong interest in ongoing engagement rather than one-time events, asking for regular showcases of emerging innovations. One technician suggested that KLM could work directly with manufacturers to demonstrate repair and inspection technologies. Their practical approach came through clearly as they wanted to see specific applications for daily work, with some asking for hands-on experiences during actual inspections. Importantly, themes from earlier interviews appeared again in these responses; this consistency across different methods strengthened confidence in the research findings, showing that the identified themes truly captured fundamental engagement barriers and enablers rather than isolated observations.

5.3 opportunities for KLM

5.3.1 Eureka as part of the Innovation Safari
KLM strategically paused innovation fairs after 2023 to realign resources during financial recovery, while maintaining its commitment to productivity and engagement objectives. However, Eureka's success in Engine Services demonstrated a new strategic approach, bringing innovation directly to employees within their operational environments rather than requiring them to seek it out in separate spaces. Eureka can scale across E&M through an "Innovation Safari", tentatively planned for November 2025, distributing demonstrations across hangars and office buildings. Employees can experience Eureka through artefacts such as videos, hands-on technology trials, and peer discussions. This transforms core tensions into advantages: embedding innovation in operational environments (Innovation vs Integration), enabling flexible engagement during work breaks (Efficiency vs Exploration), and creating collaboration within budget limits (Constraints vs Co-creation). After organisation-wide validation, it could become regular monthly or quarterly spaces, maintaining continuous innovation visibility without the costs that made traditional fairs vulnerable to cancellation.

5.3.2 Integration with Shared Innovation Platform
The second opportunity connects Eureka to KLM's upcoming shared innovation platform. Eureka could spark initial interest, then the platform becomes the natural next step for employees who want to propose applications or improvements after trying the technologies hands-on. KLM could track innovation submissions in the weeks following Eureka demonstrations to see if experiential engagement leads to active participation. This would test whether reducing barriers to technology exposure creates a pipeline effect, where hands-on familiarity builds confidence to contribute ideas. Both approaches would show whether Eureka can evolve from a research project into a sustainable strategy that bridges technology demonstration and innovation culture. Section 5.4 shows a strategic roadmap to implement Eureka within the organisation.
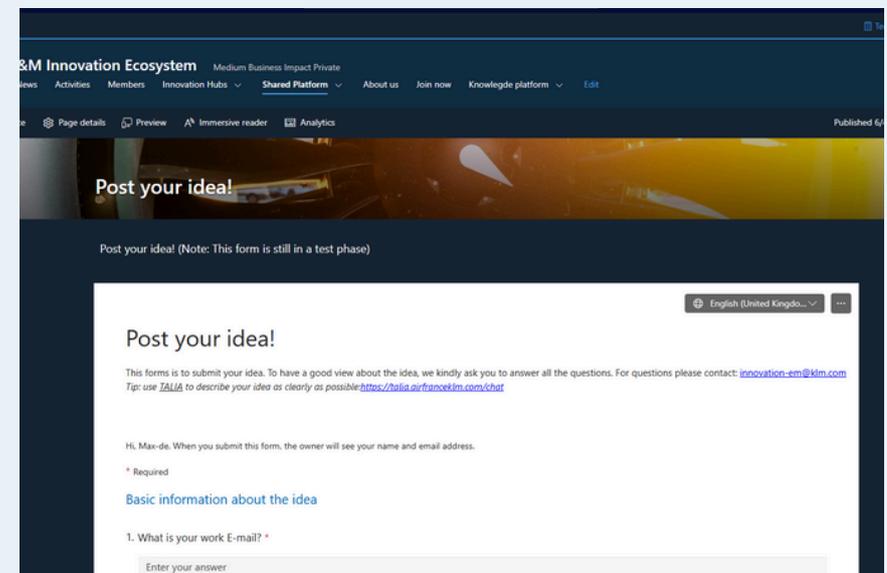

Figure 25: Previous Innovation Fair at KLM

Figure 26: The Shared Innovation Platform

5.4 strategic roadmap

This strategic roadmap facilitates Eureka's implementation within the organisation and aligns it with KLM's long-term vision and emerging trends in aviation maintenance. The roadmap provides a structured approach to managing growth and innovation across different timeframes, spanning from 2025 to 2030 to coincide with organisational milestones, including KLM's planned innovation safari in 2025 and their commitment to achieving net-zero carbon emissions in ground operations by 2030, a significant portion of which includes MRO activities. Three sequential horizons progressively expand the scope and impact of innovation engagement; it is read from left to right. Each of the horizons is explained below, and Appendix F provides a detailed explanation of the procedure.

Horizon 1 (Engage) establishes foundational capabilities by ensuring technicians can engage with emerging technologies through Eureka, while the innovation ecosystem facilitates idea sharing and peer learning among colleagues.

Horizon 2 (Expand) broadens the initiative's reach by extending Eureka to all Engineering & Maintenance employees and enabling cross-departmental knowledge exchange to break down organisational silos that currently limit collaboration.

Horizon 3 (Embed) transforms innovation culture into a self-sustaining capability across KLM, where employees naturally become co-creators and innovation integrates seamlessly into all departmental operations.

This progression balances short-term operational needs with long-term strategic transformation, creating a pathway from localised technology engagement to organisation-wide cultural change.

2025

Horizon 1

Engage

- Ensure that technicians can engage with emerging technologies through Eureka
- Ensuring that the innovation ecosystem facilitates idea sharing and peer learning

2028

Horizon 2

Expand

- Expand Eureka to all E&M employees
- Ensuring cross-departmental knowledge exchange

2030

Horizon 3

Embed

- Embed innovation culture as a self-sustaining capability across KLM
- Ensuring employees are co-creators and innovation is embedded into all departmental operations. The innovation ecosystem systematically gathers challenges from employees, and solutions are co-developed as standard practice.

Future Vision

KLM fosters a self-sustaining innovation culture through a balance of operational excellence and hands-on exploration.

Figure 27:The strategic horizons followed in the roadmap

HORIZON 1 — **2025*** — **HORIZON 2** — **2028*** — **HORIZON 3** — **2030***

HORIZON VISION

Engage technicians with emerging technologies through Eureka

Expand Eureka for all employees across E&M

Embed Eureka into the organisation as a regular service

FUTURE VISION

Embed Innovation into the DNA of the organisation

KLM fosters a self-sustaining innovation culture through a balance of operational excellence and hands-on exploration.

USERS

Target group
User values
Technicians
Management**
External Innovation Experts

- Engine Services Technicians / All E&M Technicians
- All E&M Employees
- All KLM Employees

Hands on Exploration | Co-creation | Mastery and Autonomy
Operational Excellence | Innovation cultural transformation
Future Readiness for the organisation

KLM'S STRATEGIC OBJECTIVES

Responding to operations employee shortage
Increase employee productivity by at least 5%
KLM targets to achieve zero emissions on the ground
Digital Transformation and Innovation: Using new technologies to increase productivity and ease work processes

CONCEPT PROPOSAL

PILOT EUREKA
- Test Eureka in the form of an innovation safari
- Test the Shared Platform as part of Eureka to identify technology champions

EXPAND EUREKA ACROSS ALL E&M DEPARTMENTS
- Establish eureka within each maintenance hangar
- Create dedicated innovation corners in break rooms with visual displays and technologies that can be experienced hands-on, combined with the Shared Innovation Platform

EXPAND EUREKA ACROSS KLM
- Create an autonomous innovation culture requiring minimal top-down management
- Extend innovation culture to include external stakeholders

BUSINESS

Stakeholders Involved
Actionplan
Business Value

Innovation Ecosystem Leads → Hangar Leads and Management → E&M Management → All departments → KLM's external partners

