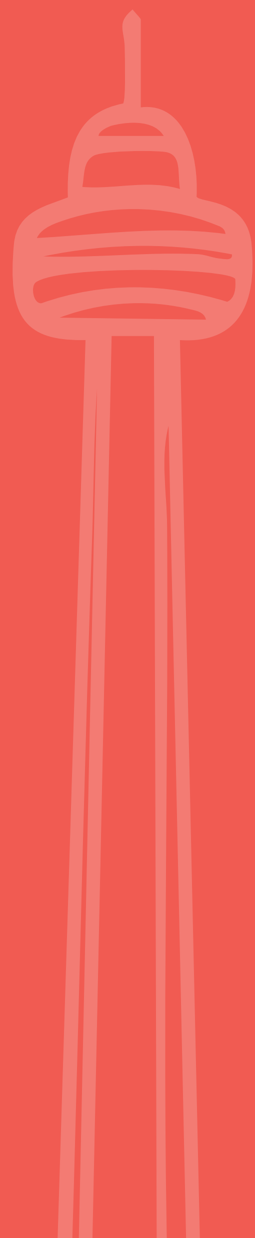
Master Thesis I June, 2025

Reimagining Systemic Instabilities in Aircraft Turnaround

A Strategic Design Framework for OEM Relevance in Future Turnaround Systems



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Master Thesis

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Preface

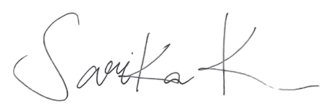
The photos on the left were taken when I was two years old, sitting in the cockpit of a Southwest flight. At the time, my mom was working at a startup in the state of Washington, USA, and my dad was doing his MBA at the University of California, Berkeley. To help her stay in the job, the company gave her twelve free flights—so she used them to visit my dad, and I went with her.

I flew often enough that year to become one of Southwest's youngest frequent fliers. After landing, the crew invited me into the cockpit. I don't remember it—but the photo stayed, and so did planes. It's the kind of moment you probably couldn't imagine happening today.

For my bachelors, I was admitted to the University of California, Davis as an Aerospace Engineering major. Although I shifted to a different path (mechanical engineering, design, and entrepreneurship), somehow still, aviation showed up again in my masters.

This thesis, is a return to that world, this time not as a passenger, but as a designer. It's where I got to bring together everything I've learned: how systems break down, how interfaces matter, and how design can bridge competing priorities. It's also been a space where engineering, design, and business finally converged. A project about efficiency, yes—but also about how design can untangle complexity at scale.

Sarika



Acknowledgments

This thesis would not have been possible without the incredible support I received along the way.

To my mentors—Euiyoung, thank you for always encouraging me, pushing me to try new things, and constantly creating opportunities for me. Your dedication to your students and your work is both inspiring and energising. I hope to carry even a fraction of it forwards in my own work.

Arno, thank you for your calm clarity amidst my barrage of ideas, thoughtful feedback, and unwavering time. The time you took to review and provide thorough feedback on all my work was invaluable.

To my parents—thank you for laying the strongest foundation I could have asked for. You gave me every opportunity to succeed and supported me, even when my choices looked different from your expectations. You gave me the space to grow, to try, and to figure it out—and I hope I've made good on that chance. I owe so much of this journey to you, and I'll carry that with me always.

To Saha—thank you for being my favorite research nerd. Working on this thesis helped me understand your love for it a little more—and maybe even become a bit like you in the process :)

To my friends back home (you know who you are)—thank you for sticking with me across time zones and making me feel whole again. And to the friends I've found here—thank you for giving me a home in the Netherlands and a community I never expected but now can't imagine life without.

This thesis may have my name on the cover, but it belongs to all of you too.

Executive Summary

This thesis investigates how aircraft turnaround operations—specifically the sequence of services between an aircraft's arrival and departure—can be made more predictable, coordinated and efficient. The work is conducted in collaboration with Airbus, who are exploring how they, as an aircraft manufacturer, can play a more active role in improving turnaround performance at airports.

Although Airbus is not directly responsible for ground operations, the company has expressed interest in understanding how better alignment between aircraft design, digital systems, and airport processes could reduce variability and improve on-time performance. The research takes a systemic design approach to analyze this complex process, focusing on the interactions between ground handlers, cockpit crew, and apron control teams.

The first half of the project combined a literature review of 50+ academic papers with 11 expert interviews across Europe and the US. A detailed turnaround timeline was constructed to visualize all critical tasks and their dependencies. Early findings show that delays often stem not from the tasks themselves, but from unclear responsibilities, mismatched timing, and fragmented communication between stakeholders. For example, the placement of wheel chocks, the timing of GPU/APU connection, and fueling coordination are often manually checked and based on informal knowledge rather than shared data or synchronized systems.

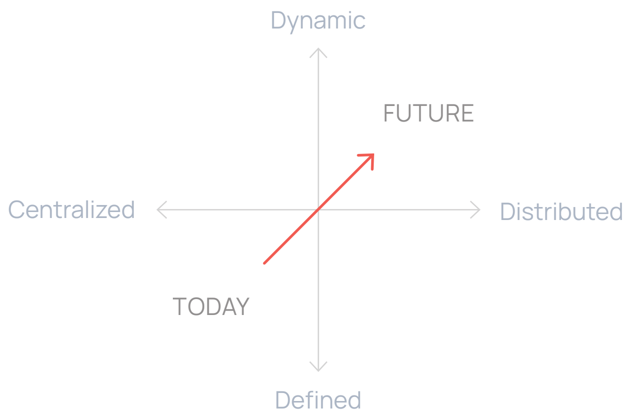
One of the complexities in this project was the limited access to operational data from Airbus and airport stakeholders. Rather than being a barrier, this challenge highlighted the realities of working in a fragmented and highly regulated sector—where insights are often siloed and knowledge is embedded in routine. This reinforced the value of design methods that can operate amidst uncertainty, using triangulation, stakeholder mapping, and co-creation to surface system-level patterns.

The insights gathered were synthesized into four systemic frictions: sequencing bottlenecks, communication breakdowns, interface mismatches, and accountability voids. These became the foundation for three speculative concepts—each proposing a radically reimagined turnaround system. The concepts challenge traditional assumptions about who owns turnaround processes and what roles OEMs, airports, and airlines could play if the industry were designed from the ground up. While deliberately idealistic, each concept draws from the research and makes visible the systemic misalignments embedded in today's operations.

These concepts were tested through a co-design session with industry professionals from airlines, airports, and aviation technology firms. The session surfaced how siloed thinking—often a result of role specialization and structural inertia—limits the ability to see and discuss systemic change. As one participant from KLM remarked, "Even after just two years in the field, you already get stuck in your own line of thinking." The speculative concepts helped break through that, sparking critical debate and uncovering deeply held assumptions about ownership, responsibility, and resistance to change.

The final recommendation is structured around a framework I call the Turnaround Futures Framework. It dictates that an efficient turnaround system is a balance between ownership and execution and calls for the centralized, defined turnaround system of today, to shift towards a dynamic and distributed system in the future.

THE TURNAROUND FUTURES FRAMEWORK



Airbus can use the framework as a way to reposition itself as a central figure as we move towards new turnaround operations in the future. Not by claiming ownership over turnaround, but by helping the system better see itself, articulate its tensions, and co-create new possibilities.

Note on Visual Creation and AI-Augmented Design

Throughout this project, I experimented with a range of new visual tools to bring certain speculative scenes and turnaround concepts to life. While all diagrams, timelines, and 2D graphic elements were created myself using design tools like Illustrator, I also made use of AI-generated imagery and 3D software to develop richer, more atmospheric visuals. These were not purely stock or externally sourced—but created through a workflow that involved tools like ChatGPT, Adobe Firefly, Photoshop, and Blender. I hope the visuals enhance your understanding of my findings throughout this report.

Table of Contents

Glossary & Abbreviations

General Airport Operations

A-CDM – Airport Collaborative Decision Making: A joint initiative to improve the efficiency of airport operations through shared data.

APOC – Airport Operations Centre

ATA – Actual Time of Arrival

ATD – Actual Time of Departure

DPI – Departure Planning Information: Messages exchanged between the airport and ATC to optimize departure sequencing.

ETA – Estimated Time of Arrival

ETD – Estimated Time of Departure

STA – Scheduled Time of Arrival

STD – Scheduled Time of Departure

TOBT – Target Off-Block Time

TSAT – Target Start-Up Approval Time

Ground Handling / Ramp Operations

APU – Auxiliary Power Unit: Onboard power unit used when GPU is not connected.

BKO – Block-On Time: Time when aircraft is parked with wheel chocks placed.

BKT – Block-Off Time: Time when aircraft starts pushback/towing and chocks are removed.

GH – Ground Handling – All services performed on the ground to support aircraft during turnaround. Typically provided by third-party contractors or airline staff.

GSE – Ground Support Equipment: Vehicles and devices used for servicing aircraft on the ground.

GPU – Ground Power Unit: External power supply used to power aircraft while on the ground.

PBB – Passenger Boarding Bridge

PCA – Pre-Conditioned Air

SLA – Service Level Agreement: Agreed service times or quality levels between the airline and ground handlers.

TAT – Turnaround Time: Total time aircraft spends on the ground between arrival and departure.

TUG – Towbar or tow vehicle for aircraft pushback or towing.

ULD – Unit Load Device: Containers used to load cargo, baggage, or mail on aircraft.

VDGS – Visual Docking Guidance System: System to guide aircraft to park precisely at the stand.

Air Traffic & Navigation

Apron – Area where aircraft are parked, loaded, unloaded, refueled, or boarded.

ATC – Air Traffic Control: Manages aircraft movement on the ground and in airspace.

Chocks – Blocks placed against aircraft wheels to prevent movement.

Cone Placement – Placement of safety cones around aircraft during turnaround.

Pushback Clearance – Permission from ATC to begin pushback from the gate.

Runway Incursion – Unlawful or unauthorized presence on the runway, leading to safety risks.

Taxiway – Path aircraft use to travel between runway and gate.

Data Systems & Automation

ADS-B – Automatic Dependent Surveillance Broadcast: Real-time aircraft tracking system.

DCS – Departure Control System: Used for check-in, boarding, and load control.

FIDS – Flight Information Display System

SCADA – Supervisory Control and Data Acquisition: Used to monitor automated systems.

Others

CO_2e – Carbon Dioxide Equivalent: Standard for measuring carbon emissions.

DES – Discrete Event Simulation

FBO – Fixed Base Operator (private aircraft service provider)

FSC – Full Service Carrier

IATA – International Air Transport Association

ICAO – International Civil Aviation Organization

IoT – Internet of Things

KPI – Key Performance Indicator

LCC – Low Cost Carrier

OEM – Original Equipment Manufacturer (e.g., Airbus, Boeing)

OTP – On-Time Performance

SAF – Sustainable Aviation Fuel

SMS – Safety Management System

SOP – Standard Operating Procedures

TMS – Turnaround Management System

01

Introduction

1.1 Why Turnaround Matters

Context & Pressure Points: Delays, Emissions & Systemic Inefficiencies

Assaia, 2024

172 million kg CO_2 could be saved annually across the industry by reducing **1 min** of APU use per flight.

Assuming **USD $7/hr** as the average value of a passenger's time, the FAA estimated the annual costs of delays (direct cost to airlines and passengers, lost demand, and indirect costs) in 2019 to be **USD $33** billion.

Ball et al., 2010

Assaia, 2023, 2024

Assaia reported that **40-50%** of all delays originate during the turnaround.

Delays cost airlines just over **USD $100** per minute.

Britto et al., 2012

ATL recorded a total of **796, 224** aircraft movements in 2024, encompassing both takeoffs and landings. This translates to approximately **1090** turnarounds per day.

Guerrieri, 2025

INDUSTRY BACKGROUND

The commercial aviation industry is navigating a growing convergence of operational, environmental, and capacity-related challenges. As air traffic volumes return to pre-pandemic levels, airlines and airports are under mounting pressure to deliver reliable, efficient, and adaptive operations. One of the most critical, yet often under-optimized, stages of flight operations is aircraft turnaround—the process occuring at the gate between arrival and departure. It is where high-frequency micro-coordination meets real-world unpredictability.

Aircraft turnaround performance directly impacts OTP, network resilience, fuel consumption, crew legality windows, and ultimately, financial performance. Airlines that consistently miss OTP thresholds face not only reputational damage but also quantifiable economic penalties and reduced scheduling flexibility (Wu & Caves, 2000; Tang et al., 2024; Schiphol Airport, 2024). From a passenger perspective, delays measurably reduce demand. A 10% reduction in delays leads to a $2.41 to $5.07 increase in consumer surplus per passenger, depending on how delay is measured (Britto et al., 2012). This implies passengers are highly sensitive to delay performance and respond accordingly when choosing carriers or routes (Ball et al. 2010).

Major airports are now operating at near-maximum capacity. In 2024, Amsterdam Schiphol recorded 473,815 air transport movements, equating to roughly 1,298 flights per day—or about 649 turnarounds daily (Schiphol, 2024). Hartsfield-Jackson Atlanta International Airport (ATL), one of the busiest airports in the world, handled 796,224 flights in 2024, averaging 2,181 flight movements per day, or approximately 1,090 turnarounds daily (Guerrieri, 2025). This volume amplifies the systemic cost of even minor inefficiencies. Across the U.S. network, delay-related costs totaled $8.3 billion for airlines and $16.7 billion in lost passenger time (Barnhart et al., 2012; Ball et al., 2010; Yimga, 2017).

From an environmental standpoint, the impact is equally significant. According to Assaia (2024), trimming APU runtime by just one minute during turnaround can save 3.16 kg of CO_2 per flight. Scaled globally, this could prevent 172 million kg of CO_2 emissions annually—a non-trivial figure as the industry attempts to meet impactful net-zero targets.

Turnaround is a high-stakes, multi-process operation involving over 75 distinct personnel and entities (OAG, 2024). Each turnaround comprises hundreds of time-sensitive micro-tasks—such as passenger boarding, baggage handling, fueling, catering, security checks, and aircraft servicing—performed under significant time and coordination pressure. Despite the critical role turnaround plays in shaping aviation performance, it remains one of the most fragmented and delay-prone segments of the flight cycle. It is a socio-technical ecosystem involving aircraft systems, dispatchers, apron control, gate agents, fueling teams, loaders, and airline ops (Tang et al, 2024).

These actors often operate with inconsistent Standard Operating Procedures (SOPs), non-integrated tools, and unclear ownership of delay. The gap between scheduled and actual turnaround time can exceed 30–40 minutes under common conditions (Assaia, 2023). This makes turnaround not just a coordination challenge, but a systems design problem.

Despite industry-wide investments in AI-driven scheduling tools and collaborative decision-making platforms (CDM), bottlenecks persist (Rieken et al., 2023). Process dependencies—like the late start of "below the wing" activities such as baggage unloading or GPU/APU connection—delay upstream tasks, compounding delays flight after flight (Assaia, 2024; Schiphol Airport, 2024). Rebollo and Balakrishnan (2014) and Deshpande and Arıkan (2012) highlight that a single upstream delay, such as an arrival delay or congestion at taxi-in, leads to inefficiencies in gate assignment and ground handling that cascade into longer turnaround times. The cost isn't just time: prolonged taxi-out congestion can add up to 26 minutes per turnaround at some airports and contribute to over €2 billion in excess airfare costs annually (CACI Limited, 2021; Schiphol Airport, 2024; Tang et al. 2024; Yimga, 2017).

This underscores the systemic issue—where even marginal inefficiencies in turnaround propagate into larger operational and economic impacts across the network.

1.2 How do we Define Turnaround Time (TAT)?

Clarifying the Boundaries of Turnaround—What's Included, What's Not, and Why It Matters

The definition of turnaround time varies across the literature, reflecting differences in scope and measurement criteria.

Wu and Caves (2000) define turnaround as the sequence of ground operations between an aircraft's landing and its next takeoff, highlighting its role in schedule punctuality, aircraft maintenance, and service efficiency. They distinguish between the relatively minimal ground service needs of short-haul flights and the more complex technical and cabin servicing required for long-haul operations. Bazargan (2015) defines turnaround—referred to as ground time—as the interval between gate arrival and gate departure, emphasizing the operational planning implications for flight scheduling and resource allocation. EUROCONTROL (n.d.) further formalizes this by distinguishing between actual turnaround time (TA), measured as the time between actual in-block and actual off-block, and scheduled turnaround time (TS), determined by airline planning and embedded buffer times.

While these definitions generally focus on the gate-bound segment of ground operations, they exclude adjacent Air Traffic Control (ATC) and/or Air Traffic Management (ATM) delays that significantly affect operational flow. For the purpose of this thesis, we adopt Wu and Caves' (2000) foundational definition of turnaround—from landing to next takeoff—as a baseline, but extend the system boundary to include ATC-related handoffs and delays. This reflects a more holistic view of turnaround as a system of interdependent tasks, rather than a fixed time window. The accompanying diagram contextualizes this definition and clarifies where ATC influences sit relative to traditional turnaround activities.

A visual representation of some of the equipment involved in a long-haul turnaround, and their placement airside.

1.3 Project Brief

A visual and contextual overview of turnaround operations and inefficiencies

CONTEXT

Turnaround inefficiencies are often framed as technical or process-level issues. However, evidence shows that the root causes are deeper and systemic. Fragmented communication, conflicting priorities across stakeholders, inconsistent SOPs, and limited real-time coordination mechanisms are core contributors to delay (Tuchen et al., 2023; Gomez-Beldarrain et al., 2025; Rieken et al., 2023).

While digital solutions are often proposed as fixes, technology without alignment is not enough. For example, at Schiphol Airport, implementation of predictive technologies stalled due to governance conflicts and institutional resistance, not technical limitations (Gomez-Beldarrain et al., 2025; Rieken et al., 2023). Without alignment between stakeholders and systems, even well-designed tools fail to deliver impact.

This project was developed in collaboration with Airbus North America under the SESAME initiative (Sustainable, Efficient, and Safe Air-Travel by Management & Engineering). SESAME is a joint research network between Airbus, TU Delft, and Georgia Tech, focused on uncovering, identifying and improving sustainable, efficient and safe air travel through design, management and engineering initiatives. Within that scope, my work focused on long-haul turnarounds—analyzing the space where aircraft, airport, and airline operations intersect.

This research applies a systems-thinking and design lens to the turnaround challenge. Drawing from the concept of dynamic stability—the ability of a system to remain efficient under disruption (Kim et al., 2022)—the project explores how misalignments between technical systems and operational realities lead to fragility. Research in complex systems and design theory reinforces that problems like this are rarely solved through isolated fixes—they require systemic reframing (Choi et al., 2001; Roozenburg & Eekels, 1995; Dorst K., 2011; Ryan, 2014).

OBJECTIVE & RESEARCH QUESTION

This project frames aircraft turnaround not as a fixed sequence of tasks, but as a dynamic, socio-technical system. Turnarounds involve a web of tightly interdependent actors—pilots, ground crew, airline ops, apron control—all operating under time pressure, with partially overlapping responsibilities, and often without shared visibility. Small breakdowns at any point—whether in fueling, baggage, or GPU connection—can cascade into wider delay propagation across the network.

Most turnaround research and tooling focus on airports and airlines. This thesis shifts the lens to the aircraft manufacturer. With Airbus as a case study, the OEM can have an influence on how aircrafts interact with the people and systems responsible for fast, safe turnarounds.

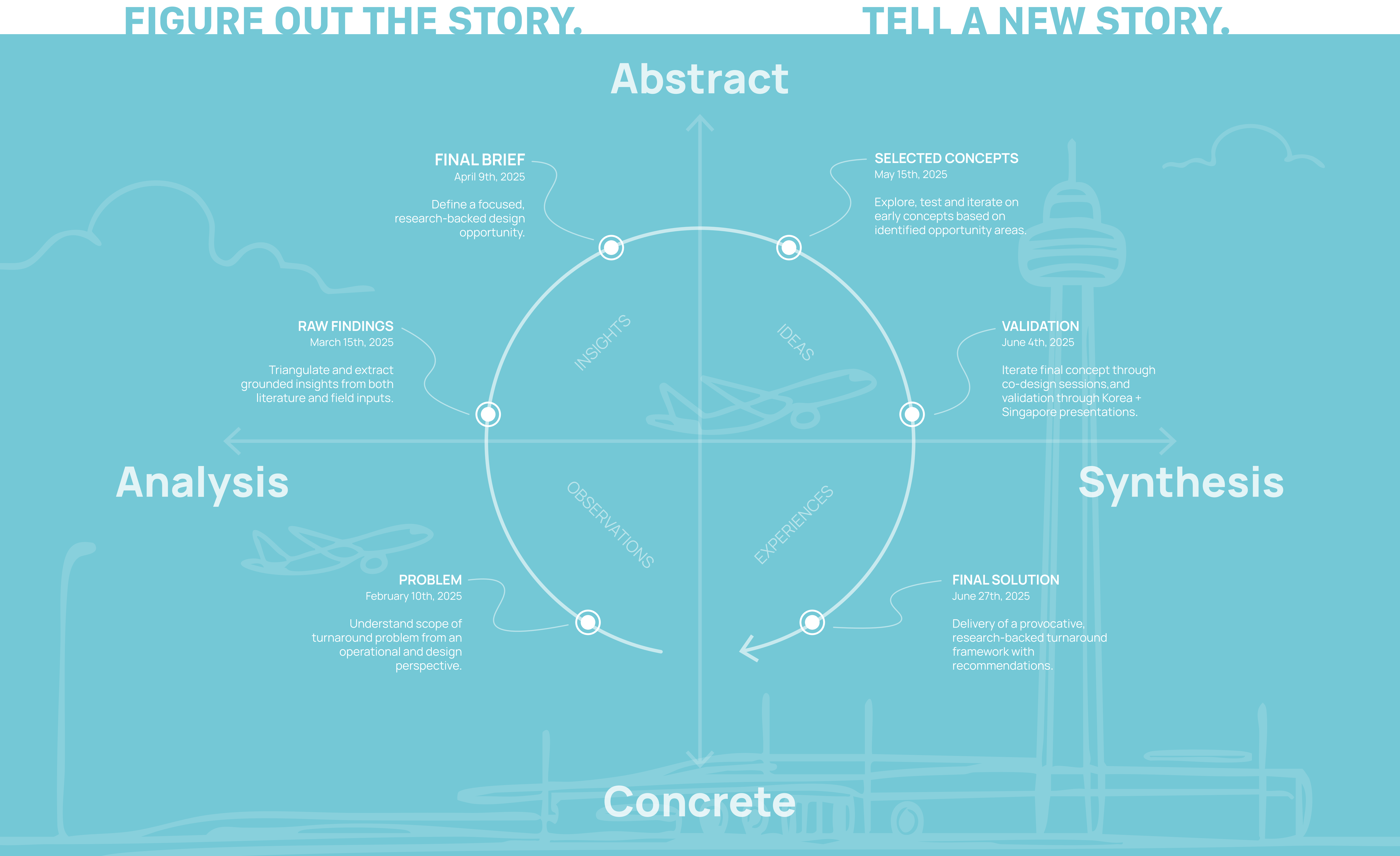
This project explores how an OEM can intervene—not by automating everything or standardizing every process, but by identifying where better aircraft-side design, interface clarity, or operational alignment could improve predictability and reduce friction. The goal is to uncover where and why instabilities emerge in the turnaround process, and to find meaningful points of leverage that an OEM can influence through strategic design.

This brings us to the research question of this thesis:

What are the critical factors causing systemic instabilities in aircraft turnarounds, and how can aircraft manufacturers mitigate these through a new systemic design approach?

1.4 Project Approach

Based on Sara Beckman's problem-finding framework, used to structure research, analysis, and design development.



02

Methodology

2.1 Research Techniques

Methodologies Used in Gathering Qualitative Data

Turnaround operations are complex and varied. The way they're managed can differ significantly across airports, regions, and airline models. While a large body of research exists on improving turnaround performance, it is spread across technical disciplines, organizational silos, and proprietary sources. Much of it is either highly specialized—focusing on optimizing isolated tasks—or broad and theoretical, offering limited practical insight. In many cases, detailed operational knowledge is either inaccessible or unpublished.

Given this fragmented landscape, this research did not aim to build a comprehensive model of turnaround. Instead, it focused on identifying system-level inefficiencies—specifically those that relate to how stakeholders coordinate, how responsibilities are defined, and how interfaces between aircraft and ground operations are designed.

The approach combined three methods:

1. **An iterative literature review**, which began with academic studies focused on discrete processes (such as fueling, boarding, or baggage handling). As the research evolved, the scope expanded to include system-level studies, consulting reports, regulatory guidelines, OEM financial filings, airline operating procedures, and other less conventional sources such as training materials and webinars. This shift was guided by gaps in the academic literature and the practical needs of the research.

2. **Expert interviews** with pilots, airport and airline staff, turnaround coordinators, and manufacturing and systems experts. These conversations helped clarify how theoretical assumptions play out in practice and revealed contradictions or overlooked dynamics in the existing literature.

3. **Visual synthesis**, drawing on methods from design and consulting, was used to map stakeholder roles, surface coordination frictions, and identify structural issues that may limit turnaround performance. These diagrams helped translate qualitative insights into clearer system-level questions. This method was used to structure information and triangulate insights.

This thesis uses the OEM's position as a lens to explore where design-led interventions might be possible. Airbus was used as a case study to ground the investigation in a real-world context as part of the SESAME project. The following section describes how the literature review unfolded over time and how its evolution shaped the rest of the project.

Method	Source Type	Purpose
Literature Review	Academic papers, thesis reports, industry documents, white papers, websites	Understand systemic and technical challenges across turnaround operations
Expert Interviews	Airport staff, pilots, manufacturing and simulation experts	Validate literature insights, uncover contradictions, highlight practical gaps
Visual Synthesis	Process maps, stakeholder flows, prioritization frameworks	Interactive structure qualitative insights into actionable design directions

2.2 Scope

Setting the boundaries of this thesis project.

Turnaround time (TAT) research spans multiple scales and intervention points. Broadly, TAT optimization research can be categorized into three levels:

1. Internal Aircraft Design
Optimizing processes inside the aircraft cabin (e.g. boarding procedures, cleaning cycles, seatling layouts, etc.). Examples of research in this area include studies by Milne & Kelly (2014) on parallel boarding, and faster cleaning protocols and cabin crew workflows by Bazargan (2007).

2. Ground Processes
Improving external ground service tasks and equipment through physical design and/or timing (e.g. baggage (un) loading, catering (un)loading, refueling, etc). Examples of research in this area include studies on dispatch optimization, baggage belt allocation and autonomous technologies by ICAO (2020), Sanchez (2009) and Stuttgart (2011).

3. System-Level Coordinations
Addressing stakeholder roles, communication, and real-time decision making frameworks that guide the whole system. Examples of research in this area include studies on automation in airports (Gomez-Beldarrain et al., 2025), dynamic turnaround management (Schultz, 2012) and flight delay on passenger welfare (Britto et al., 2012).

This thesis project intentionally focused on the system-level coordination of turnaround processes, rather than micro-optimizing individual tasks or aircraft interior workflows.

The research specifically investigated:

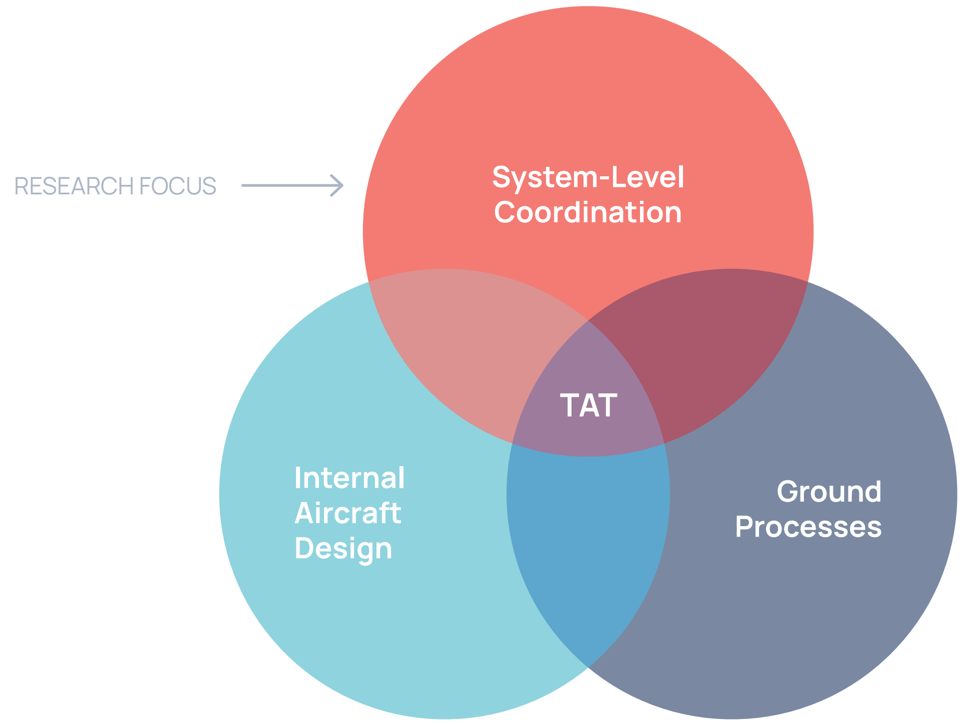
How aircraft manufacturers or OEM's, are currently perceived within turnaround ecosystems.

Why aircraft manufacturers are often excluded from operational improvement initiatives despite designing the aircraft that interfaces with all ground operations.

Where systemic design interventions could reframe the manufacturer's role to improve turnaround efficiency.

By framing turnaround inefficiencies as a systems design challenge—rather than a purely technical or procedural one—the research sought to identify leverage points where an OEM could intervene beyond its traditional boundaries.

Turnaround Optimization Areas



2.3 Literature Review

A breakdown of the type, content, and breadth of literature reviewed throughout this thesis project.

PHASE 01

The literature review began as a conventional search through academic databases, but quickly expanded in response to the fragmented and often inaccessible nature of turnaround knowledge. Early work focused on task-level optimization (e.g. fueling, boarding, cleaning), drawing from technical papers and engineering theses. While informative, these sources—like Bazargan (2007) on boarding or ICAO manuals on baggage handling—rarely addressed system-wide coordination or structural inefficiencies.

PHASE 02

As the research progressed, the review evolved across four distinct phases. Each phase introduced new types of sources to fill emerging gaps. System-focused papers like Gómez-Beldarrain et al. (2025) on airport automat dion and Schultz (2012) on dynamic turnaround control helped reframe the problem as one of coordination, not just execution. This shift was reinforced by Assaia's industry-facing Turnaround Benchmark Report's (2023, 2024), which introduced real-world metrics and exposed consistent delays across different airport ecosystems.

PHASE 03

To understand stakeholder incentives and constraints, the search expanded to include business and strategic literature. Reports from McKinsey (2023) on aviation operations and maintenance strategy highlighted the financial logic behind outsourcing and asset-light airline models. Airbus's own annual report (2023) provided insight into OEM revenue structures and service models, while Boeing's manuals contextualized physical constraints of aircraft servicing.

PHASE 04

Finally, to ground the research in operational practice, more informal learning tools were used. A Udemy course on turnaround operations offered detailed walkthroughs of ramp equipment, sequencing, and safety protocols, which helped frame more relevant interview questions and diagrams later in the project.

Together, this layered literature review enabled a more realistic and multi-sided understanding of aircraft turnaround—and helped sharpen the study's focus on the OEM's structural position within it.

The timeline below visualizes how this review unfolded over time.

Phase 01
November - December

Source Type
Acadmic papers and thesis papers

Focus Area
Focused on task-level process optimization (e.g. cleaning, fueling, boarding).

Outcome
Became highly technical - missed systemic issues.