Pilot Eureka as a part of the Innovation Safari
Ensure Eureka can be implemented across KLM by bringing in new technologies to display and identifying strategic locations to reach employees
Identify the technologies that will be presented and map the locations across the organisation that have "natural" traffic
Integrate the Shared Innovation Platform in Eureka so employees can directly share ideas after the "aha" moments

Identify technology enthusiasts and champions who already have experience with emerging technologies
Improve everyday operations by getting direct insights into what processes need to be optimised by combining Eureka with the Shared Innovation Platform
Integrate innovation metrics into Employee Promoter Scores (EPS) to measure the Innovation culture

**Management
(Including Innovation Ecosystem Leads, Continuous improvement leads and management)

**2025: Testing Eureka across locations at E&M through the Innovation Safari
*2028: The financial recovery is projected to be complete, and digital tools are widely implemented to optimise operations.
*2030: KLM aims to achieve net-zero carbon emissions in their ground operations through innovative and sustainable practices. (KLM Masterplan, 2024)
Appendix F details the research that informed this roadmap's development.*

6
Discussion
& Implications

What readers can expect: This chapter summarises the status of research questions, contributions to KLM and other organisations through practical implications, to academia in the form of theoretical implications for future research, limitations and a conclusion.

Key takeaways:
- This research tests spatial prototyping and proposes its adoption by organisations seeking to evaluate interventions.
- Personal-professional identity integration is crucial for technology adoption.
- Innovation paradoxes can be balanced rather than resolved through strategic design.
- Peer-to-peer technology transfer creates more effective adoption than top-down approaches.
- Redesigning organisational layout eliminates barriers by embedding innovation into daily workflows.
- Embed technology demonstrations within operational contexts rather than separate innovation spaces.

This felt like the end, but not really. It was that in-between moment where I had to start wrapping things up while also pausing to look back at how it all fit together. I started wondering if Eureka could actually be useful for other organisations. Are there takeaways here that could mean something for the field of Industrial Design? And what did this thesis really contribute in the bigger picture? It was a mix of closing things off and opening up new questions.

6.1 a discussion

6.1.1 a new meaning to innovation engagement through spatial prototyping

Eureka is a spatial innovation intervention that transforms familiar workplace environments into technology discovery spaces, engaging technicians with emerging technologies to foster innovation. While tested exclusively at KLM, site visits to other organisations revealed shared barriers that Eureka directly addresses: limited operational staff participation, challenges in convincing operations teams about emerging technologies, and difficulties effectively demonstrating technology value.

The three central tensions (Innovation vs. Integration, Exploration vs. Efficiency, and Constraints vs. Co-creation) underpinning the project were not only derived from interviews, but they were further validated through the implementation of Eureka, confirming their practical relevance.

While technicians formed the core target group, the needs of all stakeholders, such as the KLM management (program managers in the innovation ecosystem, continuous improvement leads, black belt professionals, business unit management teams) and external innovation experts were carefully balanced throughout the project, ensuring a context-sensitive and scalable approach.

The concept extended beyond measuring engagement; it enabled technicians to identify relevant technologies, submit new work requests, and propose operational improvements. In doing so, it not only fostered greater involvement from the technicians but also helped close the gap between innovation ecosystems and the operations environment. By granting innovation teams access to these insights, organisations are better positioned to meet operational targets, embed innovation into everyday practice, and enhance overall efficiency.

6.1.2 status of research questions

RQ: How can we activate maintenance technicians' engagement with emerging technologies to foster innovation?
Chapters 4 and 5 tackle this question by developing and testing Eureka. Chapter 4 walks through what Eureka is (a spatial intervention), how it works and how organisations can implement it. Chapter 5 tests engagement measurement by testing Eureka in real time.

RQ1: What are the current levels of awareness among maintenance technicians regarding emerging technologies, and what factors influence their access to information about technological developments in their work environment?
The interviews in Chapter 2 revealed low awareness levels, where technicians currently do not have easy access to information about technological development.

RQ2: How do maintenance technicians perceive and interact with emerging technologies in their current workflows?
This has been answered in Chapter 2. Technicians embrace using emerging technologies, especially in their personal lives, and not necessarily at work. The interviews showed that technicians want to engage under specific conditions. These include hands-on exploration, demonstrated benefits and integration into their spatial environment that encourage them to use technologies.

RQ3: What are the key benchmarks for fostering innovation in organisations?
The literature review (in chapter 1) and site visits (chapter 2) showed that where (physical space) and how you present technology (the format, video, models)) determine engagement success.

RQ4: What triggers can we test to engage maintenance technicians with emerging technologies, and how can they effectively interact with them?
Chapter 5 validated that when Eureka navigated the tensions, the engagement was the strongest. This "structured serendipity" included hands-on experimentation with technologies, seeing practical benefits through videos and avenues for deeper exploration.

"From the MRO lab, we work continuously on the creation of concepts but try to work on the mindset of the organisation and people to make these concepts more successful. For a long time, I believed that progressive behaviour was mainly a matter of individual choice and perhaps with the right innovation, people would move, explore, and create.

But Sejal's research showed us that engagement isn't necessarily a personal characteristic, but how much you enable, remove limitations and organise to connect innovations to people. This project contributed to the vision to bring innovation much more to the colleagues who do the (operational) work, rather than waiting or expecting them to "come" with the innovation and be engaged by it.

New connections have been formed, new opportunities have been signalled, and this successful concept is now being prepared to scale up and roll out in different business units.

Sejal, many thanks for your great contribution. "

Program Manager Innovations, KLM

6.2 contributions

6.2.1 For KLM
This thesis allowed me to immerse myself in KLM's innovation ecosystem, sitting in on regular meetings and understanding diverse stakeholder perspectives.

- **Implementation and Adoption of Eureka:** Eureka was validated at KLM and will be further evaluated in the form of an Innovation Safari.

- **Organisation bridge building:** Beyond the concept, the research created new communication channels between technicians and management, enabling operational insights to inform innovation decisions. It helped identify technology champions within the organisation, who can serve as points of contact for future technology roll-outs. Additionally, technician responses during Eureka testing provided valuable user feedback for KLM's upcoming Shared Innovation Platform.

- **External Network Expansion:** Several networking and knowledge-sharing activities helped expand KLM's collaborative network, including presentations at TUI Innovation Day, where employees asked questions centred on integrating this research with organisational learning and development programs, and the SkyTeam Innovation Day (Thanks, Euiyoung), UnPlug and Play sessions, and site visits (Thanks, Serdar). Eureka was also featured in the Innovation Ecosystem's newsletter (see Figure 28). These engagements resulted in concrete interest from multiple organisations seeking to collaborate on innovation engagement strategies, expanding KLM's external innovation network.

- **Strategic Foundation:** Beyond implementation, it provided three core tensions that need to be navigated while introducing innovation initiatives.

6.2.2 Broader impact and external organisations
This research offers perspective on how innovation actually happens in complex, safety-critical organisations like aviation maintenance.

- **Organisational Architecture:** Building on Moultrie et al.'s (2007) work on innovation environments and Lauff et al.'s (2018) work on prototyping, this research explores "spatial prototyping" for testing how physical arrangements affect people-technology interactions.

- **Academia:** This research opens new directions for design researchers by exploring spatial prototyping, demonstrating how to navigate tensions rather than resolve them, and revealing how personal interests influence workplace technology adoption. Section 6.5 explores these theoretical implications in detail. This work has also been translated into an academic paper submitted to a conference.

- **Cross-Industry Knowledge Transfer:** Through site visits, the project connected with organisations facing similar challenges in engaging operational staff with innovation initiatives. These interactions revealed common issues, a lack of operational staff engagement, convincing employees about the benefits of emerging technologies, and showing emerging technologies in a way to foster an innovation culture. It offered a replicable solution through the Eureka concept, creating groundwork for future collaborations and knowledge-sharing opportunities across organisations seeking more inclusive innovation ecosystems. Furthermore, section 6.4 lists practical implications for organisations on how to foster innovation, especially for operational staff.

6.2.3 Novelty
The novelty of this project lies in identifying and balancing the inherent tensions between operational needs and innovation strategies. This research revealed how tensions could become productive design materials. Eureka illustrated this by bringing innovation closer to operational environments, providing hands-on experience with technologies in a safety-critical environment and making innovation accessible.
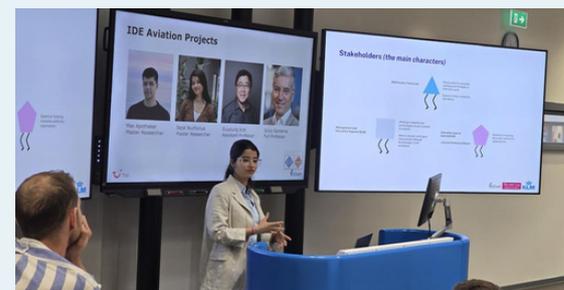

Figure 28: Article about Eureka published in the KLM Sharepoint, presented at Skyteam Innovation Day (by Euiyoung) and TUI Day (by me)

6.3 limitations

6.3.1 Limited organisational scope
This study was conducted solely within KLM, which constrains the generalizability of its findings. The organisational culture, innovation maturity, and operational structure at KLM may differ significantly from those in other companies or industries. As a result, while the Eureka concept proved effective in this context, further testing in diverse organisational settings is necessary to assess its broader applicability.

6.3.2 Sampling bias through the snowball method
The use of snowball sampling may have introduced a bias in participant selection. Since participants were often referred through existing networks, there is a higher likelihood that those involved were already interested in technological innovation. This self-selection bias could have influenced the level of enthusiasm and engagement observed, potentially overrepresenting positive responses to the concept. This limitation was addressed during the Eureka validation phase by making the exhibition open to all technicians in the breakroom environment, regardless of their prior technology interest, and the core tensions identified in the interview phase were verified through observations of diverse participant behaviours during testing. However, future mixed-methods research comparing adoption outcomes to the factors identified in the current study, while employing stratified sampling approaches to include technicians across the full spectrum of technology attitudes, would further enrich the results presented here.

6.3.3 Short-term, contextual and localised testing
The concept was tested only in one specific location within KLM and primarily involved technicians from a single department. This narrow focus was a result of lengthy internal approval processes, which limited broader organisational involvement. Furthermore, the study captured only short-term engagement, without the ability to assess long-term adoption, sustained behavioural change, or the lasting integration of the platform into daily operations. Moreover, KLM's current operational priorities leave limited resources and attention for innovation initiatives.

6.4 practical implications

6.4.1 Embedding innovation into everyday workflow
When implementing new technologies, organisations should prioritise opportunities for hands-on development over paperwork-based methods. Rather than locating these opportunities in distant innovation facilities, demonstration spaces should be integrated directly into or adjacent to maintenance work areas. This approach addresses the spatial and social barriers revealed in the research, such as technicians' limited access and perceived hierarchy. By embedding technology exploration into technicians' daily environments, organisations can encourage informal, workflow-integrated experimentation, allowing employees to "play around" with tools in the real context of their jobs.

6.4.2 Design peer-to-peer technology transfer systems
Organisations must identify and recognise natural technology champions in the maintenance workforce to move past top-down implementation. Practitioners in organisations can develop frameworks and tools that leverage peer influence mechanisms, which, according to the research, are more effective than management directives. This is because the credibility of the technology and the work environment stems from these natural advocates at the departmental, functional, and industry levels. Furthermore, design researchers can create new avenues for workplace innovation that promote exploration outside of work activities.

6.4.3 Designing spaces that enable innovation by design
Beyond physical proximity, organisations should also critically examine whether their overall spatial layouts unintentionally restrict innovation. They can explore spatial prototyping, the intentional design and testing of physical space arrangements, to foster better collaboration and innovation flow. As Moultrie et al. (2007) point out, "Firms are creating spaces based on instinct and personal judgement, rather than genuine insights based on firm evidence." By strategically designing work environments, organisations can unlock new opportunities for innovation support programs that promote exploration through spaces that enable innovation in everyday spaces.

6.5 theoretical implications

6.5.1 Spatial Prototyping for Innovation Spaces

The study identified a paradox where spatial strategies designed to facilitate innovation inadvertently reinforced the hierarchical disparities they aimed to eliminate. Management viewed separate innovation spaces positively, while technicians perceived them as marginalising due to two key factors: physical separation between work areas and innovation hubs, and perceived social hierarchies that excluded technicians from "white collar" office-based innovation activities. These findings aligned with Klitsie's (2021) research on organisational barriers, such as siloed departments that inhibit collaboration in technical domains, and Gomez-Beldarrain et al.'s (2024) identification of disconnected stakeholders as barriers to successful technology adoption in aviation contexts. The barriers extended beyond logistical problems to encompass broader organisational culture and physical space design issues. Technicians expressed their desire to be co-creators of solutions, which supported Eastwood et al.'s (2017) conclusion that participatory practices increased engagement by 34%, demonstrating how the physical and social design of participation itself either enabled or undermined user engagement.

Implications for Future Research: Future studies could navigate this paradox through spatial prototyping, which includes testing entire spaces the same way we test products. Instead of assuming how spaces should work, this approach treats physical arrangements as variables that can be designed, tested, and refined based on real user interactions (Lauff et al., 2018).

6.5.2 Navigating tensions through design

Three fundamental tensions (Innovation vs Integration, Efficiency vs Exploration, and Constraints vs Co-creation) emerged from the qualitative research, which became design constraints for concept development. Rather than resolving these tensions, the research showed that designers must strategically navigate them to address multistakeholder requirements. For instance, the exploration-efficiency paradox, where technicians simultaneously wanted autonomous discovery and structured demonstrations of clear benefits, was balanced through "structured serendipity." Rather than choosing between efficiency or exploration, Eureka created carefully designed chance encounters that enabled both. Technicians could autonomously explore technologies during coffee breaks while immediately seeing concrete, measurable benefits through peer testimonials and hands-on demonstrations. Smith & Lewis (2011) demonstrated how managing paradoxical tensions helps organisations foster more dynamic decision-making and adaptability. Kim et al. (2022) found similar patterns in aviation, where organisations achieved stability not by eliminating uncertainty, but by developing capabilities to adapt and redesign in response to disruption continuously.

Implications for Future Research: This systemic view of paradox navigation suggests that designers must consider the dynamic relationships between competing needs rather than treating each tension as a separate problem to solve. Future research could explore how Kim et al.'s (2022) 6R framework (research, reframe, repurpose, redesign, reimagine, resile) can be integrated with spatial prototyping methodologies to create dynamically stable innovation ecosystems across different contexts and industries.

6.5.3 Personal passion as Professional Catalyst

An implication from the study addresses the role of individual interests and home technology use in the receptiveness to embracing workplace technology. Through this research, individuals who used 3D printing for personal purposes showed a greater tendency to support that technology in a work setting. This suggests that technology adoption involves more than rational workplace calculations. Technicians integrate their identities and interests into their relationship with technology, creating connections that go beyond purely professional obligations. The findings indicate that technology adoption entails the inclusion of identity in both personal and workplace contexts, like the work by Wu & Lu (2013), which invalidates the purely utilitarian conception of adoption as founded exclusively on workplace-related factors, e.g., perceived usefulness or organisational sponsorship (Davis et al., 1992).