Phase 02
January - February

Source Type
More system-focused academic literature and industry reports

Focus Area
Added research on stakeholder roles, system dyanmics, digital coordination

Outcome
Shifted to looking at coordination and interfaces

Phase 03
March - April

Source Type
Udemy courses, webinars, and annual financial reports

Focus Area
Upskilled on apron operations, turnaround playbooks and tool usage

Outcome
Enabled grounded framing for interview questions and system mapping

Phase 04
May - June

Source Type
McKinsey & Bain ops strategy articles, OEM manuals

Focus Area
Introduced business logic. Gave OEM perspective and stakeholder priorities.

Outcome
Surfaced gaps between engineering logic and business realities.

2.4 Expert Interviews

A review of the experts interviewed during the research phase including their expertise, role and interview format.

Seven expert interviews were conducted during the research phase of this project. The breadth, scope, format and length of the interviews can be seen in the charts below. The first chart details the interviewee, their role, expertise and interview format. The second chart details topics discussed, key findings and key words. All names here are pseudonyms for privacy and companies are also anonymized. Any relation to real companies or people is purely coincidental.

Interviewee	Company	Role & Expertise	Length & Format	Relevance
Elias Voss	International Airport in USA (We'll call it Skygate International)	Manager of terminal operations & infrastructure	2 hour in person interview	Shared real-world constraints in airport terminal operations & stakeholder coordination
Wesley Archer	Ex-Fortune 500 (We'll call it OptiCore)	EVP at the Ex-Fortune 500 company and applied mathmeticia, expert in computational efficiency & system optimization	1 hour online interview	Discussed mathermatical modeling approaches for turnaround bottlenecks
Sean Carter	Simulation Software Company (We'll call it Simlogix)	CTO & Cofounder of the simulation software company and specialized in industrial automation & workflow simulation and a PhD in aerospace	1 hour online interview	Provided insights on simulation-driven turnaround modeling
Suhani Yeo	Airline X (We'll call it Aeroline)	Captain for 20+ years of A350, A321, A320 Aircrafts	Email interview with written responses	Insights on turnaround from a pilot's perspective discussing aircraft prep for takeoff and landing
Manav Mehra	Airline Y (We'll call it Nimbus)	Captain 30+ years of A320, Boeing 787	1 hour phone call interview	Insights on turnaround from a pilot's perspective discussing specifically role of a captain and what causes delays.
Gavin Riedel	Aviation Startup (We'll call it AeroNova Labs)	CEO and Cofounder of startup trying to optimize turnaround through digital training tools	1 hour phone call interview	Shared startup-led perspectives on using digital training tools to improve coordination and reduce human error in turnaround operations.
Dario Beekman	European International Airport (We'll call it Europort Hub)	innovation consultant at an internal airport	30 minute in person interview	Airport-side insights on innovation challenges and opportunities in implementing new turnaround solutions within existing infrastructure.

Table detailing interviewee role, expertise, format and topics.

This concludes the section on research methodologies. The following spread is a summary of my key research insights, and what methodologies I used to triangulate literature and expert interviews. →

2.5 Research Insights Summary

Key Themes and Patterns Behind Turnaround Inefficiencies

Through the methodologies (literature review and expert interviews) discussed in the previous chapter, I surfaced many important insights related to the causes of inefficiencies and delays in turnaround time. These high level insights are presented below.

Literature Review Insights

01 Turnaround is a Multi-Stakeholder System with Low Real-Time Visibility

Turnaround involves tightly interdependent tasks (fueling, catering, loading, etc.), yet the real-time coordination between teams is weak.

02 Standard Operating Procedures (SOPs) Vary Widely Between Airlines

Despite similar infrastructure, turnaround times differ dramatically across carriers, driven by internal airline culture, priorities, and contractor enforcement.

03 Digital Tools Exist, but Few are Grounded in Aircraft Design

Airports and ground handlers are digitizing (VDGS, ramp scheduling, real-time dashboards), but these tools operate outside the aircraft system boundary.

Literature Review + Expert Interview Insights

01 Airline Practice › Airport Constraints

Airports provide infrastructure, but actual turnaround timing is dictated by the airline's SOPs and contractor behavior.

02 Stakeholder Conflicts

Airlines prioritize OTP, GH operate on contract-based efficiency metrics. Manual coordination leads to lag (e.g., VDGS turned on only when plane is seen), unverified aircraft readiness, and team misalignment.

03 ATC Delays › Ground Handling Delays

Contrary to conventional assumptions, expert interviews highlight that air traffic control (ATC) inefficiencies cause greater delays than ground handling.

However, I needed a way to sift through all the information and pick and choose how to move forward with where to focus. To do this I introduced two methodologies to structure my thinking and to uncover the real inefficiencies in the turnaround sequence. These are discussed in the next section.

2.6 Triangulation Method Overview

Framing and Diagnosing Systemic Drivers of Turnaround Performance

This section outlines the dual-track diagnostic approach used to uncover the systemic forces driving turnaround inefficiencies—and to understand why Airbus remains peripheral to solving them. The combined use of consulting and design research methodologies was not purely methodological preference—it was a response to the constraints of this project. In a complex, closed industry with limited access to live operational environments or stakeholder decision-makers, the top-down strategic framing helped structure what to look for, while the bottom-up diagnostic process ensured that what was found was grounded in evidence, not assumption.

These two tracks ran in sequence—but informed each other iteratively. The top-down framing clarified what needed to be asked. The bottom-up analysis revealed what could be known, and what mattered.

PHASE 1: STRATEGIC FRAMING (TOP-DOWN)

The first move was to structure the research question through an issue tree:

What prevents Airbus from being positioned and recognized as a strategic contributor to turnaround efficiency—and what levers can it pull to influence performance?

This was decomposed into three branches.

External Exclusion: Why is Airbus excluded from industry-wide innovation efforts?

Internal Issues: What prevents Airbus from acting, even if it wants to?

Latent Contribution: What would need to be true for Airbus to play a strategic role?

Each node was broken into sub-questions, and high-impact, high-uncertainty questions were prioritized for hypothesis development. The primary question and subquestions were guided by the scope and key questions previously defined in scope section 2.2. However, at this stage, the hypotheses were directional, not validated. They formed the scaffolding for what to explore—but not yet the answer.

PHASE 2: GROUNDED DIAGNOSIS (BOTTOM-UP)

To test and go beyond these early hypotheses, a grounded, bottom-up process was conducted:

1. Affinity Mapping of Observations
Specific quotes, bottlenecks, and data points were pulled from literature and expert interviews. Each was treated as an individual causal observation and mapped visually without predefined categories. This granular extraction allowed flexibility in clustering and revealed the full landscape of systemic frictions.

2. Thematic Clustering
Through bottom-up grouping, patterns emerged in the form of recurring challenges:

- Stakeholder-related breakdowns (e.g., unclear SOP ownership, conflicting KPIs)
- Ground handling bottlenecks (e.g., delayed handoffs, inconsistent task standards)
- Operational/system-level frictions (e.g., lack of live data, rigid sequencing logic)

These patterns pointed to misalignments between actors, systems, and information flows rather than isolated process failures.

3. Definition of Systemic Frictions
These clustered insights were synthesized into four high-level frictions. Together, they describe the dynamics that contribute turnaround inefficiencies.

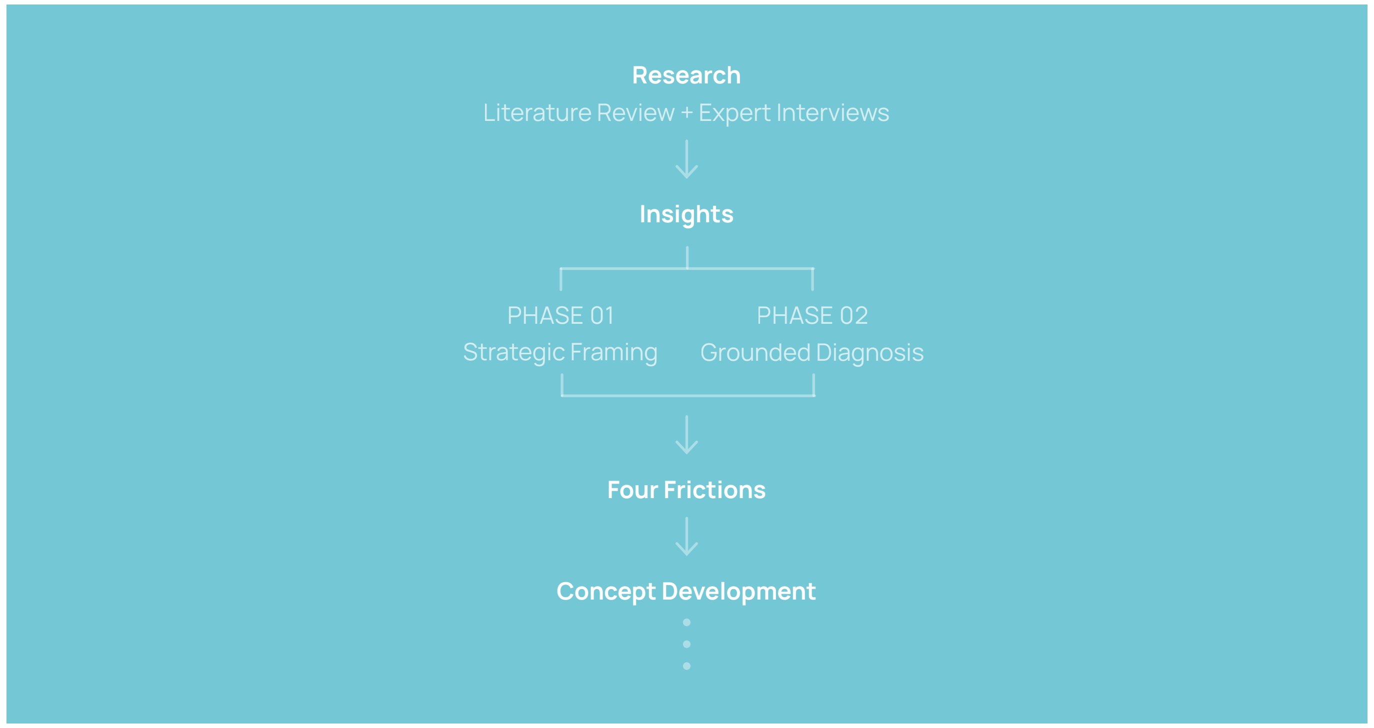
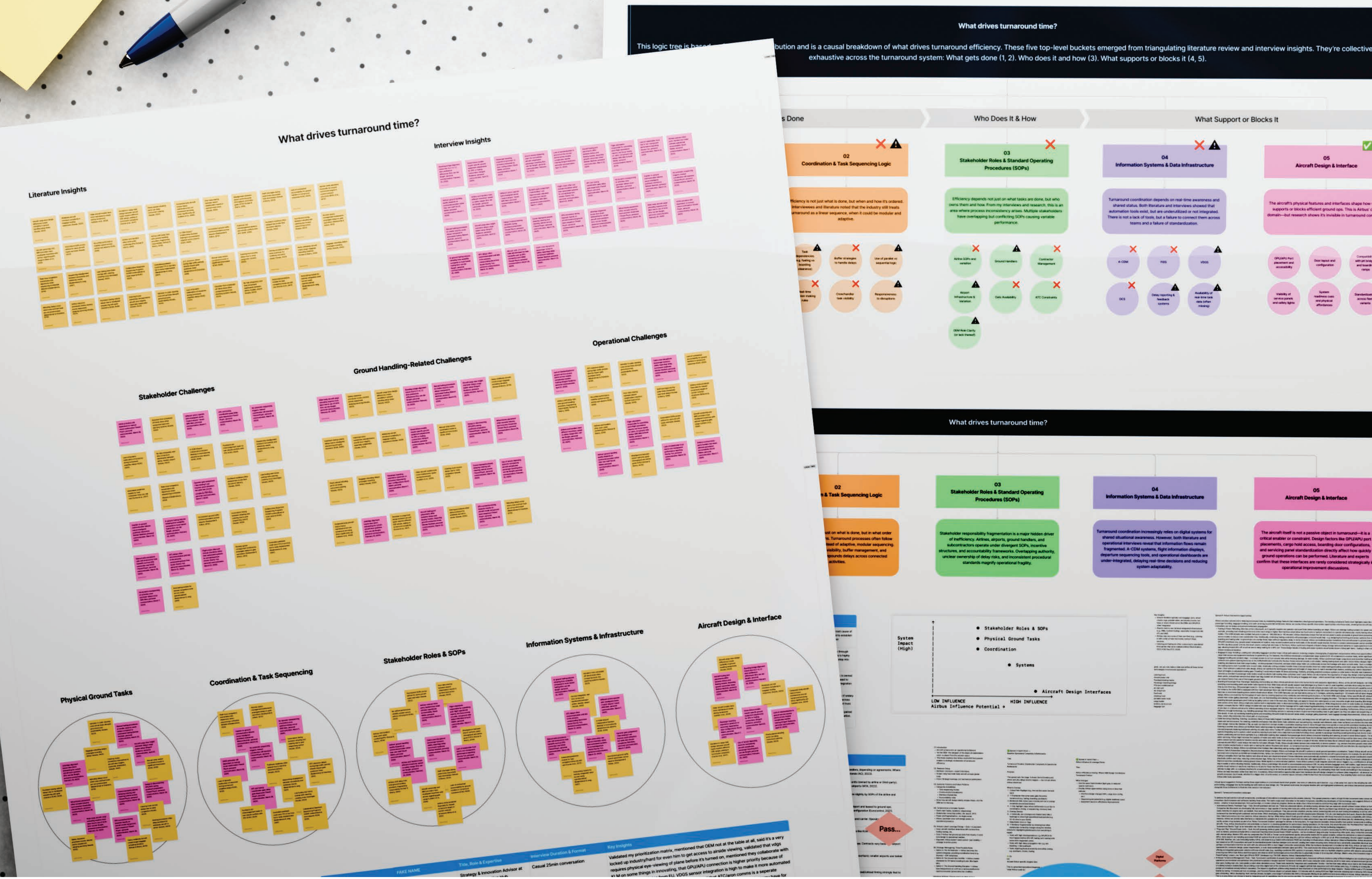


Diagram illustrating research to concept development process.

To read in more detail about each phase, please see Appendix A which shares in detail the strategic framing in phase 01, and the bottom up grounded diagnosis used in phase 02. The following chapter deep-dives into each friction that was triangulated through both literature review and expert interviews.



An overview of all the foundational work behind the research and methodologies.

03

Research Triangulation

Sequencing Bottlenecks

Rigid task orders, hidden dependencies, and poor choreography create idle time and bottlenekcs that compound throughout TAT.

> “No dynamic resequencing happens once upstream delays occur - everything just gets pushed down the line.”

Wesley Archer
Ex-Fortune 500 EVP
Personal Communication, 2025

Communication Breakdowns

Manual updates, tool silos, and desynchronized actors delay decisions and block real-time coordination.

> “In the event of communication delays with the ACISP we see the percentage of take-offs outside the slot tolerance window increase in proportion to the delay.”

Surridge et al., 2012; Svenantic Modelling of Dynamic, Multi-Stakeholder Systems

Interface Mismatches

Design misalignments between aircraft and equipment force workarounds, slow execution and increase risk.

> “Each aircraft type has predetermined steps and estimated times for their completion, as well as a unique GSE layout and connection scheme...”

Gladys et al. 2022; Turnaround Integration in Trajectory and Network

Accountability Voids

Fragmented ownership and uncelar SOPs leave no actor responsible for systemic turnaround performance.

> “The different roles, responsibilities, priorities, different opinions... among the involved stakeholders challenge the consensus...”

Gomez-Beldarrain et al., 2025; Why Does Automation Adoption in Organizations Remain a Fallacy?

3.1 Systemic Frictions in Turnaround

Where the system breaks, and why it matters.

This chapter deep-dives and fully details out each of the four systemic frictions introduced previously—Sequencing Bottlenecks, Communication Breakdowns, Interface Mismatches, and Accountability Voids.

This reframing of turnaround inefficiencies was motivated by two intersecting problems. First, during expert interviews, it became apparent that many pain points were overlapping but unclassified—for example, a delayed fueling process was attributed both to lack of SOP standardization and also poor coordination timing, despite being ultimately driven by infrastructure design and contractor logic. Second, the literature frequently described operational instabilities not by domain, but by type of dysfunction—timing misalignments, miscommunication, conflicting incentives, or ambiguous ownership. For instance, ICAO (2020) repeatedly references accountability fragmentation and role ambiguity as critical issues during turnaround, while Assaia (2023) emphasizes operational blind spots due to visibility gaps and unstandardized handoffs.

The reclassification into frictions began by clustering every insight from the literature and interview transcripts into functional types using sticky mapping. Items were not grouped by stakeholder or subdomain, but by the form of breakdown they described—was it a timing problem? A visibility gap? A handoff failure? This approach, while initially messier, ultimately enabled a cleaner synthesis: across all sources, nearly every friction point could be traced back to one of four systemic failure types. Each category now directly corresponds to a type of breakdown an OEM could either mitigate through design or enter through strategy.

Key academic sources shaped this reframing. Balakrishnan & Jung (2007) and Schaar & Sherry (2010) both describe sequencing problems and poorly timed handoffs as structural, not incidental. Meanwhile, Leblanc et al. (2024) and ICAO (2020) offer deep critiques of accountability structures, especially where SOPs vary by airport, airline, or provider. Finally, platform providers like Assaia (2023, 2024) and OAG (2023, 2024, 2025) have surfaced data on performance gaps tied to manual coordination and interface mismatch—underscoring that design affordances often silently shape turnaround time, even when no stakeholder explicitly acknowledges it.

The upcoming visuals translate each friction into a system diagram—turning them from abstract failure modes into concrete design briefs for where an OEM can intervene.

Before diving into each systemic friction, the following two spreads provide a basis for understanding the stakeholders involved in TAT, their financial ties, business models, and power dynamics in relation to TAT. →

3.2 Stakeholder Business Models and Goals

A comparative overview of the actors shaping turnaround operations—who they serve, how they earn, and what they optimize for.

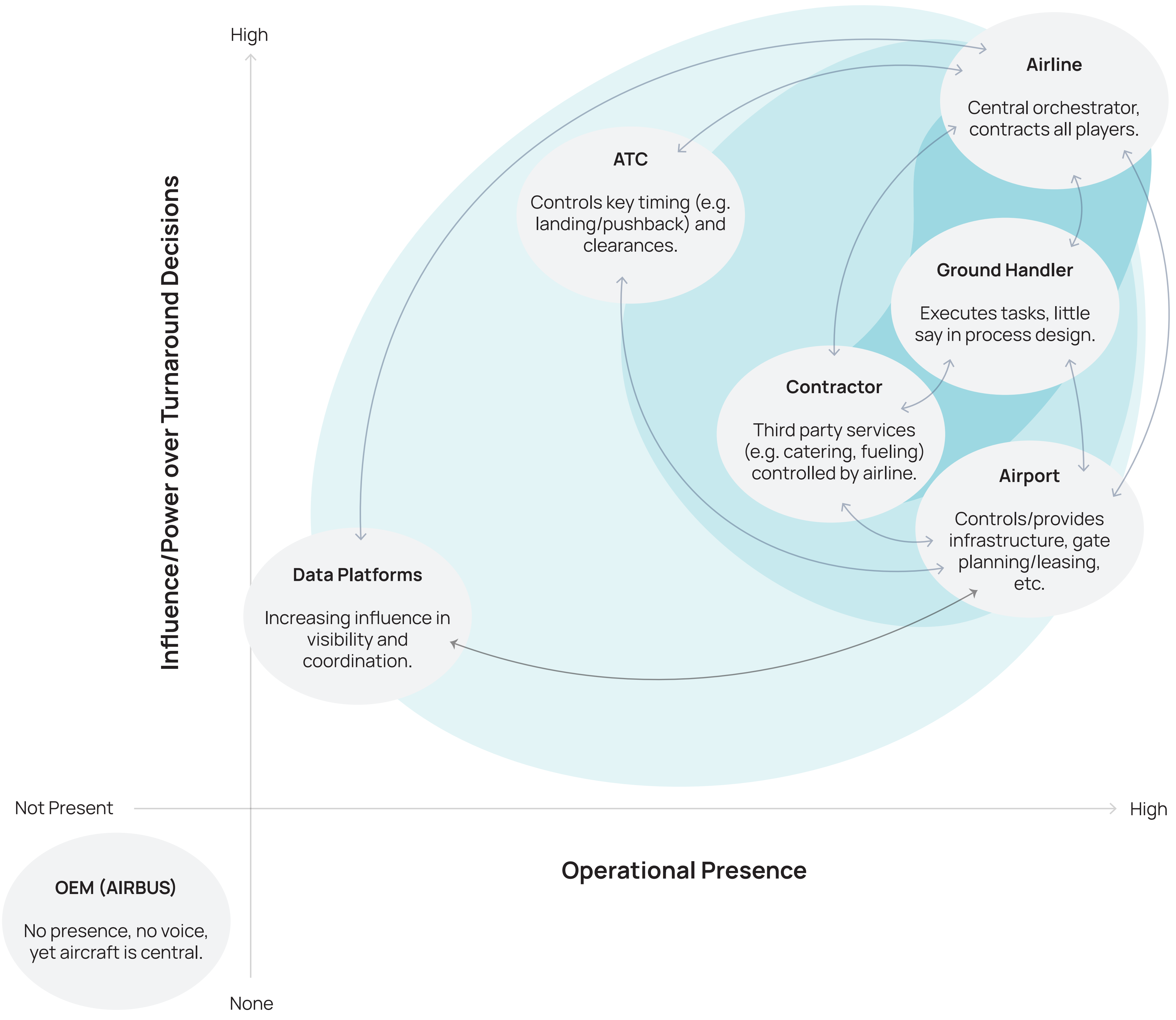
Understanding why turnaround inefficiencies persist requires more than mapping tasks—it requires understanding who owns decisions, who executes them, and what each actor optimizes for. This spread presents a comparative overview of key turnaround stakeholders—OEMs, airlines, airports, handlers, ATC, and data platforms—summarizing their core business models, incentives, and operational roles.

While not exhaustive, this table is intended as a general reference—not all stakeholders follow these exact models, and exceptions exist depending on geography, scale, and vertical integration. Still, the structure provides a useful lens to distinguish between economic incentives and service accountability across the ecosystem. See Appendix B for a full analysis of four* of the key stakeholders presented here.

	Source	Customer	Business Model	Core Role in TAT	Primary KPIs	Notes/Context
OEM (e.g. Airbus)*	Airbus, 2024 Annual Report; Adner, 2017; Belobaba, et al., 2009	Airlines (for aircraft sales primarily, service packages, digital tools)	Product + service (lifecycle)	Designs aircraft, sells via long-term contracts and maintenance agreements	Aircraft delivery, after-sales service quality, lifecycle value capture	Low direct presence during turnarounds; influence lies in design logic and serviciabiltiy constraints. Focus is on long-term airline retention.
Airline*	Belobaba, et al., 2009; Barnhart et al., 2012; Gayle & Yimga, 2018	Passengers (primary revenue)	Integrated Service + Scheduling Control	Purchases all turnaround services; owns the aircraft; defines SOPs and SLAs	OTP, fuel cost, passenger satisfaction, aircraft utilization rate	Central orchestrator; maintains highest power but often does not directly executre turnarrund tasks
Airport (Public International)*	Reece & Robinson, 2018; Murphy & Efthymiou, 2017; Eurocontrol, 2025 (Airport Ops Centres study	Airlines (lease fees), although primary revenue comes from retail tenants (concessions, parking, etc.)	Infrastructure-as-a-service	Provides gates, slots, parking and apron services; sells landing rights and leases space	Gate occupancy efficiency, delay reduction, safety, aernautical revenue per movement, airline and passenger satisfaction	Acts as landlord/operator; coordination rol varies depending on airport size and region
Ground Handler*	El Asri et al., 2018; Padrón et al., 2016; Gładyś et al., 202	Airlines (contracted SLAs)	Labor Execution-as-a-Service	Executes physical tasks (cleaning, refueling, baggage, under airline contracts)	Safety, TAT, SLA compliance, resource utilization	Has low autonomy and little strategic power; often blamed for delays without sytemic input
ATC	Huet et al., 2016; Bolić & Ravenhill, 2021; Barnhart et al., 2012	Airports	Government/Monopoly Public Service	Manages aircraft sequencing in air and portion of on-ground (e.g. taxi + pushback), apron congestion	Safety, airspace efficiency, minimal tarmac hold	Not a commercial actor; regulated by national aviation authorities; friction occurs when apron control overlaps with ground handlers
Data Platform (e.g. Assaia)	Assaia 2023, 2024; Schiphol, 2024; OAG, 2018, 2023, 2024	Airlines and airports	SaaS/Analytics-as-a-Service	Provides timestamped data, visual recognition, and performance dashboards	Accuracy of event detection, reduction of manual logs/ automation, SLA compliance insights for airline/airport	Operates on subscription or platform basis; emerging influence but not legally binding in most cases

3.2.1 Power and Decision Influence Map for Turnaround Operations

A visual breakdown of who controls turnaround decisions versus who is actually present on the ground.



DECODING STAKEHOLDER DYNAMICS

This map shows where each player actually sits. Airlines hold the contracts and set the clock, but outsource most ramp work. Airports run the infrastructure but have limited say once the plane blocks on. ATC controls the critical pushback window but isn't involved on the ground. Airbus is central to every task but has little say in real-time ops. Meanwhile, data-platform vendors are gaining influence by shaping the timestamps everyone relies on.This map is also used (and validated) later on in Chapter 5 as part of a co-design session to anchor conversations around who shapes and who executes. It helped serve as a basis for how stakeholder dynamics could evolve in future systems.

EXECUTION CHAIN
Operational control via direct service contracts.

- Top down contract driven
  - Clear SLAs
  - Financially tied: Airline pays per turnaround or per task
- Airline defines SOPs, owns service quality
- Airline has leverage via contract, others are executors

INFRASTRUCTURE & REGULATORY COORDINATION
Access and flow governed by regulation and infrastructure leasing.

- Regulatory + physical infrastructure coordination
  - No direct payments between all three
  - Airline pays airport fees (gate usage, landing, noise, etc.)
  - ATC is government-funded or semi-privatized (no invoice to airline)
- Shared power but Airline has least say in real-time adjustment. Control is through regulation + slot/time allocation, not money

VISIBILITY & COORDINATION LOOP
Data access enabled through licensing and digital service agreements (SaaS or enterprise licensing).

- Optional but strategic, tech-enabled transparency and optimization
- Data providers create operational insights
- Power here is increasing as platform defines who sees what, when.

This distribution of control and presence provides essential context for the four systemic frictions discussed next—each rooted in how these roles intersect, overlap, or misalign in practice.

Sequencing bottlenecks are not incidental—they are systemic features of a turnaround model that has not kept pace with digital coordination or adaptive scheduling. They emerge from a combination of regulation, habit, infrastructure limitations, and missing feedback loops. Until sequencing is treated as a live, optimizable system—rather than a static checklist—delay propagation, idle time, and unnecessary wait periods will continue to define the turnaround experience.

3.3 Sequencing Bottlenecks

Rigid task orders, poor choreography, and hidden dependencies.

As written in the introduction, aircraft turnaround is a critical and complex process that connects consecutive flight segments and plays a central role in airline scheduling and profitability (Rodríguez-Sanz, Á. et al. 2021.; Le et al., 2019). Defined as the period from gate arrival to pushback, turnaround comprises tightly interdependent tasks performed by multiple stakeholders (Assaia, 2023; Bazargan, 2015; Wu and Caves, 2000). Efficient execution of these tasks—such as de-boarding, fueling, cleaning, catering, baggage handling, and checks—directly affects on-time performance (OTP) and operational viability (Schmidt, 2017; Sánchez, 2009).

These tasks follow a tightly constrained sequence shaped by logical, safety, and operational rules. Activities like cleaning cannot begin before de-boarding concludes, and pushback must wait on tug availability and air traffic control clearance (Sánchez, 2009; Padrón et al., 2016). This creates a "critical path"—a chain of dependent tasks that determine the shortest possible turnaround time. Any delay in this chain extends the entire process (Schultz et al., 2012).

However, this rigidity becomes a systemic inefficiency in practice. Turnarounds are frequently disrupted by delays outside the control of the actors involved—weather, passenger behavior, air traffic flow, or mechanical issues (Rodríguez-Sanz, Á. et al. 2021.). The lack of flexibility to resequence tasks dynamically in response means small disruptions often escalate into wider network delays (Le et al., 2019; Assaia, 2023). The inability to reassign tasks or resources in real time exacerbates this fragility.

Safety regulations and spatial constraints further entrench sequential operations. Fueling, for example, typically cannot occur during boarding, and many tasks conflict physically on the apron (Padrón et al., 2016). Even when turnaround tasks are logically independent—such as catering, cleaning, and boarding—their equipment frequently overlaps in space or access points, making true parallelism physically unfeasible (Fitouri, 2013). On top of this, fragmented responsibility between handling companies, departments, and rigid procedural norms makes system-wide adaptation difficult (Schmidt, 2017; Gomez-Beldarrain et al., 2025).

While simulation tools—like Petri Nets, RCPS models, or Agent-Based Simulations—have been widely used to optimize turnaround execution, they largely accept this rigid sequencing as a given (El Asri et al., 2018; Sánchez, 2009). Improvements are often framed in terms of better planning, tighter buffers, or resource optimization—not fundamental reconfiguration. As Archer noted, current practices rely heavily on preemptive buffers:

> "now there's 13 minutes the pilot can make up, and they don't have to do anything" (Archer, Personal Communication, 2025).

But this doesn't solve root inefficiencies—it just absorbs them.

Recent AI-driven systems like Assaia's ApronAI and Schiphol's Deep Turnaround have improved visibility and coordination by tracking key milestones and sending real-time alerts (Assaia, 2024). These tools have enabled modest gains in gate utilization and time savings. However, they do not (and often cannot) alter task sequencing due to entrenched operational, regulatory, and physical limitations. As Carter put it,

> "We can't shift the whole plan dynamically when something goes wrong" (Carter, Personal Communication, 2025).

Thus, while digital tools enhance compliance with existing plans, they don't solve the deeper issue: the turnaround remains a rigidly choreographed process in a chaotic operating environment. To break this cycle, future approaches must challenge assumptions around sequencing. This could involve exploring reconfigurable aircraft layouts, operational models that enable dynamic resequencing, or regulatory shifts allowing more concurrent actions without compromising safety (Sánchez, 2009; Schmidt, 2017).

Promising directions include the use of reinforcement learning or AI-based dynamic schedulers that continuously adjust task order based on real-time conditions. Such systems could shift turnaround from a fixed critical path to a flexible network of adaptive opportunities—one that manages disruption not by buffering against it, but by responding intelligently in the moment.

The Gantt chart on the following spreads provide a visual synthesis of the key steps involved in aircraft turnaround, grounded in empirical timing data and structured around a wide-body, long-haul operational context.