Implications for future research: This challenges designers to develop holistic technology ecosystems that account for both personal passions and professional requirements rather than designing for workplace tasks in isolation, where prototypes may serve multiple roles beyond technical validation (Beyer & Holtzblatt, 1998; Lauff et al., 2018).

6.6 conclusion

This research addressed how to engage maintenance technicians with emerging technologies to foster innovation in aviation maintenance. It revealed a disconnect between innovation investment and actual engagement outcomes. While organisations invest heavily in innovation hubs and emerging technologies, many struggle with limited engagement among the very people who must ultimately implement these technologies in their daily work. The aviation industry is facing a massive staffing shortage. Boeing (2023) predicts that the industry will need 716,000 new maintenance technicians globally over the next 20 years. This makes engaging current technicians with new technologies more than just a nice idea; it's crucial for keeping the industry running. Through qualitative research methods, three fundamental tensions were identified: Innovation Vs Integration, Efficiency Vs Exploration and Constraints Vs Co-creation. Based on these identified tensions, the study developed and validated the concept Eureka, a spatial intervention that transforms everyday workspaces into technology discovery spaces. It enabled "structured serendipity", with carefully designed chance encounters to foster engagement with emerging technologies. The validation of Eureka demonstrated strong engagement across three measured dimensions. Behaviorally, 139 technicians (28% of the total workforce) visited the intervention, with 48.2% engaging in direct interaction with technologies. Cognitively, 92% actively tried to understand how technologies worked, with 7 ideas being submitted by technicians to incorporate emerging technologies into their work. Affectively, participants expressed overwhelmingly positive emotions, with fascination being the dominant response (11 out of 14 participants who completed the emotional assessment). There's much to discover about how Eureka could transform innovation engagement. The spatial prototyping opens promising avenues for creating lasting change, while the insights offer potential for bridging innovation gaps in any industry. It provides a foundation for expanding inclusive innovation practices to benefit organisations facing similar engagement challenges.

a final reflection

and a hope for the future

As I reflect on this thesis journey, one of my deepest hopes is that this work sparks meaningful change within organisations trying to navigate innovation in complex, highly regulated environments. Working within KLM, where safety, compliance, and structure naturally take precedence over experimentation, taught me the art of balancing innovation with operational integrity. Beyond the conceptual challenges, the experience of actually testing Eureka gave me invaluable real-world insights into how experimental ideas are received by management and what it takes to secure permission for new approaches in such environments. I learned that success required justifying potential operational impact, explaining concepts in straightforward language that resonated with different stakeholders, and always having multiple backup plans ready (Thanks, Serdar). This practical experience reinforced my hope that this work helps organisations create more inclusive innovation by truly understanding and adapting to the diverse ways their workforce learns and engages.

Ultimately, I believe this is how transformation begins, by gradually embedding innovative thinking into the organisation. What started as designing Eureka quickly became something much deeper, an invitation to genuinely engage with voices that rarely get heard in innovation conversations. Technicians working far from corporate innovation hubs carry knowledge that's practical, hard-earned, and incredibly insightful. This project reminded me of the profound difference between designing with people rather than for them. Working with individuals who are often labelled as "difficult to reach" taught me not just about empathy in design, but about humility, the kind that comes from really listening, constantly adjusting course, and accepting that meaningful innovation cannot happen in isolation.

Whether through spontaneous conversations in break rooms, informal testing sessions, or those unexpected moments of mutual learning, each interaction felt like a genuine step toward creating spaces where everyone's voice matters.

Throughout this process, I held onto the core goal of helping bridge the persistent gap between innovation ecosystems and the daily realities of technicians, to make the invisible visible by surfacing needs that are crucial but often buried under simple disengagement.

Looking back, this thesis represents my first real strategic design project as an individual and is vastly different from all my engineering projects. I also learnt to be more "visual" through this process, which was not one of my core strengths. This journey stretched my capabilities, challenged assumptions I didn't even know I held, and fundamentally deepened my understanding of what human-centred innovation actually means in practice.

It has shaped not just how I approach design, but why I believe design matters in the first place.

"Design is the silent ambassador of inclusion or exclusion."

Kat Holmes

Thank you for making it till here!
If you're curious to learn more

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Thank you

Page 141 (left)

DESIGN FOR our future

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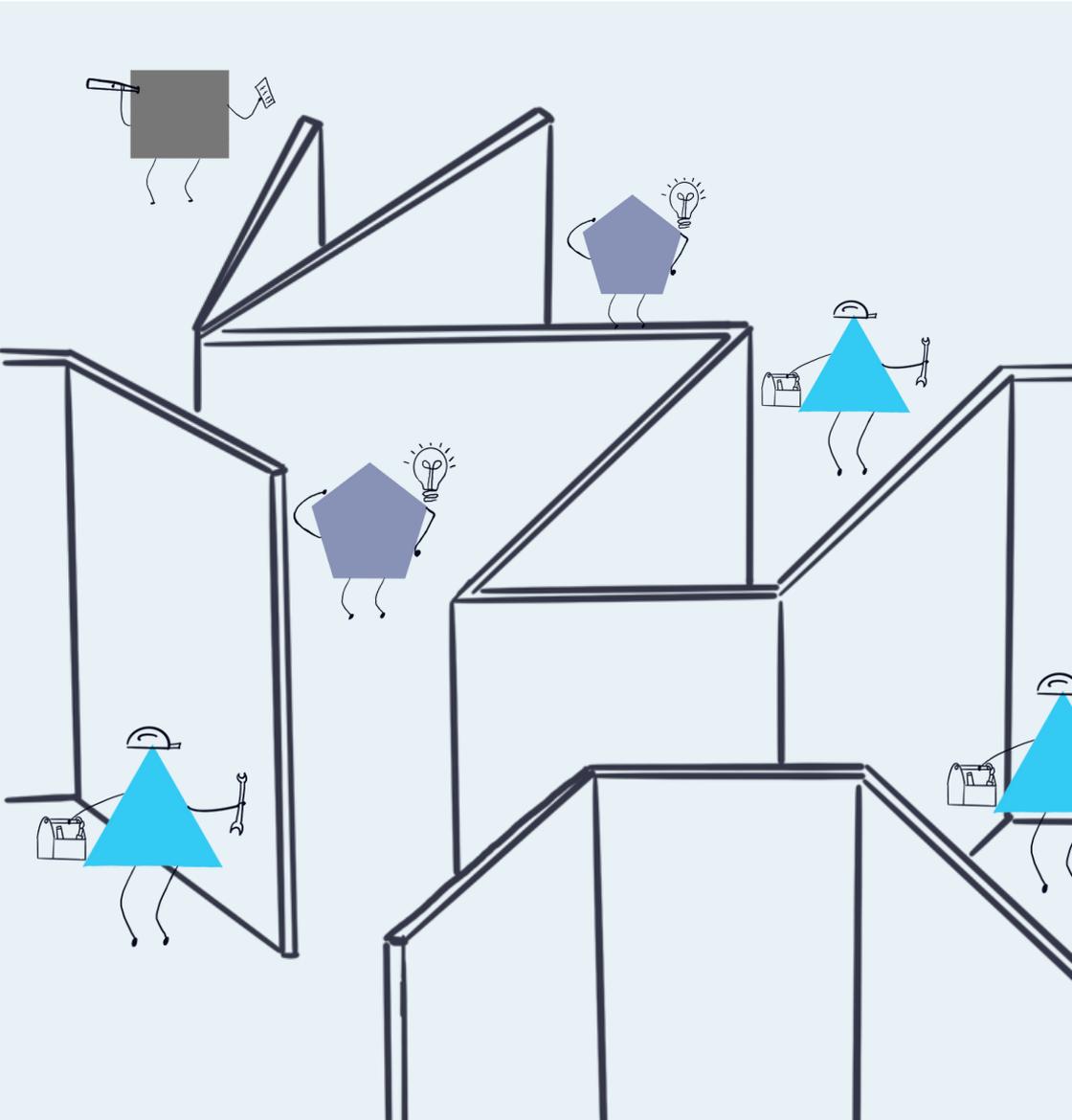
IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME
Complete all fields and indicate which master(s) you are in

Family name	Budholiya	IDE master(s)	IPD ☐	Dfl ☐	SPD ✓
Initials		2nd non-IDE master			
Given name	Sejal	Individual programme (date of approval)			
Student number	▮▮▮▮▮	Medisign ☐			
		HPM ✓			

SUPERVISORY TEAM
Fill in he required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair	Dr Euiyoung Kim	dept./section	Design, Organisation, and Strategy
mentor	Dr Katherine Song	dept./section	Sustainable Design Engineering
2nd mentor	Serdar Cifoglu		
client:	KLM		
city:	Schiphol (Amsterdam)	country:	Netherlands
optional comments			

! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.

! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.

! 2nd mentor only applies when a client is involved.

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF   -> to be filled in by the Chair of the supervisory team

Sign for approval (Chair)

Name Euiyoung Kim   Date March 24, 2025   signature

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DESIGN FOR our future

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Personal Project Brief – IDE Master Graduation Project

Name student	Sejal Budholiya	Student number ▮▮▮▮

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title Bridging the Technological Divide: Dynamic Stability through Inclusive Innovation

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Innovation in aviation enhances efficiency, sustainability, and security (Pereira et al., 2021). However, rapid advancements in aircraft design, digital tools, and automation create challenges for Maintenance, Repair, and Overhaul (MRO) operations, requiring adaptive and sustainable solutions (Stamoulis, 2022). Research highlights predictive maintenance, data analytics, and advanced inspection methods as key to minimizing downtime, yet their adoption is hindered by organizational and human factors, particularly for experienced employees. The concept of dynamic stability— in this context balancing workforce expertise with technological progress —is crucial for managing digital transitions (Kim et al., 2022). Design as a tool can support this by aligning technological and human needs, fostering an inclusive innovation ecosystem (Magistretti et al., 2021). Additionally, generational differences affect technology adoption, motivation, and engagement, necessitating targeted interventions (Elias et al., 2012). Within KLM Engineering & Maintenance (E&M), there are various business units, which include Engine Services, Component Services, Engineering, Airframe and Innovation Hubs, these include the Technology Hub, MRO Lab, Makerspace and the E&M Repair Lab. These grew out of challenges faced by KLM E&M. A key challenge was maintaining a clear overview of which business units were working on specific innovative projects. The lack of visibility resulted in duplicated efforts and missed opportunities for enhancing efficiency. Furthermore, to address these challenges, KLM has established the KLM E&M Innovation Ecosystem, designed to foster connections and knowledge-sharing among individuals and teams. This study focuses on the MRO Lab. It is a unique program where all innovations developed by AFI KLM E&M and its network of affiliates converge. It focuses on adaptive innovations tailored to the challenges of aircraft maintenance, aiming to optimize fleet performance and improve airworthiness. The MRO Lab is introducing technologies such as robotics, including 3D printing, drone technology, co-bots, and predictive maintenance using virtual reality. This study explores how aviation and similar industries can create inclusive, human-centered digital transitions, ensuring that experienced employees remain engaged. By applying design methodologies, it provides a framework to balance technological progress with workforce expertise, positioning KLM as a key case study within the broader discourse on innovation ecosystems and workplace transformation.

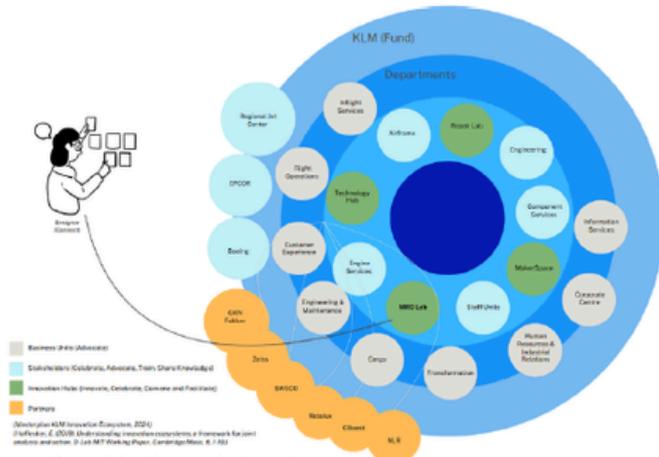→ *space available for images / figures on next page*

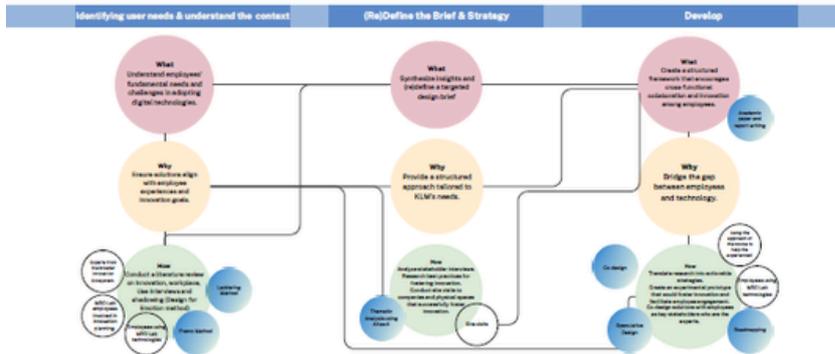Image / figure 1: Stakeholders involved in the project

Project Plan

image / figure 2: Project Plan (lays out methods that may be used)

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

There is limited research on how employees adopt digital technologies. While these advancements drive progress, they also create disruptions, particularly for experienced employees who may face challenges adapting to new systems. The initial literature review identifies this group as particularly vulnerable during digital transitions. To address this, dynamic stability is essential—balancing the expertise of seasoned professionals with the need for continuous innovation through digital integration. This study seeks to bridge this gap by examining how dynamic design capabilities may enhance innovation processes and facilitate the use of digital technologies in the aviation industry, specifically in the case study of KLM.

The proposed assignment from KLM (MRO Lab) focuses on researching best practices, developing effective strategies, and designing an adaptable innovation ecosystem that fosters cross-functional collaboration and digital adoption.

RQ1: How can we bridge the gap between digital technologies and experienced employees to foster innovation?
What are the specific challenges experienced employees face in adopting digital technologies within the MRO Lab?
How do experienced employees perceive and engage with digital technologies?

RQ2: How can we incorporate dynamic design capabilities to facilitate mindset shifts toward innovation?
How can dynamic design capabilities be leveraged to encourage innovation?
How can the MRO Lab develop inclusive innovation strategies to ensure employees across generations effectively engage with new technologies?