3.3.1 Turnaround Gantt Chart

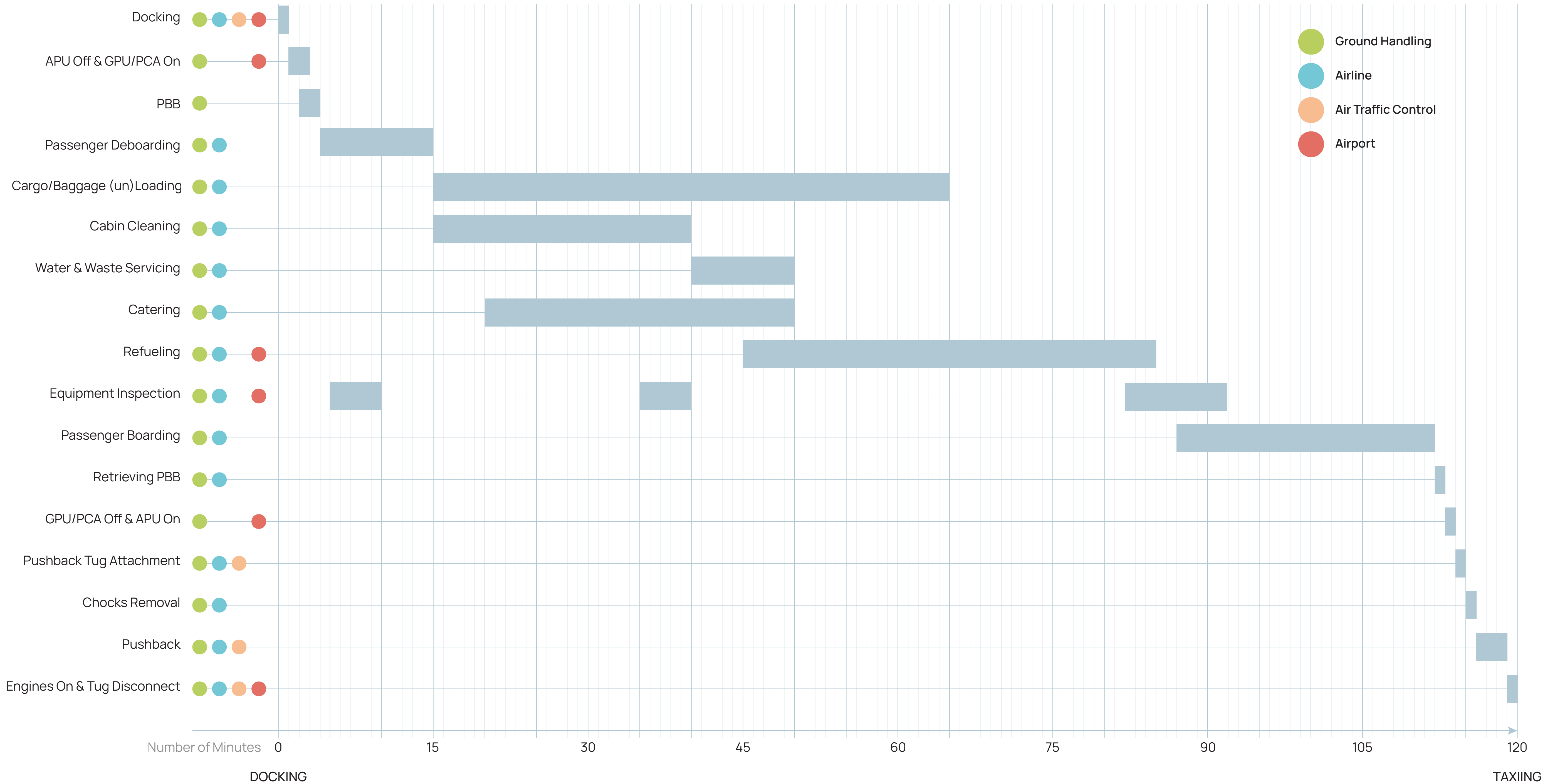
Gantt-chart of turnaround not including taxi, landing, and takeoff.

Each bar represents the duration of a specific ground handling task, positioned according to both logical sequencing and validated start/end time windows.

This model specifically focuses on long-haul, wide-body aircraft—such as the Airbus A350, Boeing 787, and Boeing 777—which exhibit longer, more complex turnarounds than narrow-body jets. Where possible, durations were drawn directly from benchmark timing data from recent operational reports (Assaia, 2023; 2024), academic literature (Fitouri Trabelsi, 2013; Schultz et al., 2012), and TU Delft master's theses (Ground Handling Processes Master Thesis, 2016). Where no precise duration was available, inferred estimates were used based on procedural logic and expert-backed operational context. For example, tasks such as equipment inspection or GPU disconnection are not consistently benchmarked but are essential inclusions and have been modeled using secondary sources.

The selected timing reflects standard full-service turns, including refueling, full cabin service, and both cargo and baggage handling. While the median turnaround time for wide-body aircraft in 2024 was 135.1 minutes (Assaia, 2024), this includes the Airbus A380-800, which skews the dataset due to its exceptional scale and servicing needs. When operating to Dubai, for example, the A380's average turnaround time reaches 160 minutes (Sahadevan et al., 2023). Excluding such ultra-large aircraft, long-haul wide-bodies like the B777-200LR, A330-300, and A340-200 typically range between 90 and 130 minutes depending on route complexity, passenger load, and service scope (Fitouri Trabelsi, 2013; Assaia, 2023, 2024; Sánchez, 2009). This Gantt chart models a representative 120-minute full-service turnaround—excluding high-complexity A380 cases and ultra-short transits—to reflect standard operational patterns for most long-haul aircraft.

Lastly, this chart is not aircraft- or airport-specific, but rather a baseline operational model. It is intended to reflect average patterns, not real-time coordination. Stakeholders involved in each task are indicated with colored icons to show role distribution. This framing reinforces how turnaround efficiency depends not only on task duration, but on inter-organizational coordination across tightly coupled roles.



3.3.2 Critical Paths

Three critical paths that greatly influence turnaround operations.

CRITICAL PATH 01: PASSENGER HANDLING

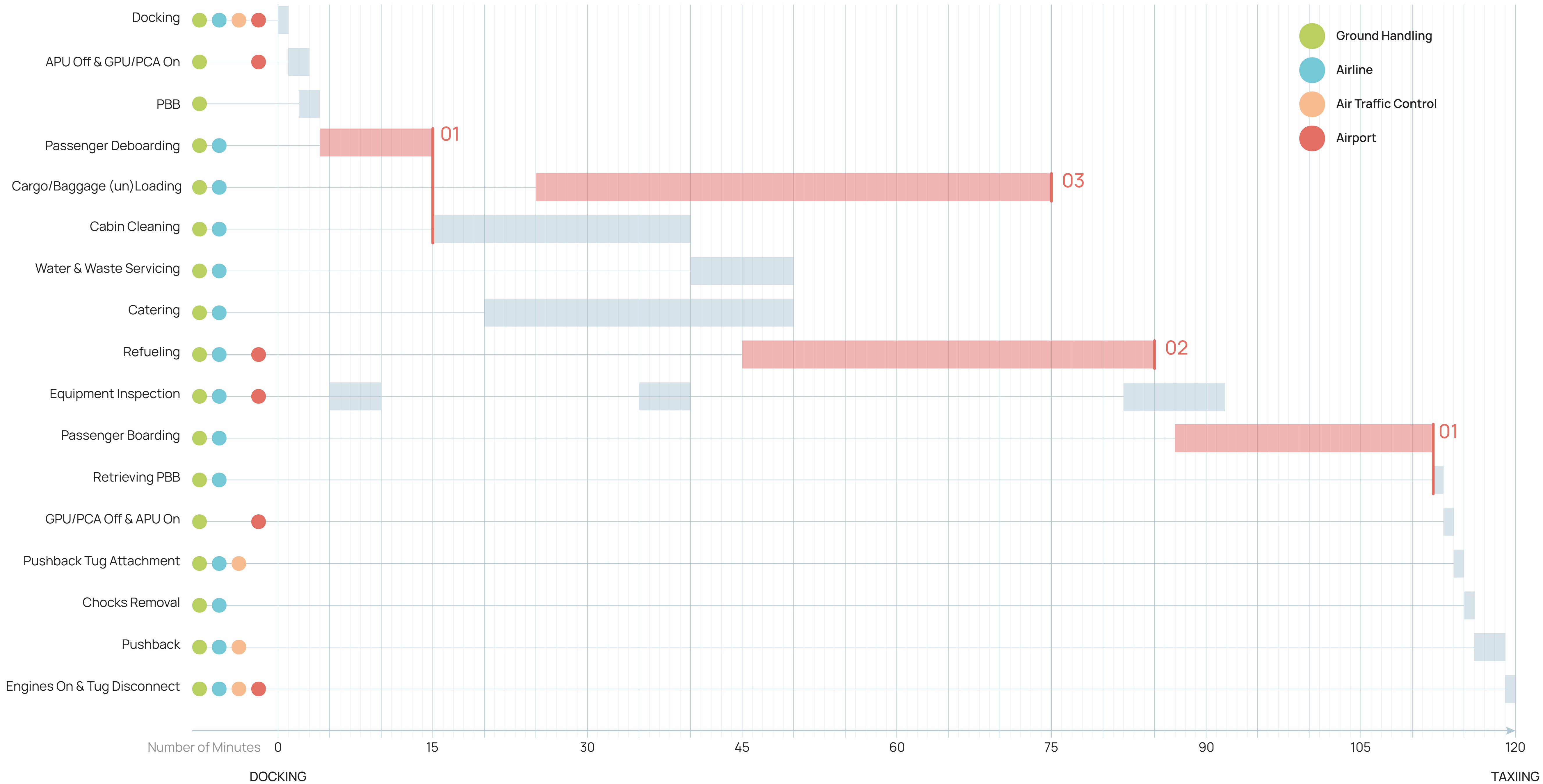
Passenger flow forms one of the most dominant critical paths in turnaround, beginning with the deployment of the passenger boarding bridge (PBB) and continuing through deboarding, cabin cleaning, catering, and eventual re-boarding. These processes are highly interdependent: catering and cleaning cannot begin until all passengers have deboarded, and boarding cannot commence until both are complete. This chain of activities—spanning from passenger exit to final PBB retraction—can account for up to 40% of the total turnaround time and is subject to significant human variability (Sanchez, 2009, pp. 132–152). Because boarding typically concludes just before pushback, any delay in this sequence directly threatens on-time departure and is rarely recoverable.

CRITICAL PATH 02: FUELING SEQUENCE

The fueling sequence is a tightly regulated and inflexible part of the turnaround process, often cited as a critical path in 57% of wide-body operations (Fitouri Trabelsi, 2013, p. 29). It must begin only after all passengers have deboarded and must be completed before boarding can start—creating a dependency chain that is both safety-driven and operationally rigid. Unlike other processes, the fueling duration is determined by the fuel quantity required and offers no buffer for recovery if delayed (Le et al., 2019). As a result, delays in fueling cascade forward, blocking passenger boarding and compressing the margin for downstream departure tasks.

CRITICAL PATH 3: CARGO TURNOVER

Cargo handling—encompassing both unloading and reloading—can be one of the longest physical tasks in a wide-body turnaround, sometimes taking up to 52 minutes (Assaia, 2024, p. 25). While cargo operations typically begin early and are performed in parallel with other activities, they must be fully completed before the aircraft can be sealed, chocks removed, and pushback initiated. This makes cargo turnover a potential final blocker in the departure sequence. However, several sources note that cargo is not always on the critical path: its timing often contains slack or overlaps with other operations. Schultz et al. (2012) suggest that only specific disruptions elevate it to critical status, and an expert interview confirms that "loading and unloading is not critical," particularly when containerized systems are used (Sánchez 2009). Thus, cargo turnover is best understood as a conditional critical path—one that is structurally important but not inherently delay-driving unless parallel operations break down.



Communication breakdowns are not caused by a lack of information—they stem from how information is shared, siloed, or delayed across actors with misaligned systems. Despite digital advancements, turnaround communication remains fragmented, analog, and reactive. Until turnaround coordination is built on real-time, interoperable communication—rather than isolated signals and redundant confirmation loops—misalignment, idle time, and task interference will remain operationally embedded.

3.4 Communication Breakdowns

Tool silos, asynchronous updates and no live coordination.

Turnaround requires continuous coordination between up to seven stakeholder groups—airlines, airports, ground handlers, subcontractors, OEMs, ATC, and support vendors. Yet, much of this coordination remains verbal, manual, and fragmented across interfaces (Schultz et al., 2012; Assaia, 2023). These micro-interactions—often involving dozens of parallel actors—are prone to disruption, particularly under stress or time pressure (Tuchen et al., 2023).

Despite the rise of digital infrastructure, analog tools like radio calls, paper logs, and ad hoc hand signals are still widely used (Assaia, 2023; Wandelt & Wang, 2024). One interviewee, Dario Beekman, emphasized that

> "manual radio and phone calls are still commonly used"

to trigger ground support actions like GPU connection or VDGS alignment (personal communication, 2025). Another, Manav Mehra, noted that fueling frequently stalls when cockpit clearance is not aligned with ramp-side status—highlighting how even basic task triggers depend on verbal chains of confirmation (personal communication, 2025).

A-CDM (Airport Collaborative Decision Making) was developed to solve this: a shared framework of milestones and information exchange meant to enable better coordination across actors. However, even in digitally mature airports, A-CDM often fails to fully integrate into everyday workflows. As Huet, Booth, and Pickup (2016) report, A-CDM is frequently underutilized, misunderstood, or treated as a compliance tool rather than a live coordination platform. Its data is rarely used dynamically on the ramp. Instead, teams continue relying on procedural memory or localized SOPs to signal readiness (El Asri et al., 2018; Assaia, 2023).

Assaia (2023) found that over 75 personnel may be involved in a single turnaround, including flight crew, ground operations, baggage, fueling, catering, and security. Yet many operate without access to a shared task status or live monitoring system. Staff perform based on intuition or habit rather than real-time coordination. Tuchen et al. (2023) suggest that under operational stress, employees often default to the familiar—radio calls, face-to-face updates—even when digital tools are available. This reflects not a lack of infrastructure, but a lack of embedded integration and trust.

Further complicating matters is the absence of a unified "clock." Airlines timestamp digitally; apron staff track via paper logs; OEM observers or APOC teams use separate platforms (Schmidt, 2017). Without a common temporal reference, it becomes difficult to trace delay origins, enforce SLAs, or adjust operations on the fly. As Mehra noted,

> "by the time the fueling team gets clearance and confirms ramp readiness, the flight crew may already be acting on a different update" (personal communication, 2025).

APOC (Airport Operations Centres), now promoted by EUROCONTROL (2025), attempt to address this by bringing decision-making into a shared space. However, even APOCs rarely bridge the ramp-to-cockpit-to-data platform divide. As EUROCONTROL states,

> "by replacing fragmented and potentially conflicting decision-making processes with a unified and coordinated approach, the APOC improves information and operational flows at airports."

Yet the actual impact varies widely depending on stakeholder buy-in and system design (Gomez-Beldarrain et al., 2025).

Communication breakdowns rarely appear in delay reports or root cause assessments. Cook, Tanner, and Cristóbal (2015) highlight that most delays result not from technical faults, but from failures between actors—unspoken assumptions, misaligned task triggers, or overlooked dependencies. As seen throughout interviews and literature, the issue is not the absence of data or tools, but the lack of a shared, live language for coordination across siloed teams.

Interface mismatches are not execution errors—they are design decisions that embed inefficiencies into daily operations. Misaligned ports, inconsistent layouts, and inaccessible panels delay tasks, force workarounds, and increase risk. Without standardized interfaces or feedback from the ground, turnaround teams inherit constraints they can't fix, only work around.

3.5 Interface Mismatches

Misalignments between aircraft and GSE.

Turnaround involves dense coordination between multiple physical systems—each requiring tight spatial alignment between the aircraft and the ground support equipment (GSE) it connects with. Yet, even at mature airports, misalignments between aircraft design and GSE are common, creating a structural friction point. Unlike communication breakdowns, which occur during execution, these mismatches stem from upstream design decisions that are rarely adjusted once aircraft enter service.

Every aircraft type introduces variation in door height, access panel placement, port locations, and service-side clearances (Schmidt, 2017, p. 27; Gładyś et al., 2022, p. 117). Passenger doors might open in different directions, cargo doors hinge opposite ways, and fueling ports may be obscured by wing structures. GPU and PCA connections are frequently placed without considering stand ergonomics, apron access patterns, or simultaneous task execution ((Airbus, 2016; Cavotec, n.d.; Deng, 2007). These seemingly minor layout differences add friction for ground handlers, especially in mixed-fleet environments.

Misplaced panels and misaligned connections force workarounds that cost time and elevate error risk. Gavin Riedel explained,

> "Every aircraft has a different layout, and the GPU or PCA connections are not standardized. This slows down training and increases mistakes" (personal communication, 2025).

Even airport-side infrastructure can become a barrier. Elias Voss noted,

> "Gate D15 is the only one that fits L2 boarding on the Boeing 787 properly. If another gate is used, the front door is needed and that slows things down"
>
> (personal communication, 2025).

These adaptations—like repositioning trucks, manually aligning hoses, or rerouting crew flows—become invisible time sinks. Schmidt (2017) emphasizes that nonstandard interface layouts increase training load and procedural complexity, which in turn elevate operational cost and coordination risk .

Refueling and PCA are among the most cited problem areas. On many Airbus models, fuel ports are positioned behind the wing, directly in the path of other GSE such as catering trucks (Airbus A350, 2016) . PCA ducts must be aligned with exact port angles—any deviation can reduce airflow efficiency and lead to fallback to the APU (Cavotec, n.d.) . These issues aren't rare. SKYbrary cites GPU carts and belt loaders as common sources of ground damage when service access panels are awkwardly positioned . Assaia (2023) also notes significant GPU delays, including a 22% deviation in APU shutdown time due to poor GPU cable access and placement..

These inefficiencies persist because no one owns the aircraft–GSE interface holistically. OEMs build the aircraft, but don't maintain apron-level feedback loops. Airlines set SOPs, but have limited say over gate design. Ground handlers must deliver under these constraints with little power to change them. Riedel remarked,

> "Aircraft manufacturers are not mentioned once in global training standards. They are completely absent from the conversation" (personal communication, 2025).

While "design for maintainability" is an embedded concept in aerospace engineering, "design for ground handling" remains undefined. There are no standardized global specs for GSE alignment across aircraft types or coordination feedback loops between OEMs and ramp-side operations (Airbus, 2024).

This problem is only set to grow. Backlogs of next-generation aircraft are being delivered to mixed-fleet carriers operating in constrained airports (McKinsey, 2025). If design choices continue to overlook apron coordination, today's frictions will scale into systemic inefficiencies. OEMs have a window to shape this future—by standardizing port placement, designing for apron ergonomics, and embedding feedback from turnaround execution into aircraft development.

Fixing these frictions doesn't require full interface harmonization. But it does demand that design processes begin to account for GSE interaction—shifting from isolated aircraft performance to system-level adaptability.

3.5.1 Ground Support Equipment

Introducing the key equipment used in turnaround and how each system connects to the aircraft and terminal.

This page introduces the physical tools required to execute turnaround on the apron. From PBBs to catering trucks, each system must connect precisely with the aircraft's structure—and do so in a live environment under tight time constraints. Understanding this physical choreography is essential to unpack why interface mismatches occur and how poor layout or coordination leads to cascading delays. This visual helps illustrate just how many different systems (and providers) are in motion at once (only some are indicated below). Each piece of GSE has its own approach path, activation sequence, and placement constraints—all of which must align with aircraft-specific interfaces and stand layout. These dependencies create friction that ground crews must navigate daily.

Visual created with AI tools and information sourced from Alonso (2019), Gladys et al. (2022), Le et al. (2019), Deng (2021), Padron et al. (2016), El Asri et al., (2018), Airbus A350 (2016), Sanchez (2009).

04 PASSENGER BOARDING BRIDGE (PBB)

PBBs, also called jet bridges, are movable, enclosed walkways that connect the terminal directly to the aircraft door. Where PBBs aren't available, mobile stairs are used on both the front and rear doors, especially on remote stands. PBBs are owned by the airport, while stairs are typically provided by ground handlers.

05 GPU/PCA

These systems provide external power and air conditioning while the aircraft is parked at the gate. GPUs supply 115V/400Hz AC electricity through a fuselage socket, and PCA units push heated or cooled air into the cabin. They can be either mobile units or integrated into the terminal infrastructure, depending on the airport.

06 CATERING TRUCK

A catering truck is a high-lift vehicle used to load meals, beverages, and galley equipment into the aircraft through dedicated service doors, typically near the front or rear. The platform elevates to the door height and contains insulated storage to maintain cold-chain standards. Catering services are usually handled by specialized airline contractors.

07 CARGO/BAGGAGE (UN)LOADER

Cargo loaders are motorized lift platforms used to load containerized freight (ULDs) into wide-body aircraft or to raise bulk items into lower holds. They align with the aircraft cargo door and use rollers to guide containers into position. The equipment type depends on whether the aircraft is configured for bulk or containerized loading.

03 WHEEL BLOCKS (CHOCKS) AND CONES

Cones are placed around key parts of the aircraft—such as engines, wingtips, and tail—to create visible safety zones that restrict vehicle and personnel movement. Chocks are heavy wedges positioned against the aircraft wheels to prevent rolling once parked. Both are deployed immediately after brake engagement and are required before most ground operations can begin. Placement protocols vary slightly by airline and handler.

08 FUEL TRUCK

Fuel trucks supply aviation fuel either by carrying it onboard or by acting as hydrant dispensers that draw from underground airport systems. The truck connects to the aircraft's fueling port under the wing or on the fuselage. Hydrant trucks are used at airports with centralized fuel infrastructure, while tanker trucks are common at smaller or remote stands.

02 PUSHBACK TUG (TOWING TRACTOR)

This vehicle moves the aircraft away from the gate by connecting to the nose landing gear. Tugs may be conventional (using towbars) or towbarless (cradling the gear directly), and can be diesel or electric. They are operated by ground handlers or airport service providers based on local arrangements.

09 BAGGAGE CART

Baggage carts are low, towable trailers used to transport passenger luggage between the aircraft and the terminal. They are typically linked in a train behind a small tug vehicle and loaded manually. Carts may be enclosed or open depending on weather and airport standards.

01 POTABLE WATER TRUCK

This vehicle refills the aircraft's clean water tanks used for galley functions and lavatory sinks. It connects to the aircraft via a dedicated service panel using sanitized hoses. The process is handled by specialized ground handling staff and varies in frequency depending on route length and operator policy.

10 LAVATORY SERVICE TRUCK

Lavatory trucks remove waste from the aircraft's onboard tanks and refill them with disinfectant fluid. The service is conducted using vacuum hoses that connect to designated service ports, usually located at the rear of the aircraft. Strict sanitation procedures separate this task from potable water services.

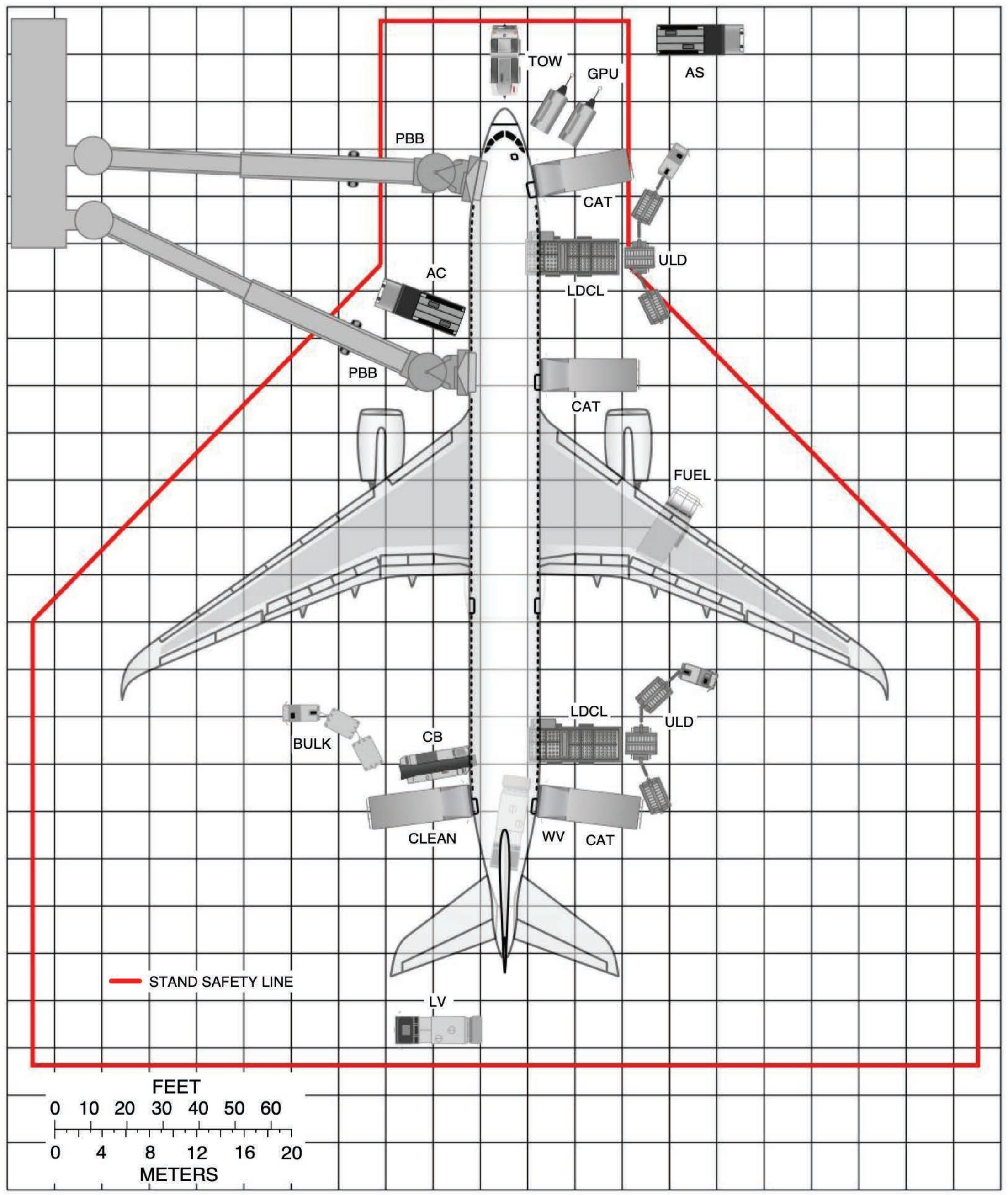
3.5.2 Owner vs. Operator of GSE

Mapping who owns versus who operates each type of equipment—and why that matters.

Building on the previous visual, this spread maps out the typical ownership and operator responsibilities across major GSE systems. Many stakeholders are involved: airports, airlines, ground handlers, third-party contractors. Each may own or operate different systems depending on the region, terminal setup, and contracting models.

While the previous spread offered a 3D representation to illustrate the complexity and spatial choreography of turnaround, the 2D layout below is pulled directly from the Airbus A350 aircraft manual to show the exact positioning of each GSE unit around the stand.

This matters because it directly affects coordination. If the person using the equipment isn't the one responsible for maintaining or configuring it, or if SOPs vary between operators, delays become harder to prevent. Mismatches in responsibility can also obscure accountability when something breaks down. Together with the layout visual, this chart underscores the systemic complexity behind seemingly simple interface problems.



Typical aircraft ramp layout. Source: Airbus A350 AC manual (2024).

Equipment	Typical Owner	Typical Operator	Notes and Variability
Passenger Boarding Bridge (PBB)	Airport	Ground Handler and/or Airline	Owned by airport as part of terminal infrastructure. Sometimes operated by ground handlers, depending on agreements. Where unavailable, mobile stairs (owned by ground handlers) are used, especially at remote stands (ACI, 2023).
GPU/PCA Units	Airport or Airline	Airport, Ground Handler, or Airline	Can be integrated into terminal infrastructure (owned by airport) or provided as mobile units (owned by airline or third-party). Ownership varies significantly across airports; integration often seen in newer or larger airports (IATA, 2022).
Wheel blocks/ Cones	Ground Handler or Airline	Ground Handler	Low-cost safety tools owned and deployed by ground handling teams. Deployment varies slightly by SOPs of the airline and handler. Required before other operations can begin (ICAO, 2023).
Pushback Tug	Ground Handler or Airport	Ground Handler	Often owned and operated by ground handlers. At hub airports, fleet may be owned by airport and leased to ground ops. Variability exists in whether tug is conventional or towbarless. Usage depends on stand configuration (Eurocontrol, 2021).
Potable Water Truck	Ground Handler or Specialized Contractor	Ground Handler	Owned and operated by ground handlers. Cleaning and filling procedures vary by country and carrier. Operators are trained and certified; timing depends on flight route (IATA Ground Ops Manual, 2022).
Catering Truck	Airline or Catering Contractor	Airline and/ or Catering Contractor	Airlines often subcontract to third-party catering firms who own and operate trucks. Airlines like KLM may own both service and truck. Integration of galley standards is required (ICAO Doc 9137, 2020).
Cargo/ Baggage Loader	Ground Handler	Ground Handler	Specialized high-lift equipment owned by ground handlers. Loaders are tailored to aircraft type. Contracts vary based on airport and airline relationships (ACI, 2023).
Fuel Truck	Airport, Airline, and/or Fuel Company (Specialized)	Airport, Airline, and/ or Fuel Company (Specialized)	Hydrant trucks are common in large airports with central fueling (owned by airport or fuel consortium); smaller airports use tanker trucks. Operations usually contracted to fuel service providers (Shell Aviation, 2023).
Baggage Cart	Ground Handler	Ground Handler	Owned in fleets by ground handlers. Variability in design (open/closed) and linkage methods. Load/unload timing strongly tied to SOPs and ramp staffing (IATA, 2022).
Lavatory Service Truck	Ground Handler or Specialized Contractor	Ground Handler or Specialized Contractor	Trucks owned and operated by handlers. Requires certified operators. High sanitation standards enforced. Timing varies with operator staffing and turnaround window. Regionally outsourced in some airports (ICAO, 2023).

Accountability voids are structural gaps that prevent collective ownership of turnaround performance. When each actor is responsible only for their part, no one is responsible for the outcome. Fragmented incentives, siloed KPIs, and diffused authority make it nearly impossible to coordinate action toward system-wide efficiency. Turnaround delays don't just stem from task-level failures—they persist because the system lacks aligned goals, shared accountability, and a mechanism to coordinate across roles.

3.6 Accountability Voids

No single actor responsible for performance across the system.

At the start of this chapter, I laid out a comparative chart of key stakeholders in turnaround—OEMs, airlines, airports, ground handlers, and others—outlining not only their roles but also the distinct KPIs each is optimized to serve. That table made one thing clear: while turnaround is a shared operation, it is not a shared responsibility. Each actor is evaluated on narrow, task-specific metrics—safety compliance, gate occupancy, OTP, SLA fulfillment—none of which incentivize holistic performance or system-wide resilience.

This disjointed framing creates gaps that aren't operational—they're structural.

While each actor is accountable for their specific role, no one is accountable for the turnaround as a whole. As cited many times previously, literature continuously notes the multitude of actors that up to 30 actors may be involved in a single turnaround, operating under different procedures, systems, and timelines (Schmidt, 2017; Assaia 2023; OAG 2023). Yet there is no entity with end-to-end visibility or responsibility. This results in what Assaia (2023), Schiphol (n.d.), and Reece et al. (2018) collectively highlight as a critical gap: a process that is vital, but structurally unowned.

This is the core of what can be described as an accountability void. Teams are measured by how well they execute their task—be it deploying jet bridges, fueling aircraft, or delivering catering—not by how they enable system recovery when plans shift (Le et al., 2019). As Rodríguez-Sanz et al. (2021) and Padrón et al. (2016) note, this fragmented accountability discourages cross-functional problem-solving.

> "People show up when they're told, and they're judged on doing their part—not on helping the system recover when things shift,"

Carter explained (personal communication, 2025). When things go off-script, this mindset becomes a liability. Planning is fragmented. Responses are narrow.

> "Most of turnaround is miscommunication... sometimes airlines don't provide correct information... then they didn't plan enough busses etc.,"

Beekman noted (personal communication, 2025). Without a stakeholder accountable for full-sequence outcomes, disruptions are absorbed rather than addressed.

Even targeted optimization can create unintended ripple effects. Speeding up one task—like baggage unloading—can delay others if cleaning crews aren't ready or fueling is blocked (Assaia, 2023). Padrón et al. (2016) explain that task-level gains don't translate to system-level efficiency unless they're coordinated. As a result, localized wins often create downstream costs.

Long-term improvement is also stifled. No single actor collects or owns data across the full turnaround, making it difficult to trace delay causes or implement end-to-end fixes. Reece et al. (2018) point out that fragmented governance structures, especially at large international airports, further prevent system-wide redesign. Innovation stalls not for lack of ideas, but for lack of shared incentives.

Meanwhile, the financial consequences remain enormous. Operational delays cost major airlines hundreds of millions annually—not due to mechanical failures, but due to institutionalized inefficiencies (Le et al., 2019; Nyquist et al., 2008; Scaraoni et al., 2021). Time lost to idle equipment or misaligned tasks directly reduces aircraft utilization—one of the few levers of profitability left in high-volume aviation.

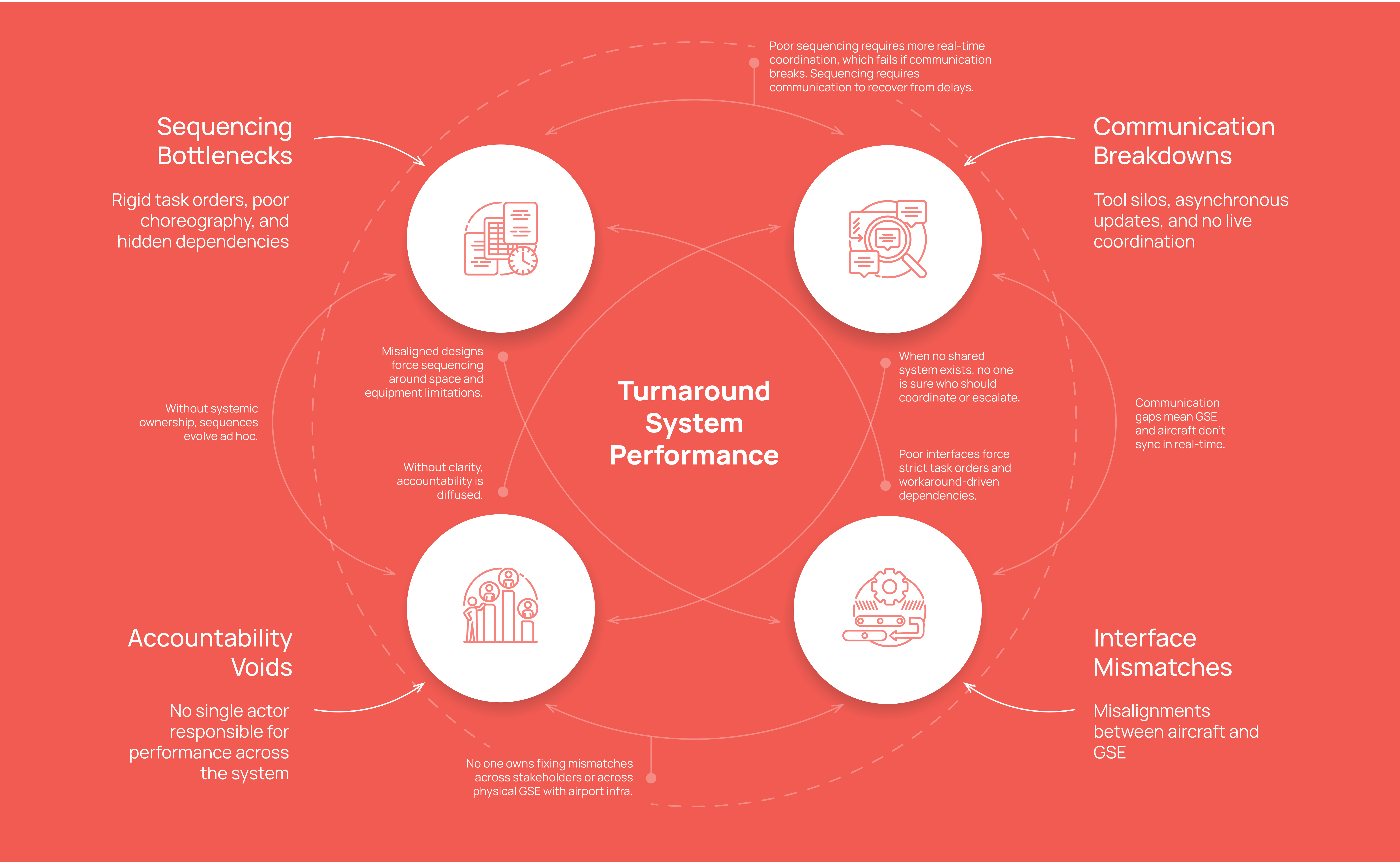
Airline models add further complexity. LCCs depend on rapid turnarounds. FSCs rely on buffers to protect schedules. Both approaches avoid the real issue: the absence of shared accountability. Sometimes, longer turnarounds act as a workaround—buying time for a system that lacks coordination (Belobaba et al., 2015; Rodríguez-Sanz et al., 2021).

To resolve this friction, the industry must move beyond silo optimization toward system-level orchestration. Earlier in the communication breakdowns section, I noted that A-CDM, while widely adopted across airports, often fails to operate as a live coordination platform—serving more as a compliance tool than a dynamic integrator. The same is true for newer solutions like TITAN, an AI-powered turnaround tool developed to align stakeholder timelines and send predictive alerts, and Decision Support Systems (DSS) that combine timestamp data, live tracking, and workflow intelligence. These platforms promise integrated control, but like A-CDM, they remain underutilized—especially under operational stress—because the core structure of turnaround lacks a clear process owner. Without institutional alignment, even the most advanced tools can't bridge what is ultimately a human and organizational gap.

Until turnaround is structured around shared outcomes and mutual accountability—rather than isolated KPIs—it will remain a patchwork of local optimizations, rather than a coordinated system built for resilience.

3.7 The Four Frictions

This visual shows the interconnectedness of each friction and their impact on TAT.



3.8 Why TAT Matters for Airbus

Why Airbus is justified in addressing turnaround inefficiencies—even if it doesn't operate the ground.

WHY INTERVENE IN TURNAROUND AT ALL?

As is now (hopefully) clear, turnaround delays are often treated as an operational or airline-side issue. But when timelines slip, the consequences quickly spill over. Late pushbacks disrupt MRO scheduling, delay follow-on flights, and increase unplanned support needs. For Airbus, this creates downstream service pressure and complicates fulfillment of Flight Hour Services, spare parts contracts, and customer performance guarantees. Even if Airbus doesn't control turnaround directly, its service business depends on how reliably the aircraft can be turned.

WHY NOW?

Airbus no longer earns only at point-of-sale: after-sales and lifecycle support generated € 5 billion (~10 %) of Commercial Aircraft external revenue in 2024 (Airbus, 2024). At the same time, APIs, digital-twin data and AI maintenance assistants now let an OEM reshape coordination without owning a single ground handling contract (McKinsey, 2024; Bazaud, 2024).

WHAT'S THE UPSIDE FOR AIRBUS?

Turnaround speed drives aircraft utilisation; utilisation drives flight-hour-based service packages (spares pooling, predictive analytics). Even a single-percentage-point utilisation gain across the 8658 aircraft backlog (Airbus, 2024) translates into hundreds of millions of euros in incremental, high-margin service revenue over the fleet's life. The chart above summarizes evidence across desirability, viability and feasibility points.

WHY THIS IS A DESIGN OPPORTUNITY

The four frictions identified earlier aren't just operational issues. They're symptoms of coordination design failures. And those failures can be redesigned. Redefining interfaces and information flows is a design task the OEM can lead, while airlines and airports keep day-to-day control.

This thesis explores where design can create system-wide impact that benefits Airbus's long-term service business—without owning operations or prescribing workflows. These levers aren't about selling more planes. They're about ensuring the planes sold deliver full value.

The next section explores design-led concepts that convert those systemic frictions into tangible value—without Airbus taking over ground operations.

	Evidence
Desirability **What stakeholders want**	At five ApronAI airports, adding computer-vision time-stamps cut average gate delay by 6 % and trimmed median turnaround time by 4 %; the same sites logged a 25 % jump in turns-per-stand once live milestones were visible (Assaia, 2024, pp. 22–23). Meanwhile, airlines face a projected 20 % global technician short-fall by 2033, forcing them to prioritise labour-light ways to keep aircraft moving (McKinsey, 2024, p. 9). Together those data points show clear operator appetite for anything that unlocks real-time resequencing without new head-count.
Viability **What Airbus gains**	Services in the Commercial Aircraft segment produced € 5 billion in 2024—about 10 % of external sales—and earned "high-teens EBIT," well above aircraft margins (Airbus, 2024, p. 86). Because those after-sales contracts are billed by flight hour, any utilisation uplift is accretive: an extra one-percent of flying time across the 8 658 aircraft still on order (Airbus, 2024, p. 14) would expand the addressable service pool by a high-hundreds-of-millions-euro figure over the fleet's life. With global commercial-aviation MRO spend forecast to hit US $135 billion by 2034 (McKinsey, 2024, p. 5), even a sliver of incremental share captured through better turnaround performance represents a material, margin-rich upside for Airbus's services business.
Feasibility **Why this is realistic now**	Airbus already invests "several billion euros per year" in automation, digital twins, and industrial AI capabilities (Bazaud, 2024). McKinsey estimates generative-AI maintenance assistants can release 15–35 % of licensed technician capacity (McKinsey, 2024, p. 11), demonstrating that the data and talent stack needed for any kind of data sharing is largely in place. Live computer-vision pilots at multiple hubs further prove the technical lift is evolutionary, not brand new (Assaia, 2024, p. 23).

3.9 Research-Specific Limitations

This page highlight the boundaries of the research and highlights key areas that were excluded, underexplored, or outside the scope of this thesis.

FRICTIONS OUTSIDE THE TURNAROUND WINDOW

- Airborne delays and airspace inefficiencies were excluded from the analysis. Although they directly impact on-time arrivals and departure feasibility, this research focused solely on ground-side frictions post-arrival and pre-departure.
- Slot allocation systems and airport congestion pricing strategies, which influence turnaround feasibility and scheduling, were considered out of scope.

STAKEHOLDER DEPTH VS. BREADTH

- The thesis does not include direct perspectives from ATC personnel, border control, or customs operators, despite their influence on sequencing and operational timing.
- Passengers' roles (e.g. late boarding, carry-on patterns, medical emergencies) were acknowledged but not systematically analyzed, as the study prioritized ground handling and coordination stakeholders.
- Ground handling companies and ramp agents—who execute most physical turnaround tasks and operate key equipment like GPU units, belt loaders, and lavatory trucks—were not directly interviewed. As a result, insights into equipment constraints, operator behavior, and on-the-ground improvisation are missing.

TECHNOLOGY GAPS

- While emerging technologies like AI, VDGS, and digital twins are referenced, this research does not assess the technological maturity, implementation cost, or operational performance of specific solutions in real-world settings.
- Cybersecurity risks associated with increased digital coordination and system interoperability were not investigated, despite their relevance to communication and system integrity.

GEOGRAPHICAL AND CONTEXTUAL BOUNDARIES

- The findings are primarily drawn from European and North American operational models, with limited insights from regions such as Asia-Pacific, where turnaround operations may be influenced by different regulatory and infrastructural constraints.
- Military, cargo-only, or low-cost-carrier-specific turnaround models were not separately analyzed, though their incentives and operational logics often diverge from hub-based commercial passenger aviation.
- Labor union dynamics, workforce training requirements, regulation and resistance to operational change were acknowledged but not explored in depth.

QUANTITATIVE VALIDATION

- This work relied heavily on qualitative synthesis (literature triangulation and expert interviews). Quantitative simulation of turnaround scenarios or cost-benefit analyses of proposed interventions were not conducted due to time and access limitations.
  Turnaround time variability metrics were discussed descriptively but not statistically analyzed against flight-level operational data due to lack of access to proprietary airline datasets.
- The research does not include quantitative comparisons between different aircraft types, despite clear differences in service requirements (e.g. wide-body vs narrow-body sequencing and equipment needs).
- Variability in Ground Support Equipment (GSE) types, configurations, and availability was not modeled or analyzed, nor were performance differences between ground handlers based on fleet size, training level, or procedural maturity. These factors likely influence execution efficiency but were out of scope.

Sketches, systems maps, and early performance charts used to translate systemic insights into visuals for this chapter.

3.10 Midpoint Reflection

The transition from research to design.

The first half of my thesis came out of frustration. Not because I didn't have data—but because I had too much of it, and none of it was clicking together in a way that actually helped me answer the question I set out to explore.

I had already built what looked like a coherent analytical framework: five "drivers" of turnaround efficiency. I mapped logic trees, grouped quotes, annotated Gantt charts, and even developed visuals and flow diagrams. On the surface, it looked polished. I shared it with peers, friends, and even potential interviewees. Nobody pushed back. But internally, I was still stuck.

The reason was simple but uncomfortable: I had answered the wrong question.

My thesis wasn't about what drives turnaround—it was about what causes systemic inefficiencies, and how Airbus, as an OEM, could intervene at that level. Somewhere along the way, I had stopped interrogating my framing. I had convinced myself I was on the right track because I had momentum, artifacts, and a story I could tell. But it's dangerously easy to believe in your own structure once you've invested time into it—and even easier when others nod along because it sounds "comprehensive."

Looking back, I realize I had been searching for ordered, step-by-step breakdowns of turnaround—assuming standardization existed and could be revealed with enough research. That mindset shaped not just what I read, but how I read it. I was subconsciously filtering for the wrong signals. At the same time, I had underestimated just how protected the knowledge in this space would be. Access was limited, fragmented, and often locked behind NDAs or proprietary tools.

Eventually I stepped back and pulled everything apart. It took my mentors' perspective to see that the issue wasn't a lack of information, but a lack of the right frame to interpret it.

That became the turning point. I stopped trying to fix the system and started reframing the problem. The Gantt chart wasn't just about scheduling—it exposed task interdependence failures. The interviews weren't just about opinion—they revealed blind spots in system ownership. Literature didn't validate—it highlighted the disconnect between academic models and operational realities.

What emerged instead were four systemic frictions: sequencing breakdowns, communication gaps, mismatched interfaces, and accountability voids. These weren't just inefficiencies—they were leverage points. They weren't just operational—they were structural. And they weren't just messy—they were deeply human.

The previous chapter mapped these four persistent frictions, which surfaced through a combination of literature review and interviews. While they appear distinct, they are deeply interdependent and point to something more foundational: a systemic misalignment in how roles, ownership, and timing are distributed across the turnaround ecosystem.

As I moved into the design phase, I kept trying to locate clear leverage points—places where a tool, protocol, or communication layer might reduce friction. But every attempt to zoom in on one task or workflow ran into the same issue: complexity. No two turnarounds are the same. Airlines outsource differently. Airport infrastructure, regulations, and fleet types vary. Even the definition of "on-time" shifts by context. I found myself questioning whether anything I designed could be relevant beyond a single case—if I could even define that case with enough fidelity.

With a background in engineering, I had expected I'd be able to ground design decisions in quantifiable insight. That didn't happen. Most critical dynamics—power structures, decisions, and delays—remained locked behind opaque processes or inaccessible datasets. I had interviews and literature, but no real-time operational exposure. This limitation forced me to reconsider not just what I could design, but whether I could design something responsibly at all.

At one point, I considered zooming into a single friction. Could I design a tooling interface to reduce fragmentation? A better process to align timing? A protocol to clarify authority? Each friction pointed to a valid opportunity, but pursuing one required fidelity I didn't have. The risk of designing something overly narrow—or worse, inaccurate—was high. So I stepped back and reframed the system as a whole.

It was in that moment of uncertainty that I got clarity. My advisors and mentors reminded me that not all design is solutionist. Especially in locked or fragmented systems, the role of design is often not to fix, but to reframe. They encouraged me to stop searching for a "validated solution" and instead ask: what kind of reflection, provocation, or narrative could help others see the system differently?

One mentor challenged me to think of this thesis as a gift to the industry—a thoughtful provocation, rooted in reality but not constrained by it. Another cautioned me not to over-generalize just to make the work feel complete. I was encouraged to embrace my position—not as an insider with full access, but as someone able to question the system without inherited assumptions. That shift changed everything.

It led me to a different set of questions:

What would this ecosystem look like if all four frictions were gone?

What would turnaround feel like if it were seamless—not just optimized locally, but designed holistically?

This chapter marks a transition in the thesis: from analyzing the system as it is, to imagining what it could become. From trying to optimize within a broken structure, to asking whether that structure is even worth preserving. It's not the final answer—but it's the clearest way I could think through the problem.

Through this speculative lens, several patterns became sharper. Turnaround doesn't break because one actor fails. It breaks because the system itself is misaligned—sequencing, incentives, interfaces, ownership, and priorities drift out of sync. Each friction reveals a gap between how the system is designed, how it operates, and who is responsible.

In this landscape, the role of the OEM is especially paradoxical. It is the one actor physically at the center of every turnaround—its product is the object around which all other actions revolve—yet it remains structurally absent from real-time operations. This absence isn't just a blind spot. It's a missed opportunity.

That realization—shaped by research and mentorship—is what pushed me toward speculation. Not to predict or prescribe, but to create a model that asks:

What would the turnaround ecosystem look like if it were reimagined from scratch—without legacy constraints, stakeholder silos, or inherited assumptions?

What follows is my attempt to explore that question. It is an idealized system, intentionally reductive and simplified. It does not aim to represent the complexity of every operational context, nor to claim completeness. Rather, it is my attempt at a provocation—a way to reflect on what might be possible if we shift our frame, and systemic frictions were no longer a given.

04

Concept Ideation

4.1 Design Area

Reimagining Turnaround from First Principles

Speculative design is not about predicting the future. It is a method for probing uncertainties, questioning dominant trajectories, and provoking discourse by materializing alternative futures (Dunne & Raby, 2013). In the context of aircraft turnaround—a tightly regulated, efficiency-driven system—speculative design allows us to momentarily suspend feasibility to explore what *should* be possible, not just what *can* be optimized.

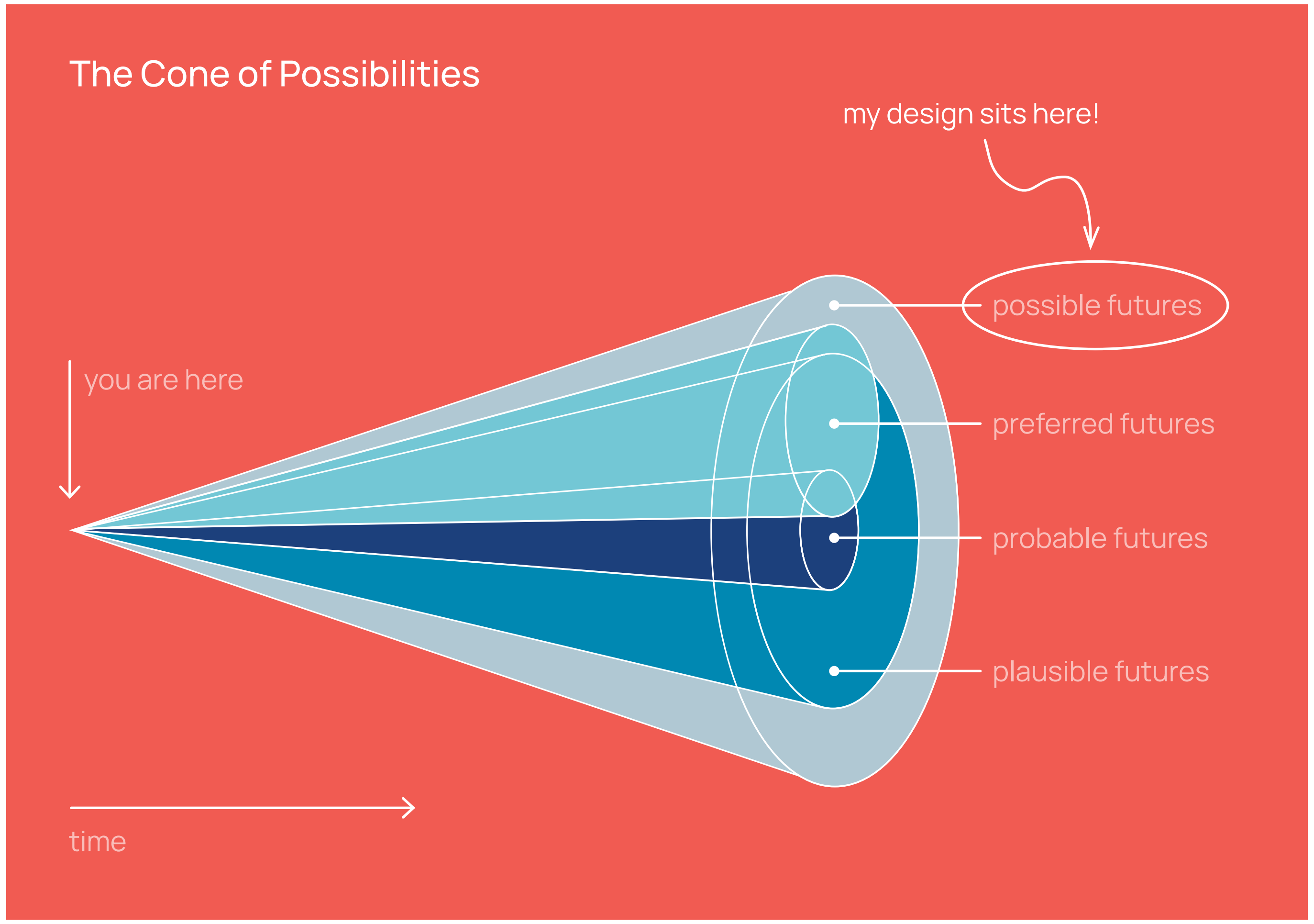
As a framework, speculative design draws from critical design traditions. Rather than iterating on the known, it projects forward from the present to imagine futures that challenge our defaults. The approach sits outside traditional user-centered design or design thinking: it does not solve user pain points nor seek near-term implementation. Instead, it acts as a thought experiment with visual and systemic artifacts (Onething Design, 2024).

To locate speculative design in the landscape of future-making, Delve's adaptation of the "Cone of Possibilities" is useful (Delve, 2023). At its core, the cone illustrates the range of potential futures: from plausible (based on current trajectories) to possible (within the bounds of physics and science fiction) to preferred (based on values and aspirations). Speculative design exists in the possible/preferred zones. It is intentionally untethered from the probable, enabling designers to stretch assumptions, test edge logics, and imagine systems we have yet to legitimize.

Given this, I decided to design a future scenario—deliberately idealized—that maps what the turnaround ecosystem could look like if redesigned around clarity, alignment, and orchestration. Again, the aim is not to prescribe a solution, but to provoke new frames for understanding an OEM's possible roles beyond aircraft design and to ideate on what an idealized, fully efficient turnaround might look like.

CORE PROVOCATION

How might the OEM play a more systemic role in reducing turnaround friction—not by optimizing isolated tasks, but by rearchitecting the logic of coordination itself?



"Cone of Possibilities" Delve, 2023

4.2 Design Brief

Reimagining Turnaround from First Principles

DESIGN CRITERIA

To ensure coherence and strategic depth, the speculative concepts are evaluated using the following constraints:

1. Structural Criteria – What must be included?

- Must define the presence (or absence) of six core stakeholder archetypes: OEM, Airline, Airport, Ground Handler, Data Platform, ATC. (Specialized Contractors are excluded as they can be grouped into the Ground Handler archetype.)
- Must reconfigure power, ownership, or coordination logic across at least one dimension

2. Functional Criteria – What must it provoke?

- Must dissolve or render obsolete one or more of the four mapped systemic frictions.
- Must reveal how current operational assumptions break down or invert
- Must retain internal coherence—i.e., the speculative world must make sense on its own terms, even if it challenges feasibility

3. Strategic Criteria – What must it question?

- Must provoke a rethinking of the OEM's role—from hardware supplier to integrator, platform orchestrator, or service provider
- Must expand the OEM's scope from product to service ecosystems, governance structures, or automated workflows
- Must challenge the current industry paradigm—shifting focus from SLA optimization to system redesign

DESIGN SCOPE & ASSUMPTIONS

This project explicitly avoids designing technical tools or hardware, or proposing marginal optimizations. Instead, it reframes turnaround as a dynamic system of actors, ownership models, and flows—provoking new possibilities by removing today's constraints. Included Actors (retained for functional reasons, not institutional realism):

Airline – process owner
Airport – infrastructure enabler
Ground Handler – execution agent
OEM – design authority
Data Platform – visibility catalyst
ATC - temporal gatekeeper

This framing aligns with ecosystem theory, where roles are defined functionally, not by legacy ownership (Adner, 2017). It also follows design strategy principles (Boeijen et al., 2020), which suggest that well-scoped constraints sharpen creativity—not limit it.

NOT INCLUDED / OUT OF SCOPE

- Physical product/tool redesign
- Incremental optimization use cases (e.g., single-task automation)
- Airline-specific SOPs or airline-centric policy interventions

ADJACENT TOPICS (ACKNOWLEDGED BUT PERIPHERAL)

- Policy and regulatory shifts
- Industry standardization and certification bodies
- Crew/passenger UX or digital tools
- Cost, procurement, or operational financing models

APPROACH SUMMARY

This speculative exploration uses each friction as a generative design anchor to provoke "what if…" scenarios. These include ideas such as:

- What if aircraft triggered their own turnaround via real-time IoT signals?
- What if autonomous pods, not ground staff, executed tasks?
- What if gates—not airlines—owned the turnaround process?

These led to the development of multiple reimagined system logics, which were filtered through two key evaluation lenses:

Internal Logic – Does the speculative world function coherently?

Strategic Provocation – Does it open up new forms of relevance for OEMs?

From these, a final set of three speculative archetypes were chosen to act as design provocations during a co-creation session. Each concept is deliberately idealized—implausible enough to challenge, yet structured enough to critique—offering a vision of what a frictionless, reimagined turnaround ecosystem might look like if rebuilt from first principles. By preserving system architecture and redefining internal dynamics, I was able to explore how an actor like Airbus—historically peripheral—could play a central, orchestrating role in future turnaround ecosystems.

The following spreads provide an overview of the ideation journey—from initial speculative triggers to final concept selection. To see the full ideation sketches and filtering from each step please see Appendix C.

4.3 Indications for a Speculative Future

Trend Forecasting - Assumed Technological Baseline in the Speculative Future

This speculative exploration builds upon clearly emerging industry trends and baseline technological assumptions. Specifically, it assumes:

Full Aircraft Electrification & Autonomy: Short-haul aircraft become fully electric/hybrid-electric with autonomous capabilities for ground operations (Maeve Aerospace, 2024; NRG2Fly, 2023; NASA, 2022).

Smart Airport Infrastructure: Airports transition to data-driven environments with IoT integration, predictive management, and operational digital twins (ACI, 2023; Zhang et al,, 2022).

AI-Native Ground Coordination: AI manages predictive modeling for turnaround tasks, optimizing ground operations in real-time (Assaia, 2023; Changi, 2023; McKinsey, 2023, 2024, 2025).

Autonomous Ground Vehicles & Equipment: Autonomous ground handling equipment operates under standardized robotic interfaces (Aviar, 2022; IATA, 2022; SESAR, 2023).

Platformized Logistics: Airports offer dynamic service packages via platforms, removing rigid contract structures (Assaia 2024; McKinsey, 2023, 2024, 2025).

These shifts, substantiated by industry forecasts, form the speculative foundation for exploring new system logics.

Electric aircrafts, autonomous airside vehicles, smart airport infrastructure visuals (NASA, Schiphol Airport, Aviar, Hyundai).

4.4 Turnaround Reimagined

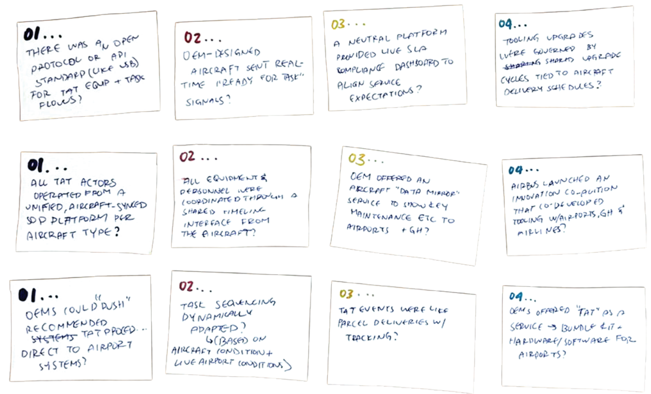
'What if...?' Across Each of the Four Frictions

From each friction identified and elaborated on in the research section, 'What if...?" questions were developed to prompt ideation across the system. Approximately 16-20 questions were developed (4-5 per friction) as seen in the image selection on the right. A subsection of these questions is listed below:

From Sequencing Bottlenecks
- What if all TAT actors operated from a unified, aircraft-synced platform?

From Communication Breakdowns
- What if OEM's offered 'TAT-as-a-service'?

This allowed for concept ideation through systematic friction removal.

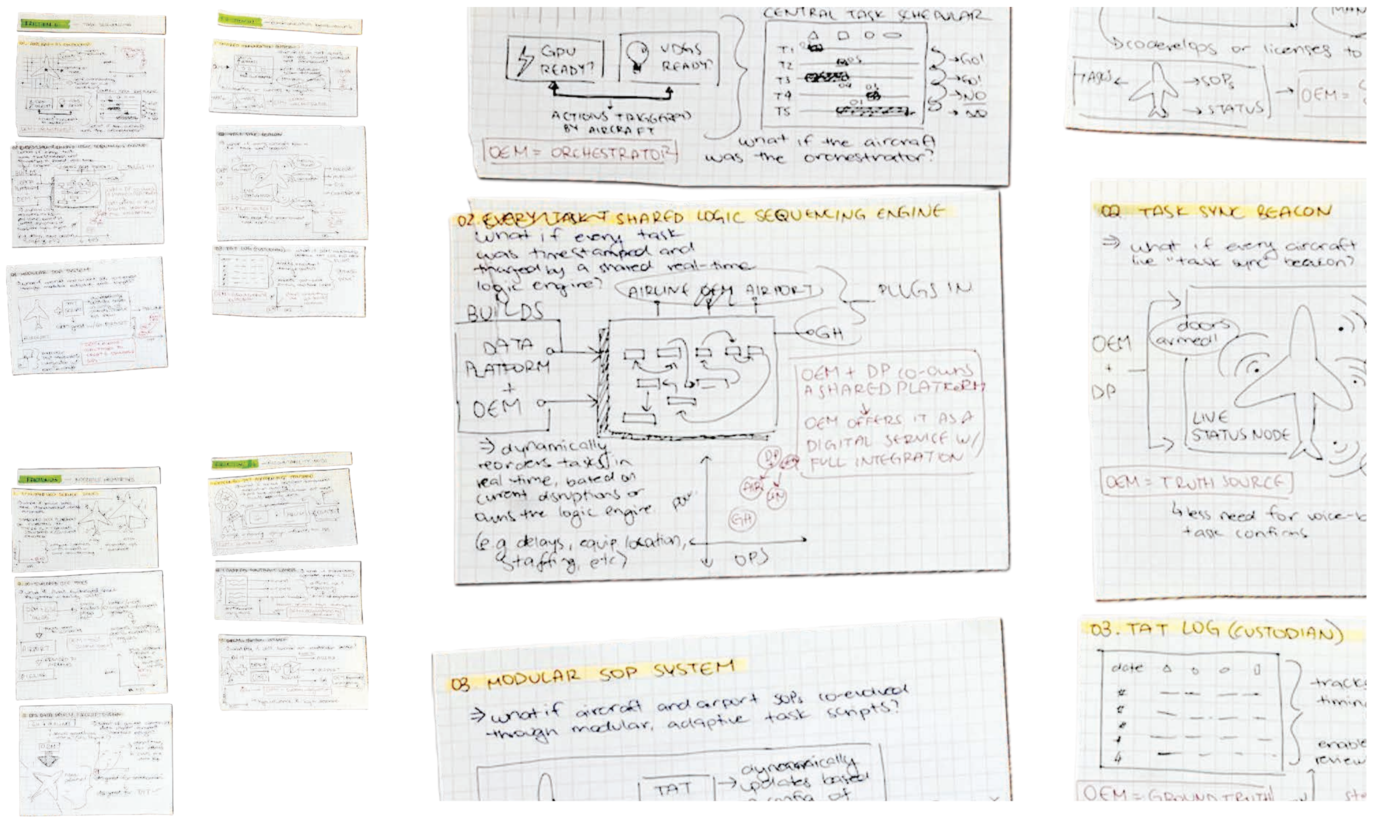


Physical mapping of "What if..." Questions per friction.