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for.
Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence)
As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a strategy to bridge the gap between digital technologies and experienced employees to foster innovation in the context of the MRO Lab. The goal is to create an inclusive, engaging strategy that ensures all employees can effectively engage with digital technologies and cross- functionally collaborate.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

Phase 1: Identifying User Needs & Context
• What: Understand employees' fundamental needs and challenges in adopting digital technologies.
• Why: Ensure solutions align with employee experiences and innovation goals.
• How: Conduct a literature review on innovation, workplace, Use interviews and shadowing (Design for Emotion method) with
   (1) Employees using MRO Lab technologies (across different generations)
   (2) MRO Lab employees involved in innovation planning.
   (3) Experts from the broader Innovation Ecosystem.
Phase 2: (Re)Define the Brief & Strategy
• What: Synthesize insights and (re)define a targeted design brief
• Why: Provide a structured approach tailored to KLM's needs.
• How: Analyze stakeholder interviews, Research best practices for fostering innovation, Conduct site visits to companies and physical spaces that successfully foster innovation.
Phase 3: Develop
• What: Create a structured framework that encourages cross-functional collaboration and innovation among employees.
• Why: Bridge the gap between employees and technology.
• How: Translate research into actionable strategies, Create an experimental prototype that would foster innovation and facilitate employee engagement, Co-design solutions with employees as key stakeholders who are the experts.

Project planning and key moments

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting, mid-term evaluation meeting, green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting 18 March, 2025	

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	
For how many project weeks	
Number of project days per week	

Mid-term evaluation 12th May, 2025	
Green light meeting 22nd July, 2025	

Comments:

Graduation ceremony 22nd August, 2025	

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

My background in mechanical engineering and work experience as an Analysis Engineer equipped me with a technical understanding of aviation at a product level. Through my master's and this thesis, I aim to understand the organisational lens and how strategies are implemented within organisations. As a designer, I aspire to make the invisible visible. In this context, I approach it by uncovering the hidden challenges that hinder digital adoption and connecting digital technologies with vulnerable groups, such as experienced employees often overlooked during digital transitions. I aim to ensure that innovation becomes inclusive and accessible to all, aligning with my broader ambition to use design as a tool for impact.

Learning Goals:
- **Understanding the Aviation Ecosystem** – Gain insight into the complexities of the aviation industry and explore how strategic design can contribute to dynamic stability within organizations.
- **Exploring different design methods** –Exploring methods such as Design for Emotion, and exploring 13 fundamental needs, best practices to foster innovation and understanding the actors in an Innovation ecosystem.
- **Uncovering Barriers to Digital Adoption** – Identify and analyze the hidden challenges that hinder the adoption of emerging technologies, particularly for marginalized employee groups such as experienced technicians.
- **Gaining Hands-On Client Experience** – Develop practical skills in client collaboration, stakeholder engagement, and strategy execution, ensuring that design solutions are impactful and feasible in real-world settings.

appendix A

This is the interview guide used to interview innovation experts and program managers

Introduction
Thank participant
Purpose: Understanding strategies to foster innovation and technology adoption among maintenance technicians
Confidentiality and recording permissions

Background
Briefly introduce yourself and your role
What are the most significant technological changes in maintenance operations recently?
What is your vision for technological innovation in your area?

Innovation Strategy
How do you structurally bring innovation into the organization's DNA?
What specific strategies foster innovation among maintenance technicians? (Share an example)
How did you handle complexity with management and employees when implementing new technologies?
Were your technology interventions targeted at specific groups or problems?

Barriers and Engagement
What are the main barriers preventing technicians from engaging with emerging technologies?
What approaches trigger curiosity about emerging technologies among technicians?

Best Practices and Future
What best practices have you identified for fostering innovation in service organisations?
How do you see the role of maintenance technicians evolving with emerging technologies?
Any final thoughts on fostering innovation that we haven't covered?

Closing
Thank participant
Next steps
Contact information for follow-up

appendix B

This is the interview guide used to interview the technicians.

Introduction
Thank you for participating in this interview
Purpose: Understanding how maintenance technicians interact with emerging technologies and how to foster innovation
Confidentiality and recording permissions

Background and Context
Could you briefly describe your role and responsibilities at KLM E&M?
What does a typical workday look like for you?
How has your job changed over the past few years due to new technologies?

Current Interactions with Technology
How do you currently interact with new or emerging technologies in your daily work?
Is there a particular technology gap you currently face in your work?
What inspired you to use 3D printing in your work? (for specific technicians)

Barriers and Enablers
In your opinion, why are emerging technologies necessary for employees within KLM E&M?
What prevents you and your colleagues from becoming aware of emerging technologies?
What would be your preferred way to be introduced to emerging technologies?

Curiosity and Innovation
What makes you curious about a new technology or approach?
What opportunities do you have to experiment with new technologies or suggest improvements?
How do you and your team typically share knowledge about new tools or techniques?

Future Perspective
What emerging technologies are you most interested in learning about or working with in the future?
If you could design the perfect system for introducing new technologies to maintenance technicians, what would it look like?
Is there anything else you'd like to share about technology, innovation, or your work that we haven't covered?

Closing
Thank participant
Explain the next steps
Provide contact information for follow-up questions

appendix C

The table below shows the code and its description after the coding process.

Codes	Description
Spatial Access Barriers	
Spatial challenges	Spatial distance between innovation spaces and work areas creates significant barriers to accessing emerging technologies and impedes meaningful collaboration.
Cross-functional knowledge gaps	Limited awareness of innovations occurring in other organizational units restricts potential technology transfer.
Adoption Enablers and Inhibitors	
Generational Perspectives and Personal-Professional Technology Transfer	Differences in technology receptiveness among workforce demographics are often shaped by personal interests and home technology use, which significantly influence workplace technology adoption patterns
Peer influence mechanisms	The role of colleague recommendations and demonstrations in fostering technology acceptance.
Leadership authorization	Management support and explicit permission to explore and implement new technologies.

Hands-on Learning and Practical Demonstration Formats	Technicians strongly prefer experiential, hands-on technology introductions through interactive demonstration events that accommodate their mobility needs, supported by success narratives that share concrete examples of practical implementation, creating a multi-sensory learning approach that prioritizes application over theoretical instruction.
Value Proposition Validation	Compelling demonstrations of both time efficiency through measurable task duration reduction and quantifiable financial advantages through cost-benefit analysis provide the concrete evidence technicians need before adopting new technologies.
Competitive relevance perception	Recognition that technological adaptation is necessary for continued operational viability.
Innovation materialization expectations	The impact of unfulfilled technology implementation promises on future adoption willingness.
Collaborative Innovation Processes	
Communication pathway clarity	Defined and accessible protocols for requesting or engaging with technological innovations.
Co-development engagement	Inclusion of technicians in the problem identification and solution development process.

Codes	Description
Innovation Environments	
Physical Innovation Spaces	Physical locations specifically designed to showcase innovation activities and technologies, characterised by visual transparency, accessibility, and distinct aesthetic elements that signal creative work.
Innovation Visibility, and Inspiration	Specialised zones or setups where emerging technologies can be displayed, experienced, and interacted with by potential users, designed to bridge knowledge gaps through direct exposure.
Contextual Technology Presentation	Presenting technologies within relevant operational contexts to maximise understanding and perceived relevance among potential users.
Technology Showcasing and Hands-on Experience	Learning processes are centred on direct, hands-on interaction with technologies, characterised by personal trial and experimentation rather than passive information reception.
Regular Inspiration Activities	Structured, recurring events or communications are designed to maintain awareness of innovation possibilities and stimulate creative thinking.
Accessible Documentation	Consistent, easy-to-consume documentation of innovation activities and outcomes that maintains visibility and interest across the organisation.