IDEATION DERIVED FROM EACH 'WHAT IF...' PROMPT

Each "what if" question triggered diverse, provocative concepts that were then illusrated and expanded upon. They aimed at fundamentally rethinking system interactions. Some examples from my ideation:
- Autonomous gate systems dynamically leasing infrastructure.
- Self-coordinated turnaround equipment networks.
- Unified, real-time operational dashboards managed by the OEM.
- Shared SLA frameworks replacing fragmented contract negotiations.
- Modular SOP kits adaptable to varying airport infrastructures.

This emphasized speculative visions that challenge existing paradigms, questioning core assumptions about actor roles and systemic ownership. At the end of this phase, I was left with around 18 speculative concepts. The image below shares a selection of the ideas illustrated.



Selection of ideation sketches from each "What if..." prompt.

4.5 Theme Clustering

Clustering the Speculative Concepts by Focus Area

To clarify the underlying systemic and technological logic of the speculative concepts, all ideas were clustered into overarching thematic groups. This organization revealed not only where interventions were focused, but also how each group challenged different structural conditions of the current turnaround system.

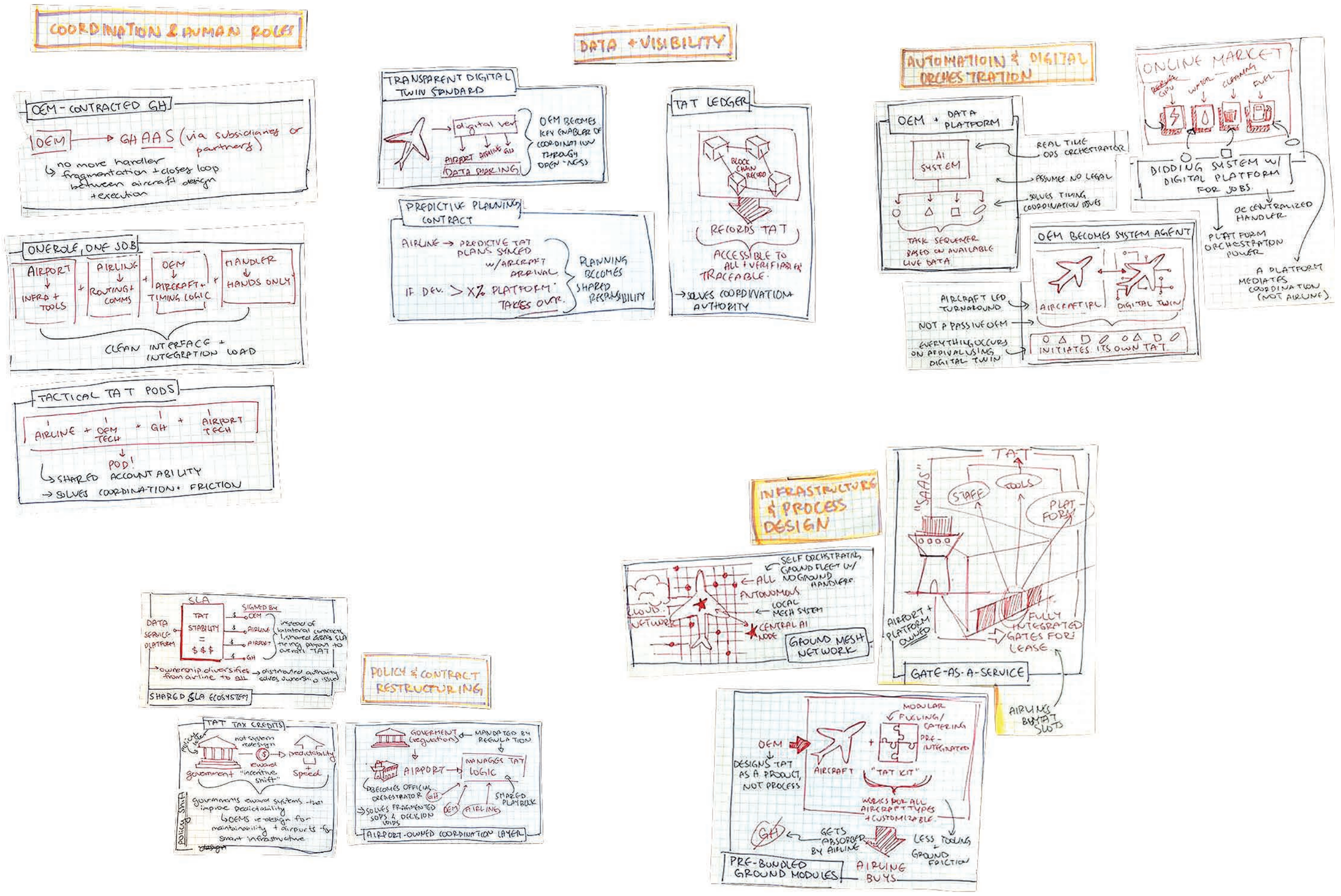
Infrastructure & Process Design explored shifts in the physical and regulatory environment—ranging from modular gate layouts and reconfigurable infrastructure to policy-led levers such as SLA ecosystems, TAT tax credits, and airport-owned coordination roles. Concepts in this group emphasized system-wide enablement through redesigned contracts, governance structures, and asset management.

Data & Visibility examined how improved access to real-time operational data and predictive models could support smarter decision-making. These concepts included digital twins, predictive planning contracts, AI-enabled orchestration tools, transparent data standards, and OEMs acting as live system agents. This cluster focused on building the information backbone required for adaptive turnaround logic.

Coordination & Human Roles centered on rethinking who executes and who orchestrates. Ideas here reimagined OEMs as service orchestrators, airports as central integrators, and turnaround teams as 'tactical pods' combining airline, OEM, airport, and ground handler staff. Many of these concepts redistributed authority and clarified accountability to reduce friction and fragmentation during operations.

Other groups included Policy and Contract Restructuring and Automation & Digital Orchestration.

This thematic clustering process enabled a clearer understanding of how the concepts differ in approach—whether restructuring physical systems, altering contractual levers, or redefining roles and information flow. It also laid the groundwork for selecting, filtering and merging ideas.



Selection of ideas clustered into each theme category.

4.6 Ranking and Filtering

Prioritzation and Assessing Feasibility/Viability Across All Concepts

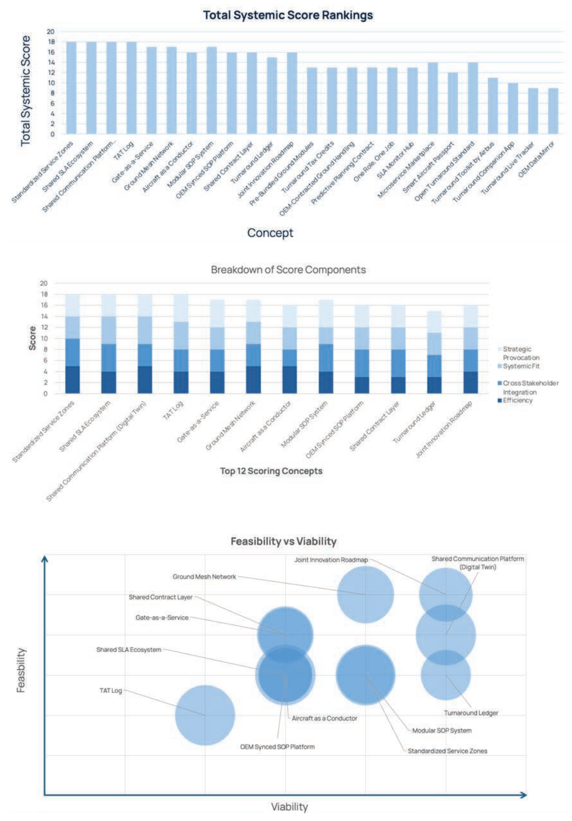
After clustering the ideas into distinct thematic groups, a structured process of ranking and filtering was conducted. This process was designed to clarify which speculative concepts most effectively addressed the systemic frictions identified, and which could coherently integrate into comprehensive new system logics.

SYSTEMIC SCORING

Each concept was initially evaluated based on its potential to address the four systemic frictions, resulting in an aggregated systemic impact score. This helped to quickly visualize the relative impact of each idea and to assign a cut-off score after which I was left with 12 ideas.

FEASIBILITY VS. VIABILITY MAPPING

These 12 ideas were then mapped onto a feasibility vs. viability matrix. This visual tool clarified how realistically each concept could be integrated into existing operational structures (feasibility), and how effectively each would offer strategic value and provoke meaningful industry reflection (viability). Desirability was intentionally excluded at this stage, as it was specifically evaluated during later validation sessions (co-design sessions with stakeholders). This ensured that the initial selection emphasized systemic coherence and strategic provocation, rather than subjective stakeholder preferences, which were addressed separately.



Snapshot of ranking and filtering graphs.

MERGING INTO THREE FINAL CONCEPTS

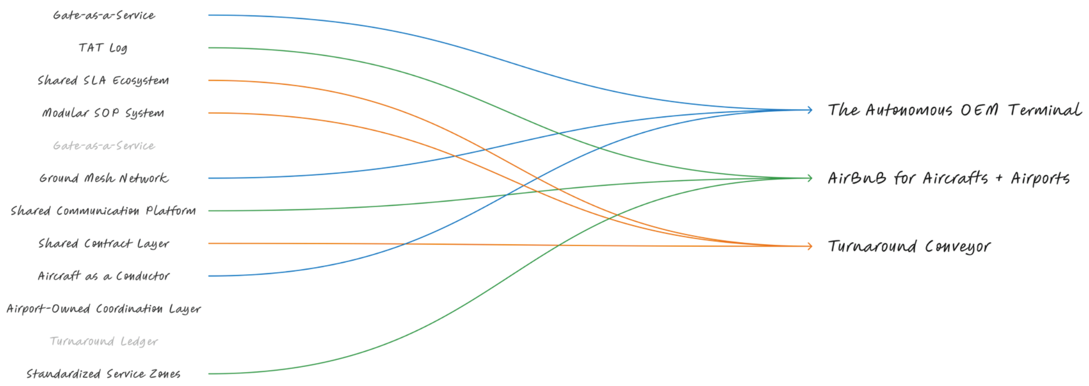
After mapping the top-ranked ideas on the feasibility vs. viability matrix, complementary ideas were strategically merged to form three coherent, provocative, and comprehensive speculative concepts. This merging process aimed to synthesize the strongest aspects of each idea, ensuring each final concept offered a distinct systemic logic and effectively addressed multiple frictions simultaneously. Each final concept is detailed in full on the following spreads.

KEY INSIGHTS FROM THIS PROCESS

Top ideas effectively dissolved multiple frictions simultaneously.

No single friction overly dominated selected ideas, ensuring balanced solutions.

Ideas selected showed both speculative novelty and internal consistency.



Sankey diagram visualizing combination of the top ranked ideas into the three final concepts.

4.7 The Three Final Concepts

The following spreads share an overview of the three final concepts. Each concept represents a distinct future logic for turnaround coordination, reframing roles and power dynamics across stakeholders.

Concept 01: The Autonomous OEM Terminal

In this first concept, the aircraft becomes a smart, self-managing node in an autonomous terminal loop. Airlines become UX/service layer brands. OEM controls aircraft and all service hardware + staff. Airport is passive infra + traffic control.

WHY IT'S REALISTIC

- OEMs already define turnaround-critical manuals, procedures, and aircraft-side requirements.
- They own deep IP on task dependencies, aircraft interfaces, and digital twin modeling.
- With growing investment in predictive maintenance, embedded AI, and autonomy, this is a natural extension.

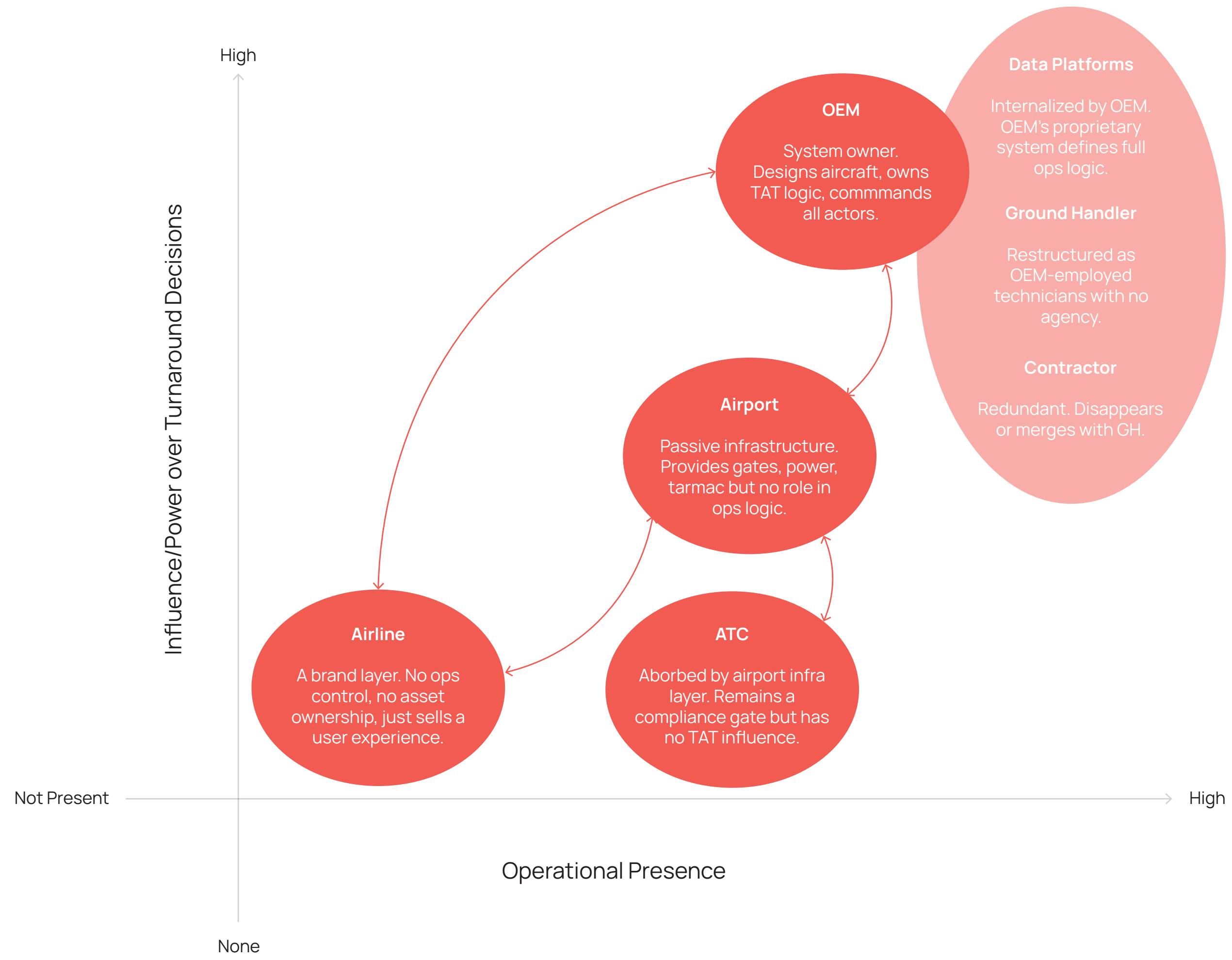
FRICTIONS TACKLED

Task Sequencing – OEM defines execution logic

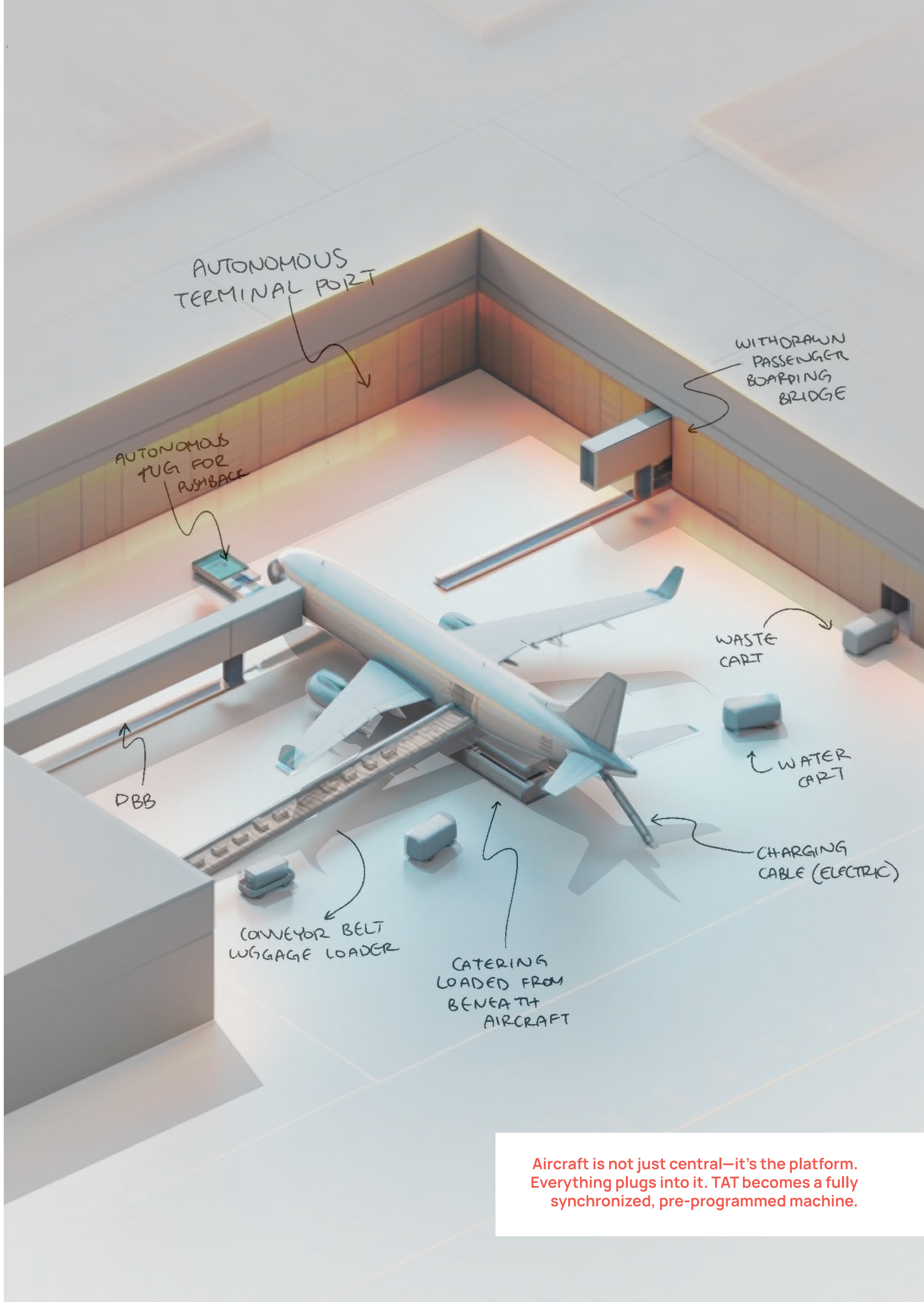
Interface Mismatches – Aircraft designed for full plug-and-play ops

Communication Breakdowns – Internalized logic replaces actor coordination

Power and Decision Influence Map for Turnaround Operations



The stakeholder map above shows an indication of what the new power balance could look like in comparison to the stakeholder map presented in the previous chapter. The key change here is the new positioning of the OEM in the top right, rather than in the bottom left off the map entirely as in the crurent system. Secondly, Data platforms, ground handling and contractor all get absorbed by the OEM as the OEM's role expands from being solely a product owner.



Aircraft is not just central—it's the platform. Everything plugs into it. TAT becomes a fully synchronized, pre-programmed machine.

Concept 02: AirBnB for Aircrafts + Airports

Marketplaces replace planning. OEMs list aircraft. Airports list gates-as-a-service and turnaround packages. Airlines act like Uber: they coordinate passenger flow and stitch services together.

WHY IT'S REALISTIC

- OEMs are the only actors who fully understand the aircraft's operational constraints, power needs, access protocols.
- They can offer APIs or data prodcuts that define aircraft readiness, standardize gate compatibility, and verify turnaround packages.
- They are not operators, but they enable reliable interoperability between aircraft and infrastructure.

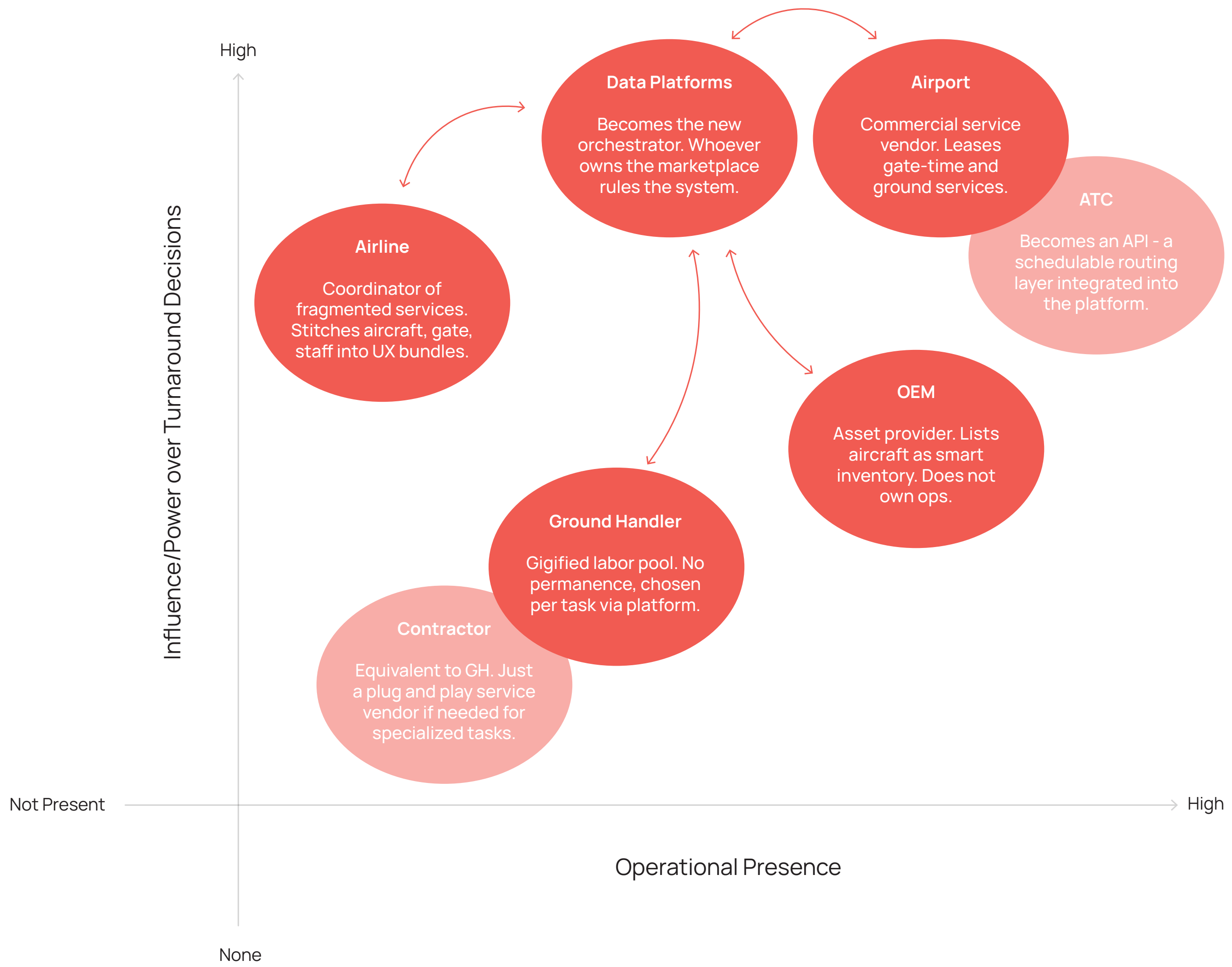
FRICTIONS TACKLED

Accountability Voids – By certifying readiness, OEM plays a role in shared assurance

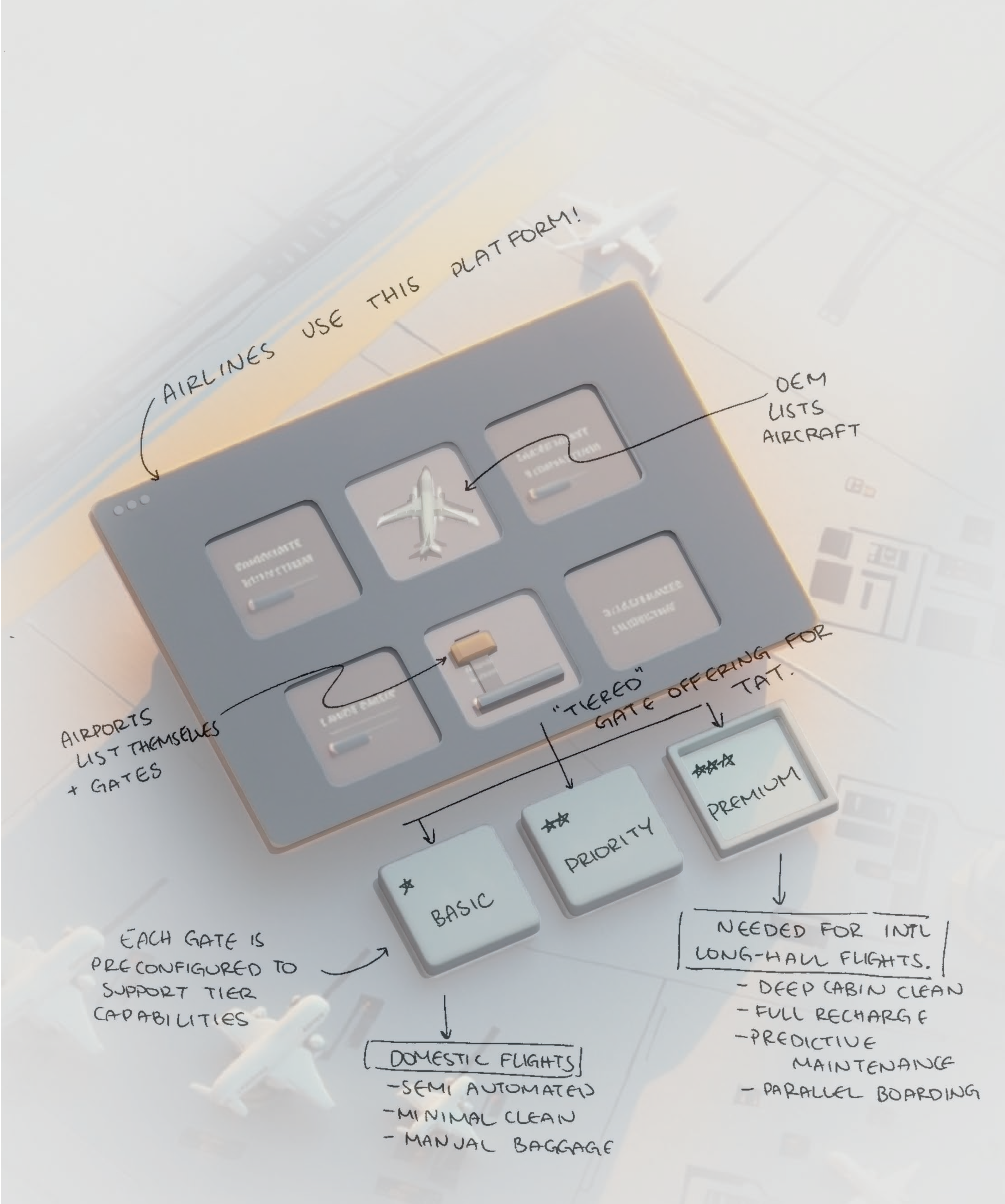
Interface Mismatches – OEM certifies airport/aircraft compatibility

Communication Breakdowns – OEM provides a common interface standard

Power and Decision Influence Map for Turnaround Operations



The key changes on this stakeholder map is the centralization of the Data Platform. Rather than having an Airline or Airport (who are key in today's ecosystem) run operations, power is handed over to a new player: the Data Platform. ATC gets absorbed by the Airport as there is no need for it to be a seperated entity, and Contractors get absorbed into Ground Handler as complexity of ground operations decreases.



Data platforms and marketplaces rule. Airlines survive by curating. You book a plane like an Airbnb + cleaning service. Everything becomes tiered, rated, and liquid.

Concept 03: Turnaround Conveyor

Turnaround is a linear flow. Airport has multiple TAT "lanes" like a car wash or baggage carousel - it becomes a factory. Aircraft itself is modular and as it moves through each module: deboarding, waste, fueling, boarding, parts are swapped out.

WHY IT'S REALISTIC

- OEMs have led modular cabin and maintenance architecture R&D (e.g. swappable modules, standardized service ports).
- They can define the physical and digital interfaces for each process unit (fueling, cleaning, boarding).
- They do not operate the system but design the aircraft to plug into a linear, choreographed ground flow.

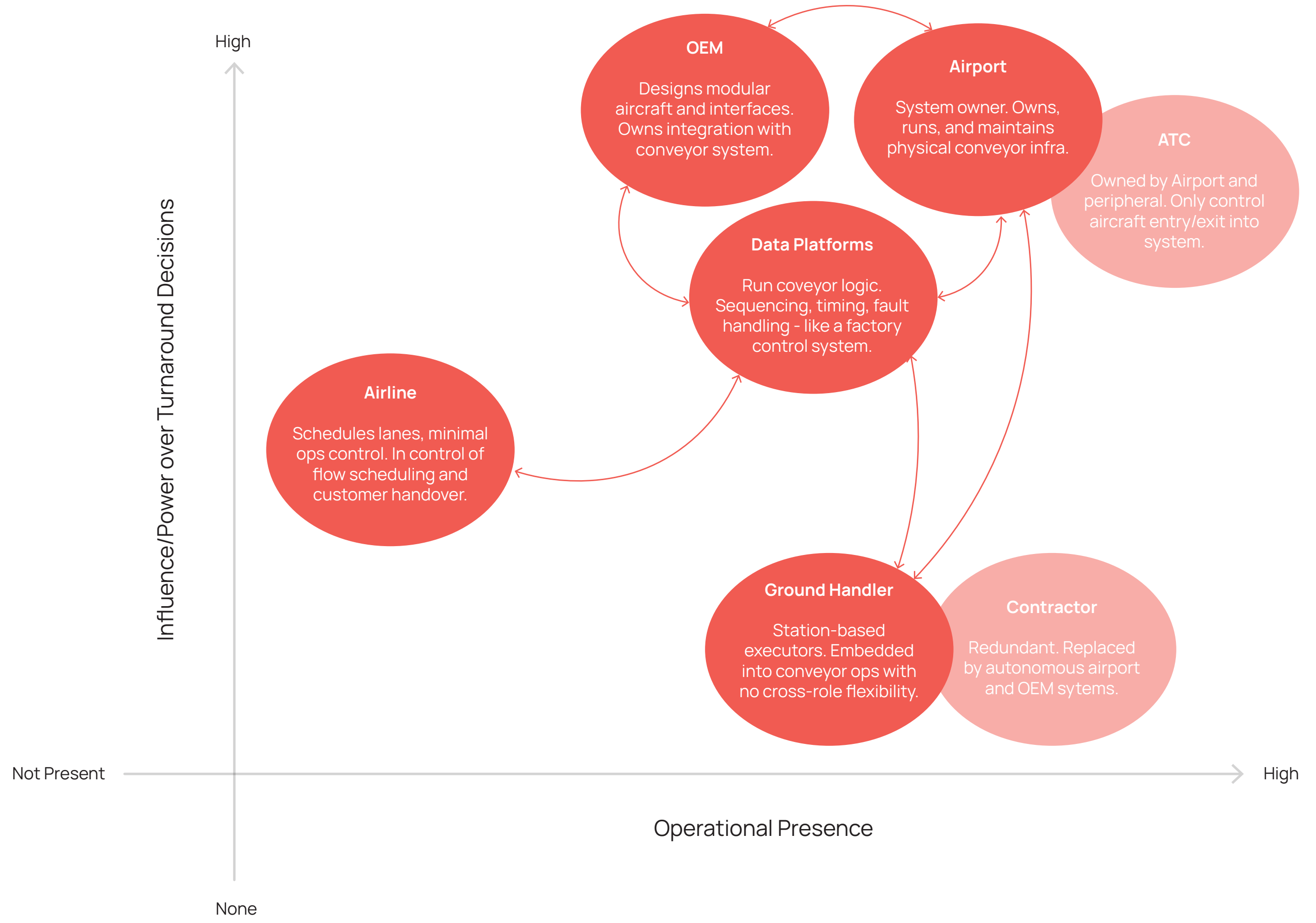
FRICTIONS TACKLED

Sequencing Bottlenecks – OEM embeds sequence logic into design

Interface Mismatches – Aircraft standardized for modular service plug-ins

Communication Breakdowns – OEM-defined interfaces reduce coordination needs

Power and Decision Influence Map for Turnaround Operations



The key changes in this stakeholder map is the new 'power circle'. Previously, the 'execution chain' was owned by the Airline and in collaboration with Ground Handlers and Contractors. In this concept, the execution chain owner is shifted to the Airport while the Data Platform schedules and the Ground Handler (plus Contractor) merely carries out the orders. The OEM role is to now not only design the aircraft, but also to own interface connections with airport infrastructure.

05

Iteration & Validation

5.1 Co-Design for Concept Validation

Co-design setup to test provocation, plausibility, and resonance across stakeholder perspectives.

To validate and test my three final speculative concepts, I held an online co-design session. This session brought together experts across aviation in various stakeholder roles (KLM, Oslo Airport, a VR training startup, and a product designer) to evaluate the speculative concepts. A design student was also included as one of the participants to help facilitate the conversation. Participants were encouraged to respond freely—ranking concepts, identifying what felt provocative, and proposing their own system visions. The session aimed to reveal hidden assumptions, challenge stakeholder boundaries, and stress-test speculative futures.

PURPOSE

To pressure-test speculative concepts through a structured yet open creative session, helping bridge conceptual provocation with stakeholder reality.

SETUP

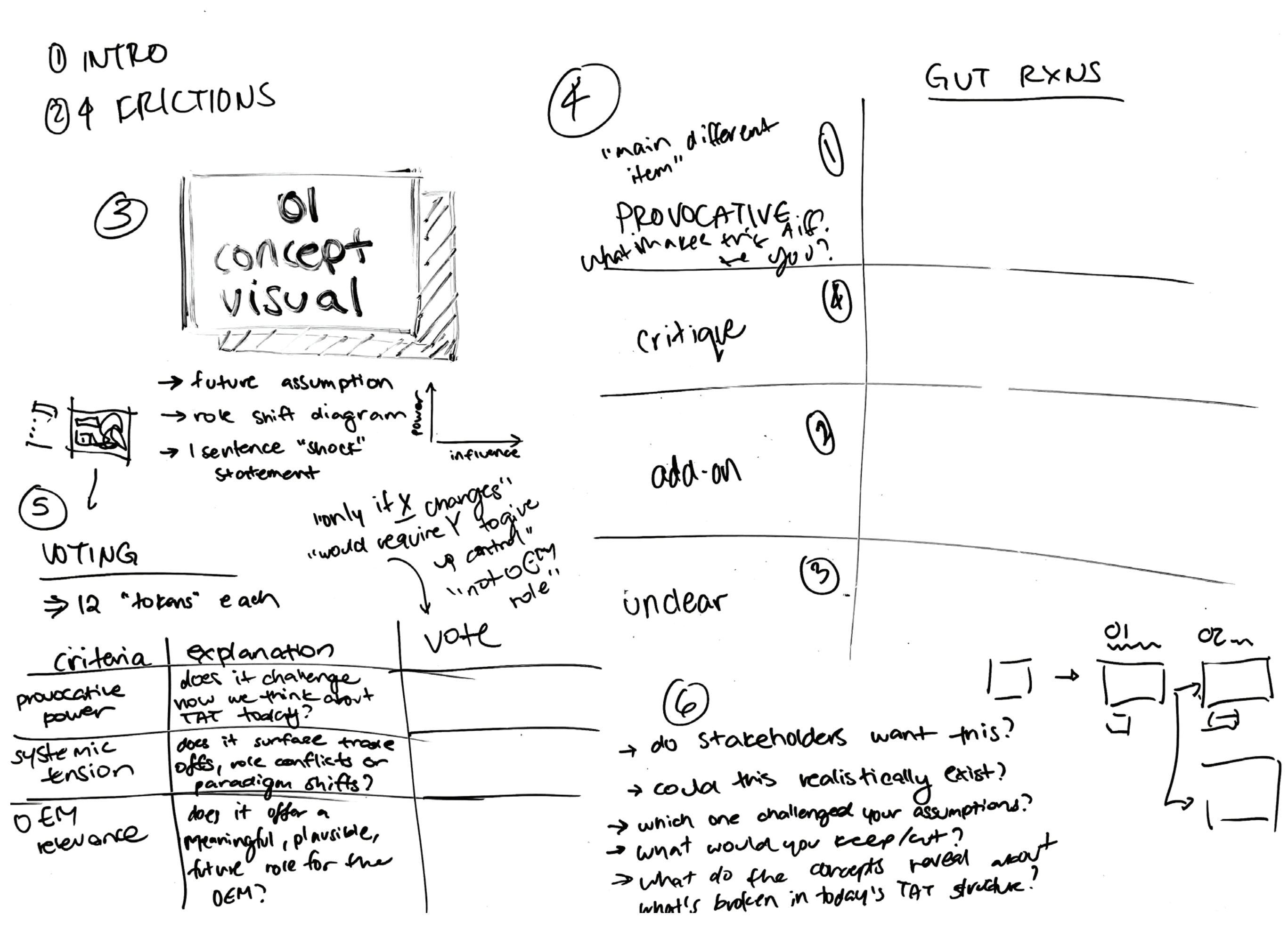
- Conducted online using Figma
- 4 participants from different stakeholder branches
- 90 minutes total
- Participants didn't know each other (designed for fresh, unbiased reactions)

SESSION FLOW

1. Introductions
2. Background & friction summary
3. Presentation of 3 speculative concepts
4. "Gut reaction" annotations
5. Pair ideation: how would you redesign turnaround?
6. Group voting & critique
7. Open discussion on tensions, surprises, and priorities

PARTICIPANT INFORMATION

Name	Stakeholder	Company & Role	Theme Raised
Marina	Airport	Head of Terminal Operations at an International Airport in Europe with 20+ years of experience in aviation.	Passenger experience, ownership of terminal operations, importance of OTP
Bastiaan	Airline	Former ground operations leader at legacy airline, now pricing manager. Background in industrial design.	Responsibility in turnaround, bridge connections, passenger experience
Gavin (same expert that was interviewed during the research phase)	Data Platform	CEO and co-founder of a startup in aviation industry using AR/VR for training.	Automation, human error reduction, safety and ownership
Sven	Designer/ Passenger	Strategic designer, visualizer and co-faciltator of the session.	UX perspective, stakeholder presence shifts, creative synthesis of speculative concepts



Ideation of co-design setup drawn on a whiteboard.

The following spread compares each concept and identifies what each step in the session uncovered about participants feelings on each speculative concept. →

5.2 Comparing the Concepts

What Stuck, What Stalled, What Evolved

After presentation of research and the three specualtive concepts, participants were encouraged to write down their immediate 'gut reactions'. This was to help them get ideas flowing, understand their initial shock and subconscious mental blocks and to make sure they fully understood the concepts themselves. Each concept provoked strong reactions—but not always in the way intended. That said, the concept or aspects of concepts that were too realistic or not speculative enough, also received the most caution.

CONCEPT RECEPTION COMPARISON

	What Worked	What didn't Work	Changes Needed
Autonomous OEM Terminal	Strong provocation. Sparked debate on future ownership and accountability.	Seen as unrealistic: "OEM's core business is selling aircraft" (Gavin). Accountability in failure was vague. Too removed from today's roles.	OEM takes full ownership—many said this crosses a line.
Airbnb for Aircrafts & Airports	Reframed value flows and stakeholder roles. Seen as "super provocative" (Bastiaan), "completely redefines relationship dynamics" (Sven).	Removed airline too drastically, causing discomfort: "Passengers book directly… is branding needed?" (Marina). Safety of passenegers and who takes liability was a key concern.	Airlines lose centrality. OEM as platform operator felt like a stretch.
Turnaround Conveyor	Lean framing clicked: "Good LEAN concept… investigate if it gives higher throughput" (Gavin & Marina). Clear system upgrade logic.	Some unclear mechanics: "Processes not done at same time—is it really more efficient?" (Bastiaan). Concerns about UX + human roles.	Airport becomes operator of flow. OEM is system logic integrator, not controller.

The above chart summarizes the feedback received on each concept including what worked, what didn't work and changes the participants felt were needed.

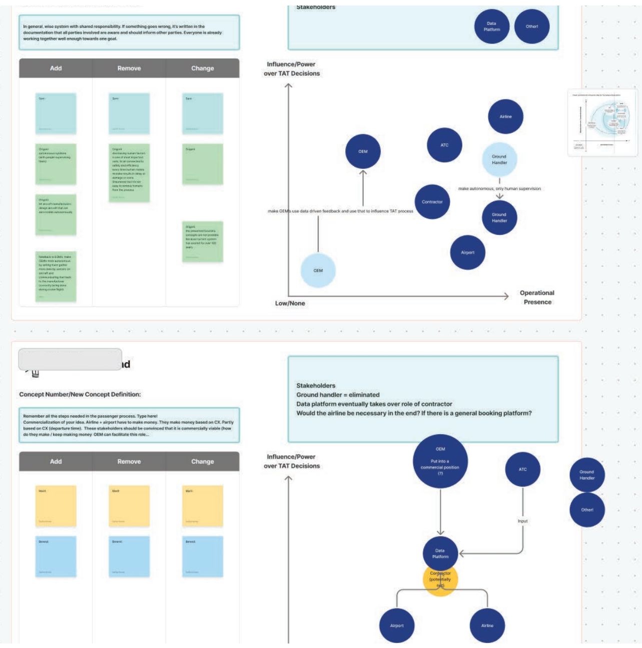
EMERGENT DESIGN CRITERIA

Following discussion of the 'Gut Rxn' section of the co-design, participants were given time to redesign turnaround themselves in pairs. They were encouraged to start with one of the three concepts I presented and build upon it or change it or to start anew. Each pair was given 'moveable' stakeholder pieces and a template of the Influence and Power Decision map so they could build their own model. Participants consistently focused on:

Shared Responsibility
System logic should reflect collaborative ownership, especially in failure modes.

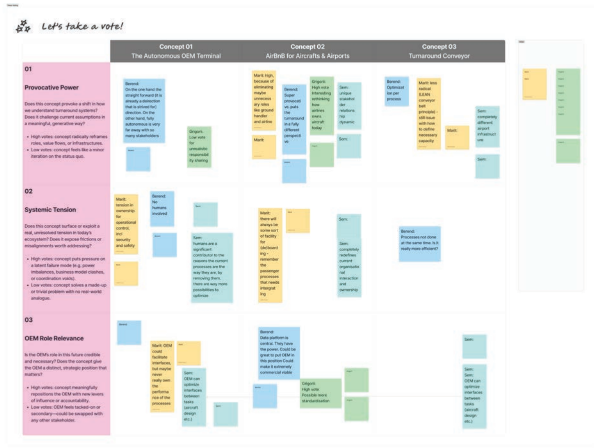
OEM Design Role, Not Control
"Make OEMs more autonomous by letting them gather data" (Gavin) — not by giving them ops ownership.

Commercial Viability
Airline and airport business models must remain intact and monetizable (Marina).



Redesign boards showing stakeholder shifts, new concept definitions, and key changes.

After initial presentation of the three concepts, the participants were presented with a scoreboard that allowed them to rank the concepts across their provocative power, systemic tensions (does it expose real-world tension in today's ecosystem), and OEM relevance. Participants didn't just vote for what was most feasible—they voted based on what provoked important tensions or opened space for new thinking.



Voting wasn't fully consistent—participants used fewer than their allotted 12 dots. Still, general preferences and skepticism are visible in how they clustered.

VOTING PATTERNS

Turnaround Conveyor received most votes overall — it felt grounded and pragmatic.
→ Voters appreciated optimization potential and could imagine lean improvements without radical system disruption.

Airbnb for Aircrafts & Airports had high provocation scores, but polarized reactions.
→ Some saw a brilliant rethink; others questioned feasibility, ownership, and passenger experience.

Autonomous OEM Terminal had the least votes and the most resistance.
→ Seen as too centralized, unrealistic on ownership, and unclear in failure scenarios.

STAKEHOLDER DESIGN PREFERENCES

Finally, following the pair ideation and final voting, there was an open discussion on the session itself. This was to understand what surprised the participants, what felt relevant to their own work, and from a design perspectie, which concepts were most relevant and why. The key takeaways are below.

01

→ Stakeholders were most comfortable with concepts that proposed clear improvements without collapsing current power structures.

02

→ OEMs were widely trusted to optimize interfaces, but not to replace or own operations.

03

→ Removing airlines, as in Airbnb model, raised identity, safety, and responsibility concerns.

04

→ Fully autonomous systems (Concept 1) were seen as directionally valid, but currently unviable.

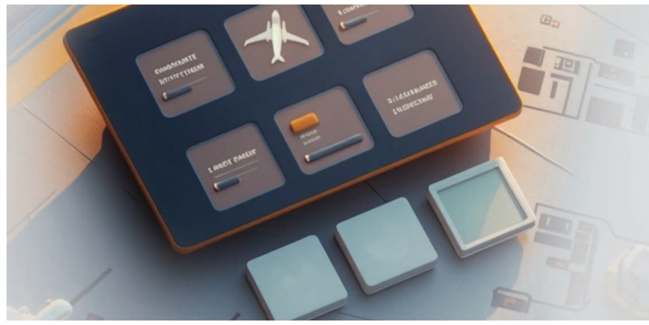
The following spread unpacks how each concept evolved based on this critique and how it gave rise to the archetypes that follow. →

5.3 Why Concepts Became Archetypes

How critique abstracted speculative concepts into generalized turnaround models.

Stakeholder feedback didn't just challenge whether each concept would work—it surfaced deeper tensions around ownership, coordination, and accountability. These reactions revealed where the original logics broke down, and which parts might still be useful if reframed. Rather than refining the concepts as solutions, I stepped back and abstracted them into four archetypes. These are not improved versions, but more general models that reflect the boundaries stakeholders were already negotiating. Each archetype simplifies the concept into a structure that others in the industry may already recognize—whether consciously or not.

This shift from concept to pattern helped clarify the space Airbus might credibly act within. It also showed where stakeholders saw room for new roles, and where they remained cautious. The next spreads trace how each concept was reshaped into their corresponding archetype.

Original Concept	Why it Couldn't Stay a Concept	What the Archetype Now Represents	Resulting Archetype
AUTONOMOUS OEM TERMINAL 	**"OEMs build planes. Making them process owners seems far from reality." – Gavin** Too centralized. The concept assumed OEMs would own not just aircraft logic, but full operational control—including staff and infrastructure. This broke stakeholder expectations around liability and crisis ownership.	A closed-loop turnaround model where the OEM designs and owns the orchestration logic but not operational execution. Others plug into the system, retaining fallback control.	**OEM Orchestrated Terminal**
AIRBNB FOR AIRCRAFTS + AIRPORTS 	**"If the airport owns infra and OEM provides aircraft, the airline has no skin in the game." – Marina** Removed too many anchors—airline as brand, safety owner, and continuity layer. Stakeholders questioned who's accountable if roles like airline or ground handler disappear. Platform logic alone didn't resolve responsibility.	A marketplace-based turnaround system where services are dynamically matched. OEM certifies standards and APIs, but does not orchestrate. Airlines remain essential to user continuity.	**Platform Mediated Turnaround**
TURNAROUND CONVEYOR 	**"Good LEAN concept, just-in-time delivery… capacity bottleneck then becomes the lanes. That should be investigated if it delivers a higher and more reliable throughput." – Gavin & Marina** LEAN metaphor made sense, but literal movement logic fell apart. Aircraft don't move through stations, and the idea raised concerns about flexibility and irregular ops. Optimization logic needed a more grounded system.	A modular aircraft and turnaround model with standardized service lanes. Ground handling becomes plug-and-play, but decision-making remains human-led and distributed.	**Modular Flow Model**

5.4 Archetype Profiles

Clear definitions of each turnaround archetype: their definition, logic, and OEM roles.

Status Quo

The Status Quo is a sequential, human-led model where SOPs guide turnaround through siloed actor roles and minimal real-time coordination. Each stakeholder operates independently with limited cross-actor integration, and systemic predictability is maintained through rigid task ownership. This model reflects the current aviation norm.

OEM ROLE

Equipment provider + manual standard setter.

FRICTION ADDRESSED

Minimal. Minor gains in coordination or predictability.

OEM Orchestrated Terminal

The OEM-Orchestrated Terminal is a centralized, closed-loop model where the OEM embeds pre-coordinated turnaround logic across all services. Execution remains with the airport, but stakeholders plug into the OEM's orchestration system, enabling synchronized flow and reducing coordination risk.

EMERGENCE

Formed in response to frustration with coordination breakdowns and stakeholder fragmentation. While stakeholders rejected full OEM control, they saw value in OEM-led orchestration logic—if operational authority remained visible.

OEM ROLE

Logic layer provider for pre-coordinated, automated turnaround operations. Avoids operational ownership, but enables seamless system behavior.

FRICTION ADDRESSED

Sequencing bottlenecks, coordination breakdowns, interface mismatches.

Platform Mediated Turnaound

Platform-Mediated Turnaround is a distributed model where turnaround services are dynamically matched via shared digital platforms. OEMs provide readiness standards and infrastructure APIs, while airlines retain responsibility for UX, passengers and operational control. This improves interoperability without collapsing traditional accountability chains.

EMERGENCE

This is a responde to critiques of complexity and siloing. Stakeholders were open to OEMs enabling interoperability—but resistant to OEMs owning the platform or passenger experience without defining safety or liabiliy ownership.

OEM ROLE

Neutral infrastructure enabler and readiness certifier—supporting dynamic resource allocation without controlling it.

FRICTION ADDRESSED

Communication breakdowns, accountability voids.

Modular Flow Model

The Modular Flow Model is a distributed, human-executed system where modular aircraft flow through standardized task "lanes." Ground handling becomes plug-and-play, with interfaces and sequencing logic defined by the OEM but executed by independent teams.

EMERGENCE

Evolved from critique of bottlenecks in rigid task sequences. Stakeholders were excited by modularity, provided it didn't remove on-the-ground flexibility or clarity in roles.

OEM ROLE

Developer of modular aircraft interface standards and lean turnaround task kits that enable fast, flexible execution.

FRICTION ADDRESSED

Interface mismatches, sequencing bottlenecks.

Each archetype blends a definition (what the system is) with operational logic (how it works). These reframed models were grounded in stakeholder critique, not just concept refinement. To better compare them, I mapped the four archetypes against two systemic tensions (discussed on the following spreads) —revealing a design space of future turnaround models. →

5.5 What Stakeholder Reactions Revealed

Themes that arose from stakeholder insights.

In addition to a comparitive analysis of each concept and their development into archetypes, stakeholder feedback revealed repeated points of concern. These concerns were not directly related to the concepts themselves, but with what they implied. Rather than resolving each concern in isolation, I stepped back to analyze recurring patterns. The repeated concerns led to six themes that captured consistent stakeholder discomforts. Each highlighted where expectations, roles, or assumptions broke down. The chart below summarizes these findings, the themes they surfaced and what it signaled.

Theme	Quote	What is Signaled
Ownership	"If something goes wrong, who owns the risk?" —Gavin	Stakeholders want flexibility, but still demand clear lines of accountability and fallback control.
OEM Boundaries	"I wouldn't see an OEM as an owner...OEM's core business is selling aircrafts." — Gavin	OEMs are trusted with tools, data, and design—but not with full ops control. There was discomfort with the idea of OEMs expanding into operational domains
Modularity	"Think about regular and disturbed ops.. how do you get back to a normal situation?" — Marina	Physical modularity is viable, but must adapt to irregularities and real ops. Linear designs must adapt to irregular, real-world conditions.
Provocation	"It's still valid, that sort of thought was provocative for me. Not to just say, OK. Let's cancel all the airlines or ground handling... That won't work, but the thought behind it - that was nice for me." — Marina	Speculative thinking sparked real tension and strategic questions.
Siloing	"Even after just two years in the field, you get stuck in your own line of thinking." — Bastiaan	Industry actors often lack cross-disciplinary conversations, limiting systemic innovation. Stakeholders struggled to comment on roles beyond their domain
Safety & Responsibility	"In case of disturbances or crisis situations — who then manages a safe and secure ecosystem?" — Marina	Even in speculative futures, safety and clear responsibility chains remain non-negotiable.

5.6 Themes to Systemic Tensions

The two debates that shape future turnaround models.

Although the six themes emerged from separate stakeholder comments, they repeatedly circled around two core dilemmas. Grouped this way, the themes converged into two systemic tensions that cut across every discussion. These two tensions didn't just reveal concerns with specific concepts—they surfaced deeper fault lines around how turnaround models are owned and executed.

1. Who owns turnaround performance—and who is held accountable when things go wrong?

Ownership → directly raises accountability gaps.

OEM Boundaries → concern over giving control to OEMs who aren't traditionally responsible.

Safety & Responsibility → highlights the critical need for clear crisis ownership.

These revealed a systemic uncertainty about who is "in charge" in future models an d how responsibility is distributed (or avoided).

2. Who drives coordination—and how much agency do stakeholders have to adapt?

Modularity → challenged rigid task sequencing and raised questions around system adaptability.

Siloing → showed how people struggle to think across disciplines, which automation demands.

Provocation → highlighted emotional resistance to radical shifts, like removing the airline.

These reflected concern over losing human judgment or operational control and highlights whether control is rigid or adaptable.

FRAMEWORK FORMULATION

Together, the two tensions presented above, form a strategic lens for identifying both misalignments and future opportunities and form the foundation of the Turnaround Futures Framework. The Turnaround Futures Framework visualizes four possible logics for how aircraft turnaround could be structured in the future. It positions emerging system models based on two tensions:

Ownership – who holds accountability when performance fails?

Execution – who actually drives and adapts the turnaround actions on the ground?

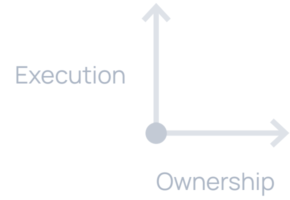
Each quadrant reflects a distinct worldview. Some are closer to today's status quo, while others signal provocative shifts in power and agency. The matrix does not prescribe a solution—it maps the strategic terrain Airbus must navigate. The following spread (6.7) layers the final four archetypes into this matrix, clarifying how stakeholder roles, power dynamics, and execution models could evolve—and where new OEM influence may be possible.

Turnaround Futures Framework

5.7 Layering the Turnaround Archetypes

A strategic framing of emerging logics, stakeholder roles, and OEM opportunity

As mentioned previously, to move from conceptual provocation to strategic clarity, I mapped the four final turnaround archetypes onto the Turnaround Futures Framework. This step was critical for translating speculative ideas into structured system logics that stakeholders could recognize—and negotiate. By positioning each archetype according to how ownership and execution are distributed, the matrix reveals the systemic implications of each future. It clarifies how stakeholder roles shift, how control is exerted or shared, and where new forms of OEM influence could emerge. This exercise didn't just visualize options; it surfaced trade-offs, tensions, and potential alliances embedded in each model. It helped identify not only where Airbus might intervene, but what type of systemic change each model would actually require. These placements serve to clarify contrasting system logics, but in reality, archetypes may exist on a spectrum—overlapping, evolving, or combining traits across the matrix.



Dynamic

OEM Orchestrated Terminal

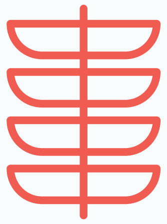
Centralized + Dynamic

The OEM takes a central role by embedding orchestrated logic across services, but allows for real-time, flexible execution by connected stakeholders. This shifts control upstream while retaining centralized model definition, enabling dynamic coordination within a closed-loop system.

Modular Flow Model

Distributed + Dynamic

This archetype decentralizes both execution and ownership, allowing modular aircraft and plug-and-play ground handling to adapt dynamically. Stakeholders independently manage tasks in real-time using flexible kits and interfaces, resulting in highly distributed and adaptive operations.

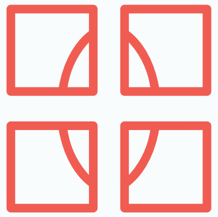


Centralized

Distributed

Status Quo

Centralized + Defined

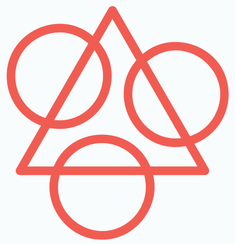


This model reflects the current state of turnaround, where SOPs and task logic are centrally set by airlines or airports, and execution follows rigid, scripted flows. Stakeholders operate in silos with limited adaptability, maintaining control through defined ownership and predictable coordination.

Platform Mediated Turnaround

Distributed + Defined

Turnaround services are allocated via distributed platforms, giving stakeholders autonomy in task execution while following predefined coordination standards. Ownership is distributed, but execution remains relatively structured through shared APIs and readiness protocols.



Defined

5.8 Implications for Airbus

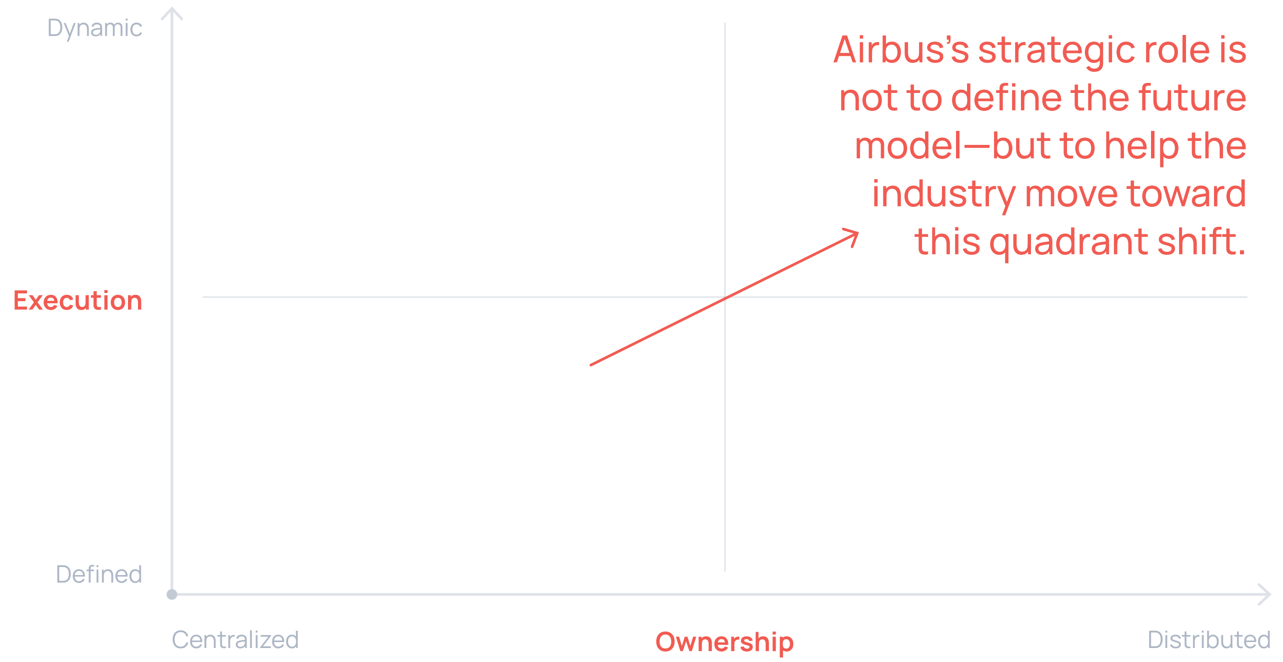
Enabling the strategic shift from centralized to distributed turnaround systems.

While each archetype could point to a distinct mode of intervention, one insight holds across all: **Airbus's long-term influence does not depend on controlling operations—it depends on enabling coordination.**

The Turnaround Futures Framework reveals that the aviation ecosystem today remains anchored in the bottom-left quadrant: centralized and defined. Coordination is rigid, SOPs dominate, and adaptability is limited. The four systemic frictions identified in this thesis—task sequencing, interface mismatches, communication breakdowns, and accountability voids—cannot be solved by optimizing within this structure. They require a strategic shift toward more distributed, dynamic system models.

This shift doesn't require Airbus to take operational control. Instead, it calls for Airbus to act as a system enabler; clarifying interfaces, setting coordination logic, and building stakeholder alignment.

Turnaround Futures Framework



WHAT STAKEHOLDERS WANT FROM AIRBUS IN THE FUTURE SYSTEM

Co-design and interview feedback revealed three consistent expectations that shaped how speculative futures were received—and what roles were considered acceptable for Airbus to play in enabling system change:

→ OEMs are trusted to define logic and enable interoperability—
...but they should not operate or control turnaround tasks. Stakeholders welcomed Airbus's ability to design coordination layers, readiness standards, and modular features. But they rejected the idea of Airbus owning day-of operations, citing safety, liability, and a misalignment with Airbus's core identity.

→ Responsibility must remain clear—especially in disruption or safety-critical moments.
Even in forward-looking futures, stakeholders demanded that ownership of failure scenarios, delays, or crises stay legible. Concepts that removed or blurred traditional actors (like airlines or ATC) received strong pushback—even if technically sound.

→ Systemic innovation is welcome—when it supports (not collapses) familiar roles.
Participants were open to breaking system logic, as long as new models were intentionally defined and did not discard critical operational actors. Coordination upgrades and interface improvements were embraced; removal of known roles or radical decentralization was not.

These expectations form the boundary conditions for credible OEM involvement—and they set the stage for Chapter 7, which outlines four strategic levers Airbus can activate to help the industry move toward more distributed and dynamic turnaround systems.

06

Recommen-dations

6.1 Repositioning Airbus Through Systemic Leverage

From Operations Outsider to Ecosystem Enabler

The previous chapter clarified that Airbus's role is not to define the future model, but to help the turnaround system transition—from today's centralized and defined operations to more distributed and dynamic coordination. This shift cannot be achieved through optimization alone. It demands a new type of intervention: not control, but systemic enablement.

Airbus is uniquely positioned to guide this transition as a designer of coordination infrastructure. It already shapes the systems (aircraft, interfaces, tools) that turnaround depends on. The Turnaround Futures Framework introduced earlier can now serve as a strategic tool, helping Airbus identify credible points of influence without overstepping stakeholder boundaries.