Organisational Structure for Innovation	
Decentralised Innovation and Innovation Ownership	Distribution of innovation capabilities and responsibilities across departments rather than concentration in a central unit, positioning innovation resources closer to operational contexts.
Embedded Innovation Representatives	Designated individuals within operational teams who serve as accessible points of contact for innovative ideas and processes, trained in moving ideas forward.
Executive Sponsorship	Active backing and protection of innovation initiatives by senior leadership, providing resources, visibility, and organisational legitimacy.
Stakeholder Ownership	Psychological investment in innovation processes by key decision-makers and implementers, created through meaningful involvement and co-creation.
Varying Receptivity Patterns	Natural variation in openness to new technologies and processes among staff, influenced by personal characteristics, experience, and circumstances.

appendix D

affinity mapping

Insights from interviews, site visits, and literature were systematically clustered to identify patterns across stakeholder groups (Beyer & Holtzblatt, 1998; Sanders & Stappers, 2008). Color coding distinguishes perspectives: blue (technicians), yellow (literature), green (KLM management), and pink (external experts).

Three themes emerged:

1. Problem-First Technology Integration - Focus on practical problem-solving
2. Accessibility Integration - Address spatial and social barriers
3. Peer Networks - Leverage natural champions and community-based knowledge transfer

1: Problem-first technology integration

- maintainence technician
- literature review
- KLM internal management and innovation experts
- external innovation experts

2: Accessibility Integration

3: Peer Networks

COM-B

The COM-B model (Capability, Opportunity, Motivation Behaviour) by Michie et al. (2011) was applied to understand the root causes of stakeholder behaviour rather than just surface preferences. While affinity mapping revealed what people said they wanted, COM-B helped uncover why certain barriers existed and how different stakeholder needs sometimes conflicted with each other. The three tensions that emerged were as follows. Innovation vs Integration arose because technicians had the capability and motivation to use technologies but lacked opportunity due to spatial barriers.
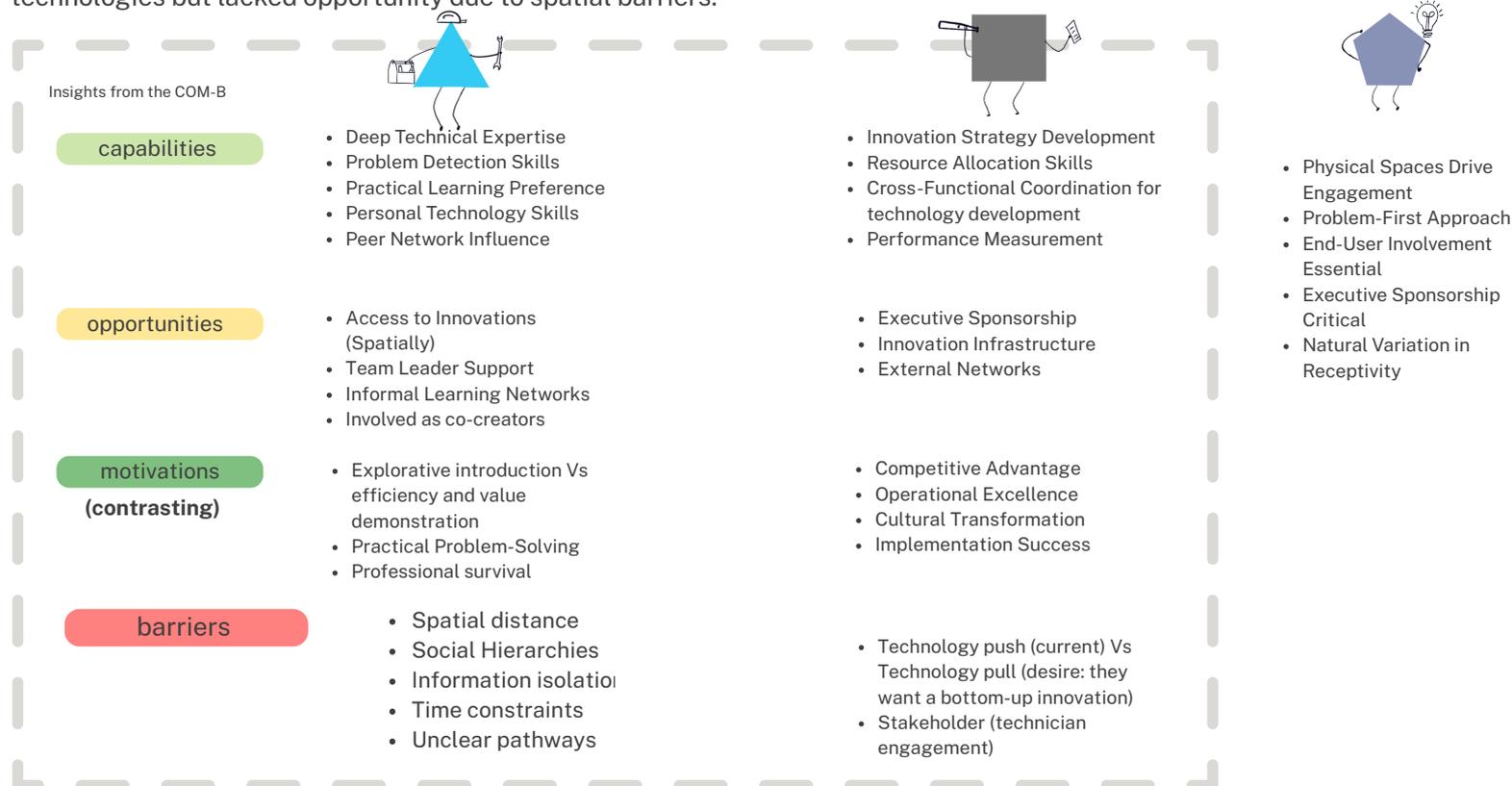
(tension line between "Access to Innovations (Spatially)" and "Physical Spaces Drive Engagement"); Efficiency vs Exploration emerged as technicians were motivated for both practical benefits AND autonomous discovery, creating competing opportunity needs (tension line between "Practical Problem-Solving" and "Explorative introduction"); and Constraints vs Co-creation developed because technicians could co-create and motivation to participate, but operational constraints limited opportunities (tension line between "Time constraints/Unclear pathways" and "Involved as co-creators").

Insights from the COM-B

capabilities
- Deep Technical Expertise
- Problem Detection Skills
- Practical Learning Preference
- Personal Technology Skills
- Peer Network Influence

- Innovation Strategy Development
- Resource Allocation Skills
- Cross-Functional Coordination for technology development
- Performance Measurement

- Physical Spaces Drive Engagement
- Problem-First Approach
- End-User Involvement Essential
- Executive Sponsorship Critical
- Natural Variation in Receptivity

opportunities
- Access to Innovations (Spatially)
- Team Leader Support
- Informal Learning Networks
- Involved as co-creators

- Executive Sponsorship
- Innovation Infrastructure
- External Networks

motivations
(contrasting)
- Explorative introduction Vs efficiency and value demonstration
- Practical Problem-Solving
- Professional survival

- Competitive Advantage
- Operational Excellence
- Cultural Transformation
- Implementation Success

barriers
- Spatial distance
- Social Hierarchies
- Information isolation
- Time constraints
- Unclear pathways

- Technology push (current) Vs Technology pull (desire: they want a bottom-up innovation)
- Stakeholder (technician engagement)

appendix E

The figures below show the tools used to measure technician engagement across three dimensions:

- **Survey Instrument:** A brief questionnaire assessing cognitive engagement, including technology relevance and understanding.
- **PrEmo Tool:** A visual method capturing emotional responses using six emotions, with technicians placing stickers on character illustrations.
- **Behavioural Observation:** Structured sheets tracking real-time engagement during a four-day validation, including interaction types, time spent, and hands-on activities.

Together, these tools provided a well-rounded validation of the Eureka concept's impact on technician engagement with new technologies.