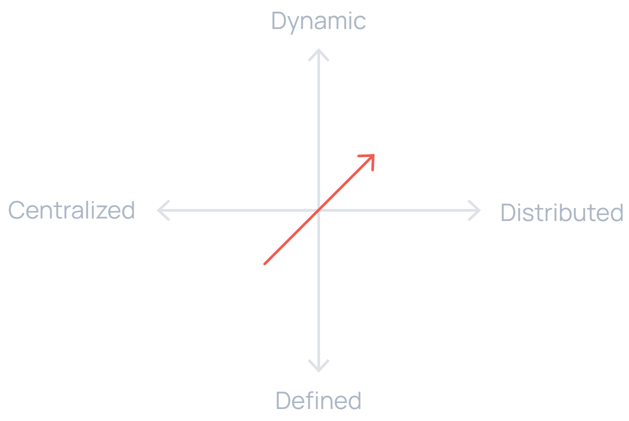
As outlined at the end of the previous chapter, stakeholders have shown support for Airbus acting as a neutral enabler of logic, interfaces, and readiness—so long as operational ownership remains clear. These preferences define two categories of strategic leverage, introduced in this chapter.

THE TURNAROUND FUTURES FRAMEWORK AS A TOOL

The Turnaround Futures Framework is more than a classification of archetypes. It acts as a roadmap for role design, helping Airbus identify where influence is both needed and acceptable. It distinguishes between who executes turnaround tasks and who owns coordination—and makes clear that these can be decoupled.

Airbus can use the framework to:
→ Position system-level roles without owning operations
→ Clarify what structural shifts (e.g., modularity, logic coordination, readiness) are needed
→ Sequence its interventions to avoid misalignment with stakeholder responsibilities

The recommendations in this chapter each activate a different strategic lever but are all grounded in the quadrant logic of the framework. They are not isolated actions, but tools to support a systemic shift in how turnaround is coordinated.



6.2 Airbus's Strategic Levers for Enabling Industry Transition

System-level roles Airbus can activate to move the turnaround ecosystem forward

Earlier phases of this thesis surfaced a broader set of potential strategic levers Airbus could activate—including interface standardization, SLA realignment, predictive analytics, and stakeholder consortia. Each addressed a systemic friction identified through literature and expert interviews.

However, by applying the Turnaround Futures as a filter—

(1) systemic leverage across the framework,
(2) feasibility with Airbus's existing assets, and
(3) strategic viability as a design-led orchestrator—

alongside co-design feedback, two entry points emerged as both high-impact and realistically actionable.

Full scores and discarded options are documented in Appendix D.

THE TWO STRATEGIC LEVERS

Strategic Lever	Transition	Airbus's Role
Design for Interoperability	Defined → Dynamic	Embed coordination logic into aircraft data layers to support any platform—not control them.
Decentralize Ground Readiness	Centralized → Distributed	Enable modular readiness assessment, training, and tooling without prescribing workflows

These levers are Airbus's clearest entry points to enable movement across the Turnaround Futures Framework—from today's rigid baseline toward a more distributed, collaborative future.

Design for Interoperability tackles fragmented coordination logic by embedding common standards into aircraft systems.

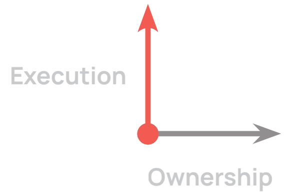
Decentralize Ground Readiness addresses the execution gap by enabling stakeholders to align with Airbus logic without Airbus owning turnaround.

Together, they allow Airbus to reposition itself—not by centralizing control, but by creating the conditions for distributed alignment.

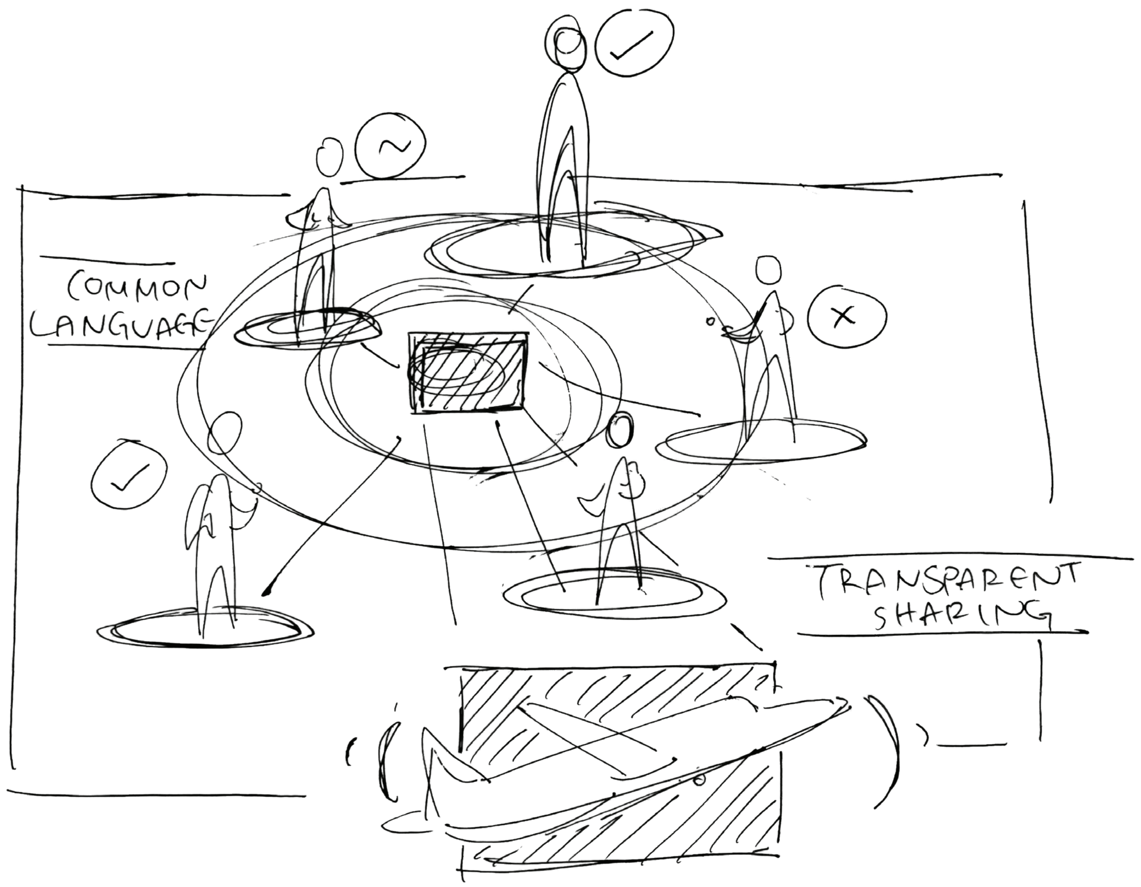
The next sections unpack each lever in depth—starting with the underlying system problem, followed by three specific Airbus interventions designed to activate that lever in practice. →

6.3 Design for Interoperability

Enable flexible coordination by embedding interoperability into aircraft design and data systems.



Supports the transition from: Defined → Dynamic



WHAT'S BREAKING

Turnaround stakeholders operate in silos. Aircraft and GSE aren't speaking the same data language, leading to timeline mismatches, duplicate inputs, and underutilized predictive capabilities.

STRATEGIC LEVER

Instead of building another end-to-end platform, Airbus enables a common logic layer (coordination API, interoperability maps, live spec templates) that these tools can plug into. This layer acts like a "universal translator" between stakeholders, not a dashboard replacement.

WHY STAKEHOLDERS WOULD SUPPORT IT

→ Airlines and airports can keep their existing systems (avoiding vendor lock-in) while aligning timelines, roles, and specs.
→ Platform providers (Assaia, INFORM, etc.) benefit from Airbus's domain authority and access to aircraft data.

RECOMMENDATIONS

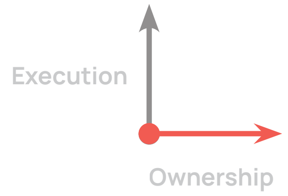
R1. Partner instead of build
Collaborate with existing players (e.g., Assaia, INFORM, ADB Safegate) to define a shared coordination API that syncs turnaround timelines and aircraft readiness data.

R2. Publish open spec libraries
Create and publish open-source turnaround specification templates that define process logic, interfaces, and role responsibilities. These serve as foundational design assets for consistent system understanding.

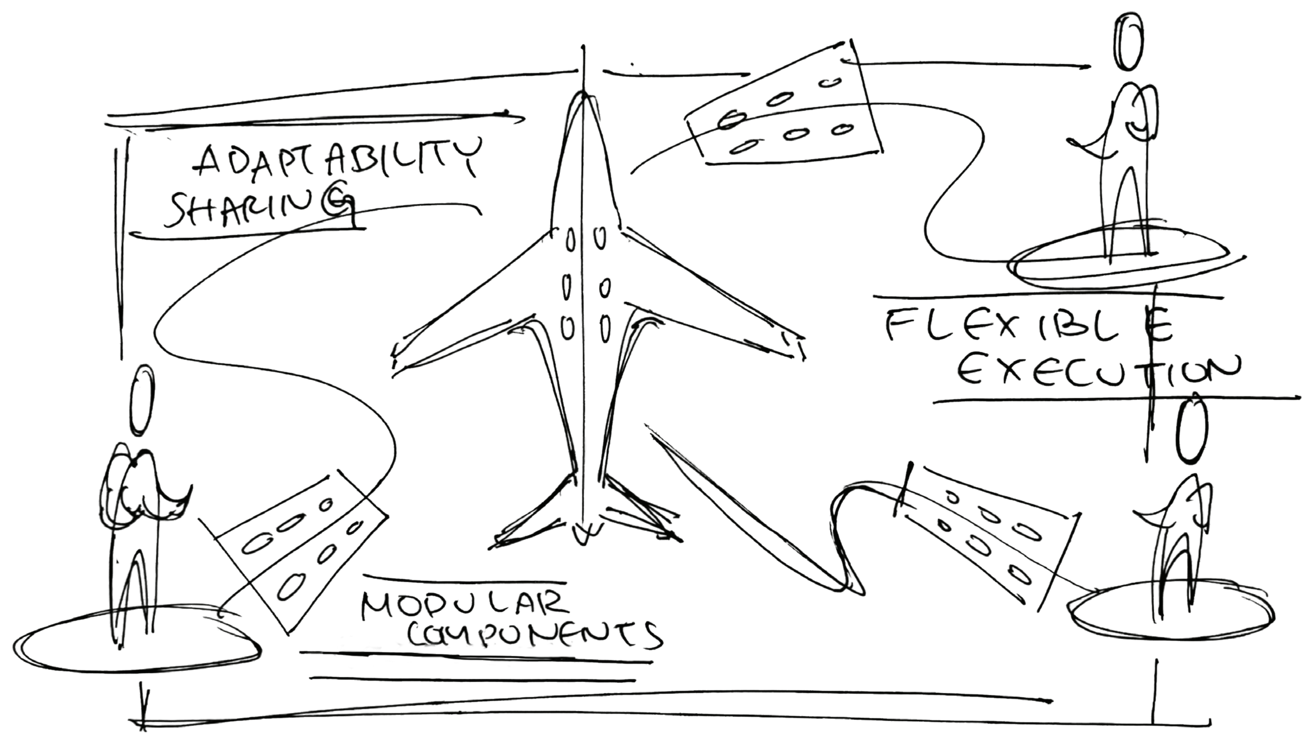
R3. Enable passive integration
Let airlines/airports use their own tools while receiving validated Airbus aircraft coordination logic via plug-in APIs—not new dashboards.

6.4 Decentralize Ground Readiness*

Shift execution capability to airports and handlers through modular readiness standards and open knowledge flows.



Supports the transition from: Centralized → Distributed



WHAT'S BREAKING

Airbus can verify that hardware is at TRL 9, but has **no consistent view of whether gates, GSE and crews are at Ground Readiness Level (GRL) 0-4 for that aircraft. PDFs replace active knowledge transfer. Innovative ground tech (automated baggage handling, automated pushback tugs, etc.) advances without Airbus input or compatibility assurance.

STRATEGIC LEVER

Airbus convenes and co-develops an aircraft-ground readiness certification framework: a way for GSE providers, airports, and training teams to self-assess alignment with each aircraft type across data, tools, clearance zones, and remote ops readiness.

WHY STAKEHOLDERS WOULD SUPPORT IT

→ Ground teams and tech startups gain visibility and standardization.
→ Airlines and airports reduce time-to-service risk.
→ Airbus gains insight into on-ground realities without dictating the solution.

RECOMMENDATIONS

R4. Co-develop a readiness framework (GRL)
Work with IATA, MRO providers, GSE vendors (e.g., Aviar, Mototok), and airlines to create modular spec checklists covering data access, plug compatibility, and remote ops capability.

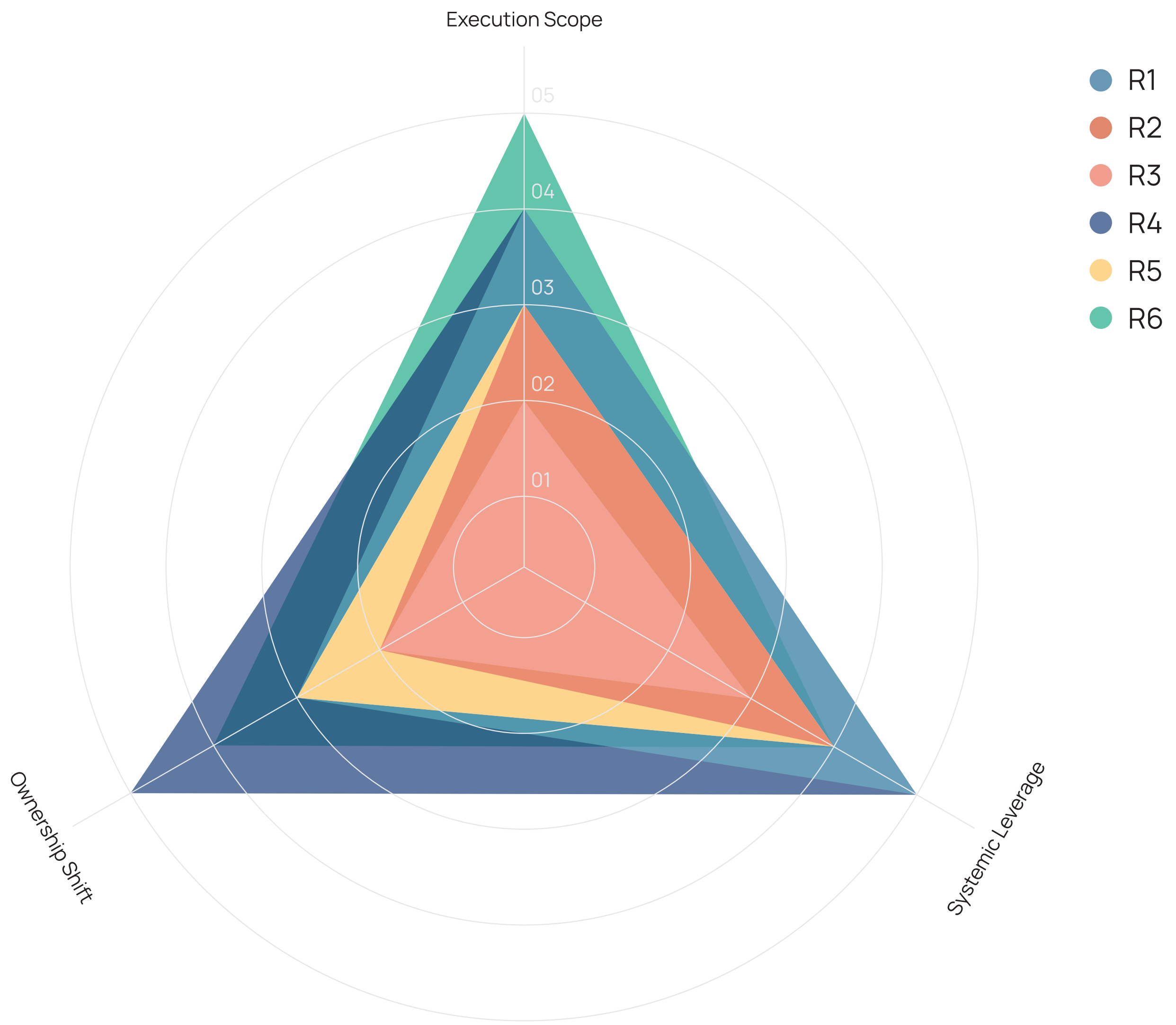
R5. Launch a shared training portal
Digitize and consolidate Airbus's aircraft turnaround guidance—currently scattered across PDFs—into a role-aligned training database that supports GSE vendors, airports, and MROs. Unlike the spec libraries (R2), this portal is tailored for operational readiness.

R6. Integrate MRO + ground team feedback loops
Embed GSE and trainer feedback into the aircraft validation cycle—shifting from one-way documentation to ongoing alignment.

*Ground Readiness Level (GRL) = the combined technical and operational maturity of an aircraft–GSE pairing across five dimensions (Tech, Data, Training, Regulatory, Safety).
**GRL intentionally extends NASA's TRL (tech), DoD's MRL (manufacturing) and EASA's CRL (certification) by adding field-operations and data-integration readiness.

6.5 Recommendations Radar Spider Map

Mapping each recommendation across execution impact, ownership shift, and long-term system leverage.



EXECUTION SCOPE

How much the recommendation changes real-time or near-real-time coordination on the stand. All six moves are meant to unclog the stand or the entry-into-service process, so they naturally score well on "Execution Scope."

SYSTEMIC LEVERAGE

How much it unlocks broader, longer-term ecosystem benefits (adaptability, data network effects, cost structure). Systemic leverage is intentional. Each recommendation is mapped to a quadrant shift in the Turnaround Futures Framework, anchoring them in long-term ecosystem change.

OWNERSHIP SHIFT

Degree to which decision-making or accountability moves away from the airline toward a shared or local actor. Ownership is the limiting axis. Airlines still sign SLAs, airports own the gate, and regulators own safety. An OEM can nudge those boundaries, but not seize them—so even bold moves (R1, R4, R6) top out at 4/5 on that axis.

RANKING SUMMARY

1. Top systemic bets: R1 and R4 score highest overall; they re-wire the logic layer (R1) or the readiness level (R4) without demanding new hardware.

2. High-impact but heavier change: R6 ranks highest on execution scope and nearly as high on leverage, but requires the biggest cultural/process shift.

3. Solid enablers: R2 and R5 lift data quality and human capability; moderate scores across all axes.

4. Foundational basis: R3 is essential for friction-free integration but delivers value mostly when the others are already in motion.

6.6 Partnership Landscape

Identifying strategic partners shaping the future of turnaround execution.

The two levers proposed in this chapter—Design for Interoperability and Decentralize Ground Readiness—are not initiatives Airbus can implement alone. Every recommendation within them relies on existing industry momentum across digital tooling, ground equipment, and training ecosystems. As discussed previously, rather than duplicating these efforts, Airbus can amplify its impact by partnering with the actors already shaping operational practices on the ground.

This spread highlights key players operating within five high-relevance domains. These partners are not simply suppliers—they represent active nodes of innovation that Airbus can connect to its aircraft data, readiness logic, and system architecture. Mapping this landscape offers a starting point of potential collaborators for Airbus to implement the six recommendations.

Future partners are not limited to this landscape.

Domain	Key Players	What they do	Why Airbus should care
Predictive Turnaround	Assaia, Inform, Folio3 AI, Deep Turnaround, Veovo, Wipro/TARMAC.ai, IBS Software (iFlight), AirportLabs	Video AI + timeline prediction	All already feed real-time gate & milestone data to multiple hubs; their APIs could slot directly into an Airbus logic-layer.
Remote/ Autonomous Pushback	Mototok, Schopf, Goldhofer Phoenix, Kalmar Motor, TLD Jet Tug, Aurrigo Autonomous Tug, Douglas/Textron GSE	Electric, remote-controlled tugs	Affects turnaround time, requires aircraft interface alignment. These firms supply the bulk of electric or tele-operated tugs now on order at FRA, JFK, SIN. Airbus interface specs will have to align with their coupler geometries and data buses.
Ground Training & Readiness	Aeroimpulse, Lufthansa LEOS, Aviar, IATA Training, CAE, ICAO TRAINAIR, NATA Safety 1st, Nsflow, ScopeAR, CAE XR, Augmented Knowledge	Training and SOP design. Hands-free AR overlays, step-by-step work cards, remote expert support.	Helps Airbus shift from PDF to interactive format. Any "readiness-certification" scheme will be dead on arrival unless it plugs into the bodies that already license ramp staff worldwide. Embeds Airbus logic layer & readiness tags directly into ramp workflows; reduces errors, preserves tacit know-how, fast onboarding.
GSE Coordination	Mallaghan, INFORM GroundStar, Damarel FiNDnet, Veovo Resource Manager, SITA Airport Management	Realtime GSE dispatch + readiness	Early alignment prevents tarmac conflict/ miscoordination. These suites already dispatch GSE and staff in >200 airports; partnering avoids building another dashboard from scratch.
Digital SLAs/Data Contracts	Ink Innovation, Honeywell, SkyThread for Airlines (blockchain SLAs), SITA eWAS Contracts, FLYR Fusion (AI contract analytics)	Convert PDF SLAs into machine-readable smart contracts; expose them via APIs with real-time compliance tracking and AI analytics	Digitised SLAs are the quickest proof-point for an open-spec library: live contracts that sync aircraft data, readiness states, and stakeholder roles in real time. Partnering with a specialist here lets Airbus pilot role-aligned templates and show immediate value beyond Honeywell dashboards.

6.7 Strategic Levers Roadmap

This 36-month roadmap translates the two strategic levers introduced in 6.3 (Design for Interoperability) and 6.4 (Decentralize Ground Readiness) into an executable sequence of actions. It starts with the partnership landscape by suggesting how to move key actors from "potential collaborators" to partners. By phasing the work (Foundations → Tooling + Specification → Validation & Scaling) the plan balances feasibility with the long-term viability and desirability goals laid out in the recommendation radar (6.5). The backbone of the schedule is the new GRL system—drafted in Phase 01, piloted and published in Phase 02, and standardised in Phase 03. GRL extends the Turnaround Futures logic with a five-dimension score (tech, data, training, regulatory, safety) that gives every aircraft-GSE pairing a common yard-stick for "system readiness." As detailed in 3.8, every minute of turnaround saved adds direct margin and aftermarket opportunity for Airbus; sequencing the roadmap this way therefore ties each recommendation to demonstrable financial upside.

Recommended start date is January 2026—use the remainder of 2025 for executive alignment and partner coalition setup (e.g., SESAME: Schiphol, ATL, Delta, KLM).

07

Discussion

7.1 Validation Through Industry Engagement

The thesis was presented at Aviation Innovation Day 2025 in Songdo, South Korea, where the Turnaround Futures Framework prompted discussions with a wide range of stakeholders—airport innovation teams, digital twin providers, MRO engineers, researchers, and ground operations startups. While the individual recommendations were not formally shared, many of the challenges they address surfaced organically in both formal sessions and side conversations.

A recurring pain point was the lack of usable technical documentation in MRO workflows. Multiple participants, especially those working on digital twin solutions, emphasized how difficult it remains to access machine-readable data from OEMs. One startup described the frustration of having to manually extract specs from 400+ page PDFs just to simulate basic ground operations. For them, the issue wasn't a lack of tooling, but a lack of structured access to the underlying data needed to drive those tools. These observations echoed the rationale behind some of my recommendations—especially those that argue for more open logic layers, shared access points, and API-driven collaboration.

Another thread that came up repeatedly was the gap between who owns responsibility and who actually executes on the apron. Several airport representatives explained how they are operationally accountable for turnaround performance but have no formal authority over airline-contracted ground staff. This structural mismatch mirrored the thesis's framing of "ownership vs. execution" as a systemic friction. It was reaffirming to hear how often this tension plays out in daily operations—often leaving the responsible party without the tools or authority to make improvements.

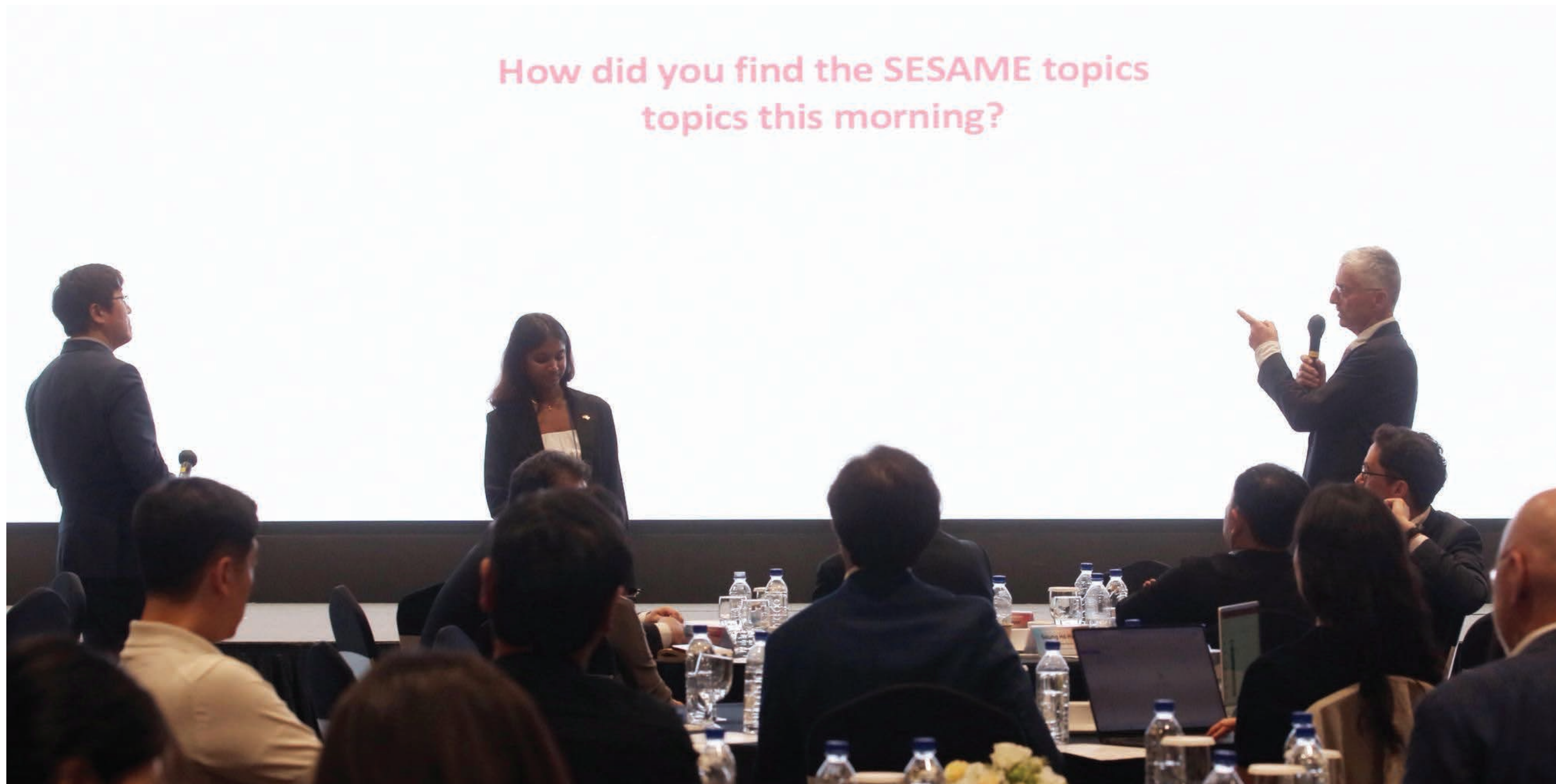
This was further illustrated by a TU Delft professor, who offered a familiar in-flight example: If a flight attendant refuses to serve coffee during descent, they may face a service complaint. If they comply and something goes wrong, they may be personally liable. It's a simple, relatable scenario that reflects a deeper design flaw in many aviation systems—where accountability doesn't always map to decision rights.

Many conversations also touched on inertia in the system. There's growing recognition that paper-based SOPs and fragmented platforms are no longer sustainable, especially as automation and predictive systems become more common. Yet speakers also acknowledged how difficult it is to change these practices given entrenched habits, regulatory constraints, and fragmented data ownership. For this reason, more incremental moves—like passive integration and shared tooling—seemed to resonate as plausible starting points, even if not discussed explicitly through the lens of the thesis.

Throughout the day, what stood out was not the novelty of the thesis's ideas, but their resonance. Most participants weren't unfamiliar with the issues—but appreciated the structured lens through which those issues were framed. The quadrant-based Turnaround Futures Framework seemed to offer a vocabulary for tensions they already felt but hadn't articulated in system terms.

In summary, the discussions in Songdo reaffirmed several underlying insights:

- Systemic misalignments are widely felt. Stakeholders across domains shared stories of mismatched authority, fragmented data, and outdated SOPs.
- Airbus has space to lead as a logic provider. Participants saw potential for a role focused on orchestration and information flow, rather than ownership or operations.
- Data access is a core constraint. Lack of structured, machine-readable spec data limits progress in areas like training, simulation, and autonomous coordination.
- Incremental change may be the most viable entry point. Low-friction moves that work within today's contracting and operational models were seen as both realistic and desirable.
- Framing matters. The quadrant and futures archetypes didn't provide answers, but helped surface patterns and tensions in a shared language that enabled cross-stakeholder discussion.



7.2 Positioning Within Literature

While much of the existing turnaround literature focuses on optimizing isolated operational tasks—such as gate allocation, fueling delays, or baggage sequencing (Schultz et al., 2012)—this thesis adopts a systemic lens rooted in complexity theory and organizational misalignment. It builds on strands from dynamic stability theory, actor-network theory, and collaborative decision-making literature to uncover deeper structural tensions driving turnaround inefficiencies.

DYNAMIC STABILITY AND STRUCTURAL RIGIDITY

Dynamic stability theory challenges the notion that aviation systems should be optimized for static efficiency. Instead, it posits that these systems must adapt fluidly under disruption (Kim et al., 2022). In their DRS paper, Kim et al. argue for a shift from idealized planning models to responsive coordination frameworks—emphasizing the importance of resilient structures over deterministic control . This thesis builds on that logic by identifying rigid SOPs and centralized orchestration as core limitations. Turnaround processes are shown to require adaptive interfaces and shared ownership models to remain functional under stress—particularly in cases of delay propagation or stakeholder conflict.

SOCIOTECHNICAL RESISTANCE AND ACTOR MISALIGNMENT

Gómez-Beldarrain et al. (2025) and related literature on automation in complex organizations show that even technically sound solutions (e.g., automated task allocation or digital monitoring) often fail due to institutional inertia and unclear accountability chains . In airport contexts, these challenges manifest as invisible dependencies—where catering, pushback, and GPU providers execute critical tasks without integration into formal command structures. This reinforces the need to shift from narrow optimization to systemic design—aligning roles, responsibilities, and authority across stakeholder boundaries.

DATA OWNERSHIP AND A-CDM LIMITATIONS

Research on A-CDM reveals that even advanced coordination platforms break down when data access and authority are not aligned. EUROCONTROL's 2016 A-CDM Impact Assessment highlights frequent mismatches between information visibility and decision rights—particularly when multiple parties (airlines, handlers, ATC) share infrastructure but operate under fragmented mandates . This thesis echoes that pattern in showing how shared apron environments exacerbate ownership voids, particularly during off-nominal events.

MRO AS A PARALLEL CASE

Maintenance, Repair, and Overhaul (MRO) operations face similar systemic ambiguities. Chandola et al. (2022) identify how regulatory fragmentation, unclear task ownership, and dependence on third-party providers reduce overall MRO productivity. This directly parallels turnaround dynamics, where OEM-issued protocols must be interpreted and enacted by outsourced staff, leading to gaps between standardization and real-world execution.

ATC, AIRLINE, AND AIRPORT BUSINESS MODEL TENSIONS

ATC presents comparable coordination challenges. EUROCONTROL (2018) identifies how capacity issues are intensified by fragmented responsibilities across Air Navigation Service Providers (ANSPs), airlines, and airports. Execution authority often resides with ATC, while planning and resource allocation fall to airport or airline stakeholders. This structural separation of control and accountability creates vulnerabilities during disruption scenarios, echoing the ownership-execution tension outlined in this thesis. Similarly, as EUROCONTROL (2018) notes, airports are increasingly expected to manage delay performance and overall service quality, despite limited authority over operational partners such as ground handlers or catering providers—most of whom are contracted directly by airlines. This disconnect reinforces the systemic friction where performance accountability is not matched with operational control, complicating both routine coordination and crisis management.