Survey used to measure cognitive engagement

PrEmo tool used to measure affective engagement

Measuring Engagement

Date:
Day:
Morning session:
Observer:

Metric	Measurement	Notes
ATTENDANCE & PROXIMITY		
Total Visitors	_____ visitors	
Technician Visitors	_____ technicians	
Zone A (Direct Interaction)		
Zone B (Close Observation)		
Zone C (Peripheral Interest)		
TIME-BASED ENGAGEMENT		
Average Session Duration	_____ minutes	
Longest Session	_____ minutes	
Shortest Session	_____ minutes	
Peak Engagement Period	_____ time	
BEHAVIORAL ACTIONS		
Touched Interface/Equipment		
Used Inspection Tools		
Took Photos/Videos		
Printed Materials/Parts		
Asked Questions		
Called Colleagues Over		
Attempted Inspection Task		
Used VR Glasses		
Operated Drone		
ENGAGEMENT INTENSITY (1-5 scale)		
Hour 1 (11:00-12:00)	_____	1=Minimal, 5=Peak
Hour 2 (12:00-13:00)	_____	
Hour 3 (13:00-14:00)	_____	
Hour 4 (14:00-15:00)	_____	
ENGAGEMENT PATTERNS		
Solo Engagement		
Pair Collaboration		
Small Group (3-4)		
Teaching Others		
OUTCOMES		
Completed Full Inspection Cycle	_____ count	
Requested Follow-up Information	_____ count	
Scheduled Demo/Meeting	_____ count	
QUALITATIVE OBSERVATIONS		
Most Popular Feature		
Common Questions Asked		
Technical Issues Observed		
Improvement Suggestions		

Behavioural Engagement: Blank measurement sheet

Measuring Engagement

Date: 30th June, 2025
Day: Monday
Morning session: ✓
Observer: Sejal, Shannon (during break)

Metric	Measurement	Notes
ATTENDANCE & PROXIMITY		
Total Visitors	_____ visitors	
Technician Visitors	_____ technicians	0
Zone A (Direct Interaction)		++++ 11
Zone B (Close Observation)		++++ 111
Zone C (Peripheral Interest)		++++ ++++ ++++ 1111
TIME-BASED ENGAGEMENT		
Average Session Duration	_____ minutes	(5-10 minutes) / 15 for direct
Longest Session	_____ minutes	15 minutes
Shortest Session	_____ minutes	2-3 minutes
Peak Engagement Period	_____ time	lunch break / shift change
BEHAVIORAL ACTIONS		
Touched Interface/Equipment		++++
Used Inspection Tools (smart table)		1
Took Photos/Videos		1
Printed Materials/Parts		111
Asked Questions		++++
Called Colleagues Over		111
Attempted Inspection Task (smart table)		
Used VR Glasses		1
Operated Drone		1
ENGAGEMENT INTENSITY (1-5 scale)		
Hour 1 (11:00-12:00)	4	1=Minimal, 5=Peak → lunch break
Hour 2 (12:00-13:00)	2	
Hour 3 (13:00-14:00)	2	
Hour 4 (14:00-15:00)	5	due to shift change
ENGAGEMENT PATTERNS		
Solo Engagement		11
Pair Collaboration		11
Small Group (3-4)		1
Teaching Others		11
OUTCOMES		
Completed Full Inspection Cycle	_____ count	
Requested Follow-up Information	_____ count	111
Scheduled Demo/Meeting	_____ count	1
Made Purchasing Inquiry	_____ count	
QUALITATIVE OBSERVATIONS		
Most Popular Feature		3D printing
Common Questions Asked		How to use it for work
Technical Issues Observed		
Improvement Suggestions		

Behavioural Engagement: Filled measurement sheet

appendix F

structure of the roadmap

The structure of the roadmap followed the balancing of short-term operational needs with long-term strategic transformation, creating a pathway from localised technology engagement to organisation-wide cultural change. The roadmap structure addresses the inherent tension between maintaining current operational excellence while fostering the exploration and adoption of emerging technologies, ensuring that innovation becomes embedded in KLM's organisational DNA rather than remaining an isolated initiative.

trend research

Reskilling for a Digitally Enabled Maintenance Workforce
The aviation maintenance sector faces a growing skills gap, with over 716,000 new technicians needed globally in the next 20 years and nearly 50% of the current workforce approaching retirement by 2030 (Boeing, 2022; CAE, 2023). Simultaneously, digital transformation is reshaping maintenance operations. Integrating digital tools can increase MRO productivity by 10–15% while reducing emissions (Ramco Systems, 2023), yet many frontline workers still lack access to the technology needed to work effectively (Deloitte, 2023).

Breaking Silos Through Cross-Functional Collaboration
The expansion from E&M to all employees reflects the trend toward breaking down organisational silos. Recent data shows 71% of manufacturers cite the inability to attract and retain employees as their primary challenge (Manufacturing Workforce Study, 2024).

Innovation as Core Capability
The progression toward making innovation a "regular service" represents the trend of developing core innovation capabilities. This aligns with research showing that sustainable innovation requires embedding creative processes into organisational DNA rather than treating them as separate initiatives (Edwards-Schachter, 2018). The approach recognises that long-term competitive advantage comes from developing organisational capabilities that make innovation a natural part of daily operations (Cooper, 2019).

Technology-Enabled Engagement
The roadmap's emphasis on technology engagement reflects the trend toward informal workplace learning facilitated by digital tools. Research demonstrates that contextual, technology-mediated learning is more effective than traditional training approaches (Ellinger, 2005; Eraut, 2004), particularly when it connects to workers' immediate operational needs and challenges. Companies with engaged, well-supported employees tend to perform better financially. Gallup (2020) found they're about 21% more profitable on average.

Scaling Predictive and Maintenance Activities
According to Aviation Week Network (2023), predictive maintenance and automation are now gaining real traction in MRO settings. But adopting these technologies means more than just installing hardware. It requires a new way of thinking and a workforce that's trained to work alongside automation. That includes understanding data, trusting machine insights, and staying agile as tools evolve.

why this future vision

This vision is theoretically grounded in the tensions that emerged from the research.   It aligns with the broader goal of embedding innovation within the organisation, and balancing operational excellence (constraints, integration and efficiency) and innovation (innovation, exploration and co-creation).

appendix G

Tables 1 and 2 show the strategically selected participants involved in interviews and a creative facilitation session to capture key voices from KLM's innovation ecosystem.

- Interviews (Table 1) included maintenance technicians (n=8), KLM innovation managers (n=3), external experts (n=4), and specialized roles like a drone pilot. This mix ensured insights from end-users (maintenance technicians) to strategic decision-makers (KLM management and innovation experts).
- Facilitation session (Table 2) included continuous improvement leads and black belts. (for understanding strategic priorities, resource allocation)

Table 1: List of participants

Participant Number	Participant
1	Project Manager (KLM)
2	Project Manager (KLM)
3	Project Manager (KLM)
4	Innovation consultant (external)
5	Innovation expert (external)
6	Innovation expert (external)
7	Maintainence Technician
8	Maintainence Technician
9	Maintainence Technician
10	Direct support (intermediary between technicians and program managers)
11	Maintainence Technician
12	Drone Pilot (Mainblades)
13	Maintainence Technician
14	Maintainence Technician
15	Maintainence Technician
16	Maintainence Technician
17	Innovation expert (external)

Table 2: List of participants

Participant Number	Participant
1	Black belt professional
2	Black belt professional
3	Data Transformation and continuous improvement lead (Airframe)
4	Data Transformation and continuous improvement lead (Component Services)
5	Data Transformation and continuous improvement lead (Engine Services)
6	Head of Data Transformation and Continuous Improvement Lead
7	Program Manager, Innovation