INDUSTRY PARALLELS AND CONTRIBUTION

While this thesis is grounded in the operational realities of aviation turnaround, the systemic tensions it exposes—particularly around authority, adaptability, and role clarity—are not unique to this domain. After presenting this work at the 2025 AI and Aviation Innovation Symposium in Korea, a participant pointed out its resonance with Norbert Wiener's cybernetic theory, which frames systems as governed not by rigid hierarchies but by feedback and adaptive control (Wiener, 1948). From this lens, the thesis does not propose a new theory, but rather applies existing systemic principles to the traditionally conservative and operationally rigid domain of aviation. The novelty lies in reframing turnaround as a living system—one that should be structured to respond to variability, not constrained by fixed definitions and siloed authority.

7.3 Limitations & Future Work

This project aimed to reframe turnaround as a systemic challenge and to identify where Airbus, as an OEM, might enable industry-level coordination. While it generated a strategic framework and forward-looking recommendations, several limitations shaped the outcomes:

ABSTRACT NATURE OF THE OUTPUTS

The Turnaround Futures Framework and strategic levers are deliberately high-level and conceptual. While they clarify where systemic intervention is needed, they stop short of implementation guidance. This is both a strength and a limitation. By avoiding prescriptive solutions, the work retains flexibility across stakeholder contexts—but it also requires further translation to be operationally actionable.

LIMITED OPERATIONAL ACCESS

The project was conducted without direct access to live turnaround environments or proprietary operational data. Interviews and validation sessions provided critical grounding, but the absence of on-site observational research limited the ability to verify assumptions or capture tacit routines. As a result, the findings are framed as hypotheses for industry dialogue, not definitive truths.

RELIANCE ON EXPERT-LED PERSPECTIVES

User testing and co-creation were limited to industry experts and stakeholders already engaged with innovation. Perspectives from frontline turnaround workers—those most affected by the frictions explored—are underrepresented. Future work should prioritize deeper engagement with these actors to validate desirability and practicality.

SPECULATIVE ELEMENTS AND VALIDATION SCOPE

The speculative concepts and framework directions were tested through a co-design session and further discussed at an international aviation forum. While these interactions confirmed relevance and resonance, they remain qualitative. The project would benefit from deeper validation across more operationally diverse contexts.

TRANSFERABILITY OF THE FRAMEWORK

Though the framework was received positively across adjacent sectors like MRO and training, its transferability remains untested. Claims of relevance beyond aircraft turnaround are based on thematic resonance rather than field application.

LIMITED TIME AND ITERATION

As a master thesis project, the timeline constrained the depth of iteration and scope of inquiry. Several trade-offs were made to maintain conceptual clarity. The thesis prioritized mapping systemic patterns and framing strategic roles over detailing process ownership handoffs, data infrastructure implications, or governance mechanisms for implementation. Similarly, the speculative directions were tested through one co-design session and high-level industry discussion, but not subjected to iterative cycles of challenge, revision, and revalidation. Trade-offs were also made in the decision to focus on aircraft turnaround as a core case, leaving other promising contexts like ATC, MRO, towing, or training unexplored despite emerging relevance. A longer or more embedded project could have unpacked how the proposed levers would play out within specific business models, contract structures, or OEM–airport–airline interfaces.

FUTURE WORK

Future research should translate the Turnaround Futures Framework into more concrete implementation strategies. This includes mapping how each lever would interact with contractual arrangements, data-sharing protocols, and certification bodies. A broader validation across regions, airline models, and operational scales (e.g., low-cost carriers vs. legacy hubs) would test its generalizability. There is also potential to explore the framework's applicability in similarily fragmented domains. Eiter industry adjacent—like MRO, UAM operations, or digital twin-enabled maintenance; or new domains such as port logistics, rail-hub operations, hospital patient flow where similar coordination frictions and accountability gaps persist. Finally, future work could experiment with scenario planning or simulation to test how proposed shifts in execution and ownership might unfold in real operational timelines.

08

Conclusion

8.1 Final Conclusion

This thesis began with a core question: What are the critical factors causing systemic instabilities in aircraft turnarounds, and how can aircraft manufacturers mitigate these through a new systemic design approach? In response, the project mapped four systemic frictions—sequencing bottlenecks, communication breakdowns, interface mismatches, and accountability voids—across the aircraft turnaround ecosystem. These were not isolated errors, but structural breakdowns embedded in how tasks are owned, shared, and executed across stakeholders.

To engage with these frictions beyond surface-level fixes, the second half of this thesis deliberately shifted toward speculation. I developed three future turnaround concepts—each exaggerating a different coordination logic—to provoke critique, expose assumptions, and explore what might be possible if these frictions were structurally resolved. These scenarios were never intended as blueprints. They were designed to raise a more critical question: What would turnaround look like if the system itself were designed differently?

These speculative futures were then tested in a co-design session with industry experts from KLM, Schiphol, Aviar, and others. Their feedback helped sharpen the design implications and validate the framing: turnaround doesn't break because one actor underperforms—it breaks because ownership and execution are distributed in ways that no one actor fully controls, and no one actor has the mandate to redesign.

This insight led to the development of the Turnaround Futures Framework—a quadrant model that maps coordination models along two axes: who owns turnaround logic (centralized vs. distributed) and how rigid or adaptive its execution is (defined vs. dynamic). Rather than proposing a fixed outcome, the framework visualizes how the system could evolve—and what kinds of interventions might enable that shift.

From this foundation, two strategic levers were proposed:

(1) Design for Interoperability, which enables the transition from defined to dynamic execution by embedding coordination logic into aircraft systems and APIs without enforcing top-down control, and

(2) Decentralize Ground Readiness, which enables the transition from centralized to distributed coordination by building modular readiness standards and shared frameworks for visibility and alignment.

Together, these levers are operationalized through six actionable recommendations—from partnering instead of building, to co-developing readiness frameworks, to publishing open spec libraries and launching shared training portals. Rather than prescribing how others should operate, each intervention enables Airbus to support system-wide coordination—without assuming execution ownership.

This role reframing was further validated during Aviation Innovation Week 2025 in Korea, where stakeholders from OEMs, MROs, airports, and research organizations affirmed the relevance of the thesis framing. Discussions repeatedly circled back to the same structural issues—ownership gaps, unclear accountability chains, and rigid coordination tools—and emphasized how these are not abstract challenges. They are visible, operational constraints with daily consequences.

Ultimately, this thesis illustrates that aircraft turnaround inefficiencies are not just technical problems, but structural ones. They stem from how responsibilities are distributed, how readiness is surfaced, and how coordination unfolds across siloed actors. Solving them requires more than optimization—it requires new mental models, shared frameworks, and actors willing to take on the quiet work of enabling change.

This project does not claim to predict the future of turnaround. But it does offer something often missing: a way to frame it, a way to begin designing toward it, and a way to invite those responsible for it to shape it—**together**.

8.2 Personal Reflection

Two years ago, I arrived at TU Delft thinking I was here to become a better product designer—someone who could ideate fast, sketch beautifully, and develop clever, tangible solutions. Somewhere along the way, I began to see design not just as a discipline of form and but also as a discipline of framing. That it is not just making things, but making **sense** of things. That shift has defined my time here more than any project, and it's taught me what kind of designer I really am.

Through this thesis and everything leading up to it, I've realized my strength isn't in aesthetics or visualization. It's in navigating complexity, in asking the right questions, and in creating frameworks that help teams align, decide, and act. I've found myself at the intersection of engineering, business, and design—not as a translator, but as a synthesizer.

Research, once something I rushed through to "get to the ideas," has become something I genuinely value. Especially after presenting in Korea, I saw how different it feels to stand behind your own thinking, not just your designs. No one validates you in research—you have to validate yourself. But when done right, research doesn't just inform—it provokes. It makes space for new questions and can influence industry conversations.

This project also challenged how I define tangibility. In design—and in many disciplines—we're often asked to deliver something "tangible and impactful," something that "moves the needle." I used to equate that with quantifiable outcomes: faster processes, measurable savings, visible change. And at some level, that's still true. But I've come to understand the value of design that operates earlier in the process—not in the outputs, but in the conditions. In the frameworks, narratives, and mental models that help people see their roles differently and make better decisions. These things don't always show up in a dashboard, but they shape how systems behave and what becomes possible. That, too, is impact.

The isolation of thesis work—the silence, the responsibility, the lack of real-time feedback—was one of the hardest parts. But it taught me to trust my own thinking. To know when to speak and when to stay quiet. That, to echo the old saying, the smartest people in the room are often the ones who observe more than they talk.

Reflecting on the goals I set before starting this thesis—to grow as a systems thinker, to develop frameworks from research, to become confident with ambiguity and collaboration—I can say I've done that. Not perfectly. Not all at once. But enough to feel proud of how far I've come.

And beyond the thesis, the move to the Netherlands itself has changed me. I've learned how to live slower. How to protect my time. How to carve out space for creativity and trust that the connections between all my past experiences—engineering, startups, strategy, design—are real and will reveal themselves with time. I've realized that success isn't about constantly moving forward. Sometimes it's about starting over—but from a higher point.

What I'll take with me from TU Delft isn't just a set of methods or deliverables—it's a mindset. A comfort with the abstract. A belief that systemic design can provoke change. And a deeper trust in my ability to shape not just products, but the conditions that make better futures possible.

Thank you for reading :)

If it sparked any interest or
curiosity, I'd love to hear from you.

Sarika Behara Kumar

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Appendix

Appendix A

Phase 01: Top-Down Strategic Framing

The first step was to frame the right problem. Rather than jumping to isolated operational fixes, the research began by asking:

"What prevents Airbus from being positioned and recognized as a strategic contributor to turnaround efficiency—and what levers can it pull to influence performance?"

The issue tree is structured into three primary branches—External Exclusion, Internal Issues, and Latent Contribution—to surface a complete and non-overlapping view of what prevents Airbus from contributing strategically to turnaround performance. This framing was guided by consulting best practices in diagnostic structuring (MyConsultingOffer, 2024; McKinsey & Company, 2013). In designing the issue tree, the goal was to create categories that were MECE. Each branch addresses a distinct logic stream of limitation:

External Exclusion explores systemic dynamics beyond Airbus's control—how other stakeholders perceive, exclude, or sideline Airbus from turnaround-related innovation. This branch focuses on ecosystem-level dynamics: who defines problems, who gets invited to solve them, and what role OEMs are assumed to play.

Internal Issues focuses inward, examining the organizational, cultural, and structural factors within Airbus that may prevent it from acting—even if it wants to. This includes internal coordination breakdowns, misaligned KPIs, or a lack of situational awareness about ongoing turnaround initiatives outside the company.

Latent Contribution looks forward: it asks what would need to change, internally and externally, for Airbus to become a strategic actor. This branch helps frame potential interventions—not just by fixing what's broken, but by building what's missing.

These three categories were chosen after early research revealed that the barriers to Airbus's involvement in turnaround efficiency were not purely operational or technical—they were strategic, perceptual, and systemic.

Structuring the problem this way allowed each hypothesis to be tested from a different angle, and later synthesized into a unified diagnostic model.

Prioritizing Strategic Unknowns for Hypothesis Development

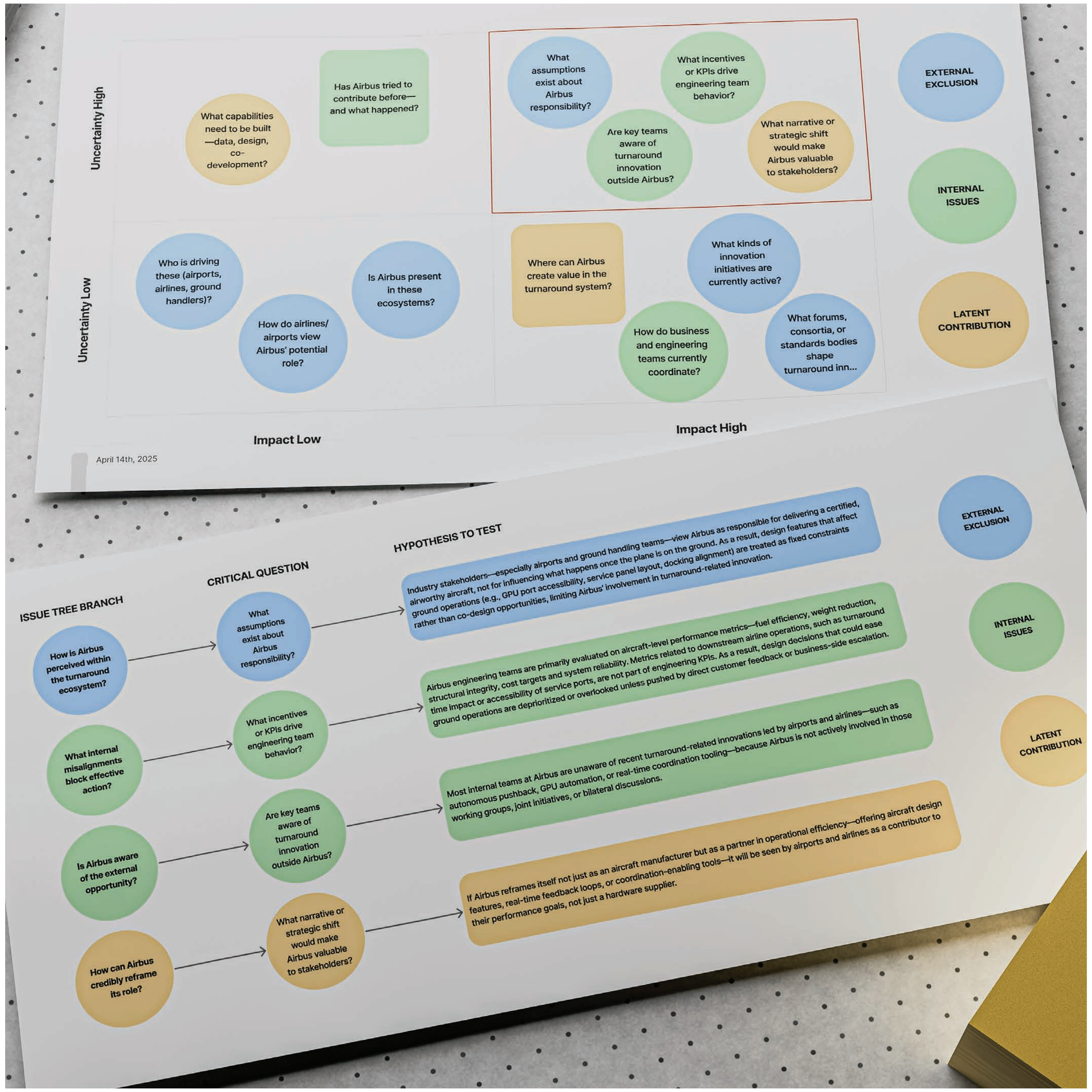
After developing the full issue tree, the next step was to identify which questions mattered most for strategic diagnosis—and which ones still lacked sufficient insight from initial research.

To do this, the sub-questions from each branch of the issue tree were mapped into a 2x2 prioritization matrix based on Impact (How critical is this question to answering the overarching problem?) and Uncertainty (How unresolved is this question given current knowledge?).

The original categories—External Exclusion, Internal Issues, and Latent Contribution—were maintained to ensure thematic consistency. Each colored bubble represents a question from the issue tree placed based on judgment from early literature and interview analysis. Four questions emerged in the High Impact / High Uncertainty quadrant. These became the priority hypotheses for targeted triangulation. Each was then:

- Mapped back to its parent node in the issue tree,
- Reformulated into a crisp critical question, and
- Translated into a hypothesis to test using future synthesis, and workshop findings.

This helped shift the research from descriptive mapping to structured, directional exploration—turning open-ended investigation into a focused diagnostic probe.



Based on the impact-uncertainty matrix, four critical hypotheses were selected from the issue tree. These were not treated as answers—but as framing tools to guide what to look for during bottom-up synthesis. The hypotheses were:

1. Industry stakeholders view Airbus as responsible only for airworthy aircraft—not ground operations—limiting its involvement in turnaround innovation.
2. Airbus engineering teams deprioritize ground operation efficiency because KPIs focus on fuel performance, weight, and reliability.
3. Airbus is unaware of external innovation efforts in turnaround because it is not present in the forums or partnerships driving them.
4. To contribute strategically, Airbus must reframe its role from hardware provider to operational design partner.

These hypotheses shaped how early interview data and literature were parsed during the affinity mapping stage.

For example:
- If Airbus is excluded, where and how is that exclusion visible in stakeholder behavior?
- If internal incentives misalign, are there signs of disconnect between business and engineering priorities?
- If reframing is needed, what would a new role for Airbus actually look like in the system?

These hypotheses were not directly tested in isolation—but instead acted as filters for pattern recognition during the thematic clustering process. Ultimately, they helped focus attention on the systems behind inefficiency, not just the symptoms.

Hypothesis	How it Showed up in Research
Stakeholder view OEM's as only responsible for airworthy aircraft - not ground operations.	Interview quote showing OEM's not invited to innovation forums; literature showing operational tooling developed without OEM input
Airbus engineering KPIs don't prioritize turnaround.	Interview with engineering leads showing no metrics for GPU/APU usability, fueling port efficiency, etc.
Airbus is unaware of external industry efforts/innovations in turnaround.	Evidence from literature & interviews: lack of Airbus presence in consortia, no references to OEM-led tools
Airbus must reframe its value from hardware provider to design partner.	Synthesis across design/interface frictions showing where Airbus could enable better outcomes

Phase 02: Bottom-Up Grounded Diagnosis

While the strategic issue tree helped define the unknowns around Airbus's position, the hypotheses framed in that step had not yet been validated at that stage. They represented directional assumptions drawn from early interviews and literature—but still needed empirical grounding.

In effect, the early hypothesis map framed the right strategic questions while the affinity mapping and clustering helped uncover answers to them.

1. Affinity Mapping of Observed Challenges
Insights from both the literature review and ten expert interviews were systematically extracted and visualized as individual causal fragments (sticky notes). These were color-coded by source and presented without pre-defined structure to preserve bottom-up emergence.

2. Thematic Clustering
The next step was to group similar bottlenecks and systemic contradictions into thematic zones. Sticky notes were clustered based on shared functional impact—rather than actor or ownership. Three major clusters emerged: stakeholder-related challenges, ground handling challenges, and operational misalignments. These clusters helped identify where frictions were recurring, cross-cutting, or embedded in broader systems.

3. Defining Functional Drivers
From these thematic clusters, four systemic frictions were defined—each representing a core inefficiency that consistently disrupts turnaround performance:
Sequencing Bottlenecks: Rigid service orders, hidden dependencies, and poor choreography lead to idle time and task overlap.

Communication Breakdowns: Manual updates, tool silos, and asynchronous decision-making delay coordination and introduce risk.

Interface Mismatches: Misalignments between aircraft design and ground service equipment create workarounds, delays, and safety compromises.

Accountability Voids: Fragmented roles, unclear ownership, and misaligned incentives leave no actor responsible for overall system performance.

This reframing shifted the analysis from discrete causes to structural failure modes that cut across stakeholders and processes. It allowed individual insights to be grouped by systemic friction, rather thatn actor of function.
This grouping showcases that turnaround inefficiency stems not from isolated failures, but from embedded system flaws. Finally It also offers Airbus a lens to identify leverage points—whether latent, emerging, or ready to be activated.

Each of these four frictions will be discussed in detail in the following chapter.

Appendix B

OEM (Airbus)

1. Core Role in Turnaround

Airbus Commercial designs and manufactures civil aircraft used by global passenger and cargo airlines. It is responsible for the configuration of all physical aircraft interfaces relevant to turnaround operations—cargo doors, fueling points, power ports, service panels, and boarding access. While these interfaces define the operability of ground tasks, Airbus has no direct involvement in real-time turnaround execution. It provides technical documentation and training to the airline but does not interact with airports or ground handlers after aircraft delivery.

2. Business Model

Primary Revenue: Aircraft sales. In 2024, Airbus delivered 735 commercial aircraft and secured 2,319 gross orders, bringing its year-end backlog to 8,658 aircraft—valued at over €500 billion in future revenue (Airbus, 2025a).

Secondary Revenue: Services and aftermarket support.

- This includes spare parts, upgrades, retrofits, technical publications, and training packages.
- The commercial services business generated €5.2 billion in revenue in 2024 (Airbus, 2025a).
- Airbus targets a doubling of services revenue to €10 billion by the early 2030s (Airbus, 2025b).

Revenue Recognition: Revenue is recognized progressively, with milestone-based payments during manufacturing and final recognition upon delivery and acceptance by the airline.

3. Sales and Delivery Process

Order Cycle: Aircraft are typically ordered 2–8 years before delivery, depending on production line capacity and backlog.

Customization: Each airline configures its aircraft—interior layout, galley and lavatory placement, optional systems. Airbus engineers adapt manuals and service documentation accordingly.

Delivery: Completed aircraft undergo final tests and are handed over at a designated delivery center. Airbus provides engineering support and training but does not integrate aircraft into daily airline operations or participate in on-ground procedures.

4. Aftermarket Services & Data

Lifecycle Support: Airbus supports aircraftover 20–30 years via maintenance programs, digital upgrades, and service contracts. Airlines may subscribe to full flight hour services (FHS), where Airbus manages ongoing maintenance and logistics.

Skywise: Airbus's integrated digital platform, launched in 2017 in partnership with Palantir. Used by over 140 airlines by 2024 (Airbus, 2025a), Skywise enables predictive maintenance, fleet performance tracking, and operational optimization.

- Skywise data access is contingent on airline consent.
- Ground handlers and airports typically do not interface with Skywise.
- While Airbus does not break out exact revenue, Skywise is considered a core growth pillar of the €5.2B services segment (Airbus, 2025b).

5. Constraints & Dependencies

Certification & Regulation: Aircraft and any major design changes must be certified by authorities (EASA, FAA, etc.), often taking years. This makes it difficult to rapidly iterate on physical features that may cause ground-handling inefficiencies.

Dependency on Other Actors:

- Airport infrastructure (e.g. gate size, fueling equipment) and ground handler SOPs vary widely and often mismatch with Airbus design standards.
- Airbus has no authority over these actors post-delivery and does not engage in regular operational feedback loops with GHs or airport ops teams.

Limited Feedback Visibility: Operational issues (e.g. GPU connection, cargo access) may be reported informally by airlines, but there is no direct data pipeline from turnaround operations back to Airbus's design or support teams unless Skywise is adopted.

Airline (Legacy or Full-Service Carrier)

1. Core Role in Turnaround

Airlines are the central coordinators of the aircraft turnaround process. They schedule flights, own or lease the aircraft, and are responsible for ensuring the aircraft is serviced, refueled, cleaned, and boarded on time. While most airlines do not execute ground tasks themselves, they define turnaround expectations and control performance monitoring. Execution is handled either by in-house teams or contracted ground handling companies, depending on the station and airline model (Belobaba et al., 2021).

2. Business Model

Revenue: Passenger fares (both business and leisure segments), cargo transport, ancillary services (e.g., baggage fees, seat upgrades), and loyalty programs.

Cost Structure:

- Fuel (~25–30% of total operating costs)
- Aircraft ownership or leasing
- Crew salaries and hotel/layover expenses
- Maintenance (in-house or contracted)
- Ground handling services (outsourced or internal)
- Airport fees (landing, parking, gate, passenger services)

Utilization Logic: Airline profitability is highly sensitive to aircraft utilization. Maximizing daily flight hours per aircraft—by minimizing ground time—is a central driver of network efficiency and revenue (Gross & Lücker, 2013).

3. Turnaround Execution & Ownership

Airlines own the aircraft and define turnaround Standard Operating Procedures (SOPs) per aircraft type, route, and airport. They are responsible for allocating ground time, sequencing service windows, and ensuring all regulatory and logistical steps are met before pushback.

Turnaround tasks are usually executed via:

- Outsourced providers under service-level agreements (SLAs)
- Or in-house ground ops teams (common at hub airports for full-service carriers)

Airlines are also responsible for:

- Dispatch and slot compliance
- Crew readiness and boarding call coordination
- Delay attribution and internal reporting

4. Incentives & Priorities

Airlines are highly incentivized to minimize turnaround time because:

- Faster turns = higher fleet utilization = more revenue (Cook et al., 2009)
- OTP affects customer satisfaction, downstream schedule integrity, and regulatory compliance
- Delays cause cascading network disruption, especially on long-haul flights with tight rotations or crew legal limitations

Airlines measure performance against internal benchmarks and IATA-defined delay codes, but often lack real-time visibility into sub-tasks unless tightly integrated with the ground handler's system (Belobaba et al., 2021).

5. Constraints & Dependencies

Fragmented Execution: Airlines operate across many airports with varying infrastructure, equipment, and staffing standards.

Limited Control Over Infrastructure: Gate assignments, GPU availability, fueling infrastructure, and terminal layouts are owned by airports—not airlines.

Accountability Without Control: Airlines are held financially responsible for delays, even when caused by infrastructure or third-party execution.

Lack of Task-Level Data: Unless integrated with digital turnaround platforms, airlines may only receive time-stamped delay codes—not root causes.

Training & SOP Variability: When using third-party GH teams, airline-defined SOPs are subject to local interpretation and variable enforcement.

Airport (International & Public)

1. Core Role in Turnaround

Airports act as infrastructure providers and airside orchestrators. They do not operate aircraft, but they control the environment in which aircraft turnaround takes place—including stands, gates, jet bridges, fueling infrastructure, terminal layouts, and ATC.During turnaround, the airport governs:

- Gate assignment and stand availability
- Access to fueling hydrants, fixed electrical ground power (FEGP), and pre-conditioned air
- Passenger boarding bridges
- Airside movement coordination (e.g., pushback clearance, tug routing, sometimes apron management)
- Airports often provide access to contracted services (e.g., ground handling firms, catering, lavatory services), though they rarely execute these tasks themselves (de Neufville & Odoni, 2013).

2. Business Model

Airports generate revenue from two broad categories:

- Aeronautical Revenue: fees from airlines (e.g., landing, take-off, parking, passenger service charges). These charges are typically regulated by governments and are cost-recovery based, meaning they usually enable airports to break even, not generate profit (ACI, 2023).
- Non-Aeronautical Revenue: commercial income from parking, retail concessions, food services, and real estate. These form the majority of profits, in some airports as high as 40–60% of total revenue (IATA, 2022; Gillen, 2011).

For example, Schiphol's total revenue in 2022 was €1.5 billion, of which 44% came from non-aviation activities, including retail and real estate (Schiphol Group, 2023). Hartsfield-Jackson Atlanta, one of the busiest airports globally, is owned by the City of Atlanta and funded through a mix of bonds, passenger facility charges, and federal/state grants. Aeronautical revenues support operational costs; non-aeronautical streams help fund capital investments (City of Atlanta, 2023).

3. Turnaround Execution & Ownership

Airports own and maintain physical infrastructure (runways, stands, terminals) and sometimes manage services like baggage systems, gate assignment, or ATC (if not separately managed). Ownership of tasks varies:

- ATC may be state-run (e.g., FAA in the U.S.) or airport-managed.
- Gate allocation is often airport-led but subject to airline agreements.
- Apron access, fueling infrastructure, and GPU sockets are usually airport-controlled.

4. Incentives & Priorities

Airports are primarily incentivized to:

- Maximize aircraft and passenger throughput
- Minimize delay propagation across the network
- Maintain high on-time performance rates to retain airline partnerships and slot coordination reputation
- Comply with safety, environmental, and regulatory standards (ICAO, FAA, EASA)

Turnaround efficiency benefits airports by:

- Enabling more traffic through the same infrastructure
- Reducing congestion and gate conflicts
- Improving slot utilization and revenue per gate

However, they are often not directly responsible for the delay causes (e.g., slow baggage loading) but may still face reputational and traffic consequences.

5. Constraints & Pain Points

Inflexible Infrastructure: Gate and fueling layouts may not align with aircraft design or GH workflows.

Fragmented Stakeholder Environment: Airports must coordinate with multiple airlines, GH companies, and ATC systems—all with competing priorities.

Limited Operational Visibility: Many airports lack real-time task-level insight unless integrated with airline or GH digital systems.

High CapEx / Slow Change Cycles: Infrastructure changes (e.g., new jet bridges, fueling systems) require multi-year planning and investment.

Gate Conflicts & Scheduling Pressures: When one aircraft delays, it causes cascading gate reassignments, especially at fully utilized hubs.

Ground Handler

1. Core Role in Turnaround

Ground handling companies are the primary executors of physical turnaround tasks on behalf of airlines. They manage services such as baggage loading and unloading, aircraft cleaning, catering uplift, pushback, lavatory and potable water service, deicing, and often passenger boarding coordination. Airlines typically delegate these operations to GH providers through location-specific contracts. In many cases, multiple ground handling companies operate at the same airport, serving different airlines with varying procedures and expectations (IATA, 2022).

2. Business Model

Ground handlers operate under short- to mid-term service-level agreements (SLAs) with airlines. These contracts define service scope (e.g., ramp handling, cabin cleaning, cargo) and performance metrics such as on-time delivery, baggage accuracy, and incident rates.

- Revenue is generated per service rendered—usually calculated per turn, per passenger, or via monthly flat-rate contracts.
- Cost structure is labor-heavy, with high dependence on low-wage, shift-based workforces, often hired through third-party staffing firms. This creates high turnover rates—routinely exceeding 30–50% in major hubs (IATA, 2022).
- Major global players include Swissport, dnata, and Menzies Aviation, each operating across dozens of countries and serving hundreds of airlines. Swissport alone served over 265 million passengers and handled 2.3 million flights in 2023, generating €3.1 billion in revenue (Swissport, 2023).

GH companies must adapt to each airline's SOPs, which may differ even at the same airport. One GH team may service ten airlines, each with different boarding policies, aircraft types, and documentation protocols. This creates substantial procedural variability and risk of error, especially when training cycles are compressed or teams are understaffed.

3. Turnaround Execution & Ownership

While the airline retains legal accountability for turnaround outcomes, the GH provider executes nearly all physical tasks on the ground. These include:

- Ground power connection (GPU), belt loader setup, baggage cart loading/unloading
- Coordination with fueling teams (unless airport- or airline-owned)
- Pushback preparation and execution
- Cabin cleaning and lavatory service
- Coordination with catering trucks and crew

Most GH providers do not own the infrastructure (e.g., gates, GPU systems), but must interface with it precisely. They are required to comply with airport safety protocols, airline service specs, and real-time dispatch orders—yet often lack integrated tools for shared situational awareness.

4. Incentives & Priorities

Ground handlers are incentivized to:

- Minimize idle time between tasks and maximize daily turns per team
- Avoid penalties for SLA violations (e.g., delays attributable to ramp operations)
- Win long-term contracts with large airline clients by demonstrating OTP contribution

5. Constraints & Dependencies

High Task Variability: Every airline may define different SOPs for the same task (e.g., boarding call triggers, lavatory service timing), requiring constant staff adaptation.

Staffing Volatility: Ramp agent turnover remains high across the industry due to low wages, inconsistent hours, and limited career progression (IATA, 2022).
Communication Gaps: GH teams often lack visibility into upstream airline data or real-time gate changes—decisions that directly affect their ability to deliver on time.

Liability Constraints: GH companies are liable for errors but operate in constrained environments (e.g., time, space, staffing). Aircraft damage, baggage loss, or service delays may lead to penalties, but root causes often stem from misaligned systems or compressed schedules.

Appendix C

The Three Final Concepts

Concept 01: The Autonomous OEM Terminal

The aircraft becomes a smart, self-managing node in an autonomous terminal loop. Airlines become UX/service layer brands. OEM controls aircraft and all service hardware + staff. Airport is passive infra + traffic control.

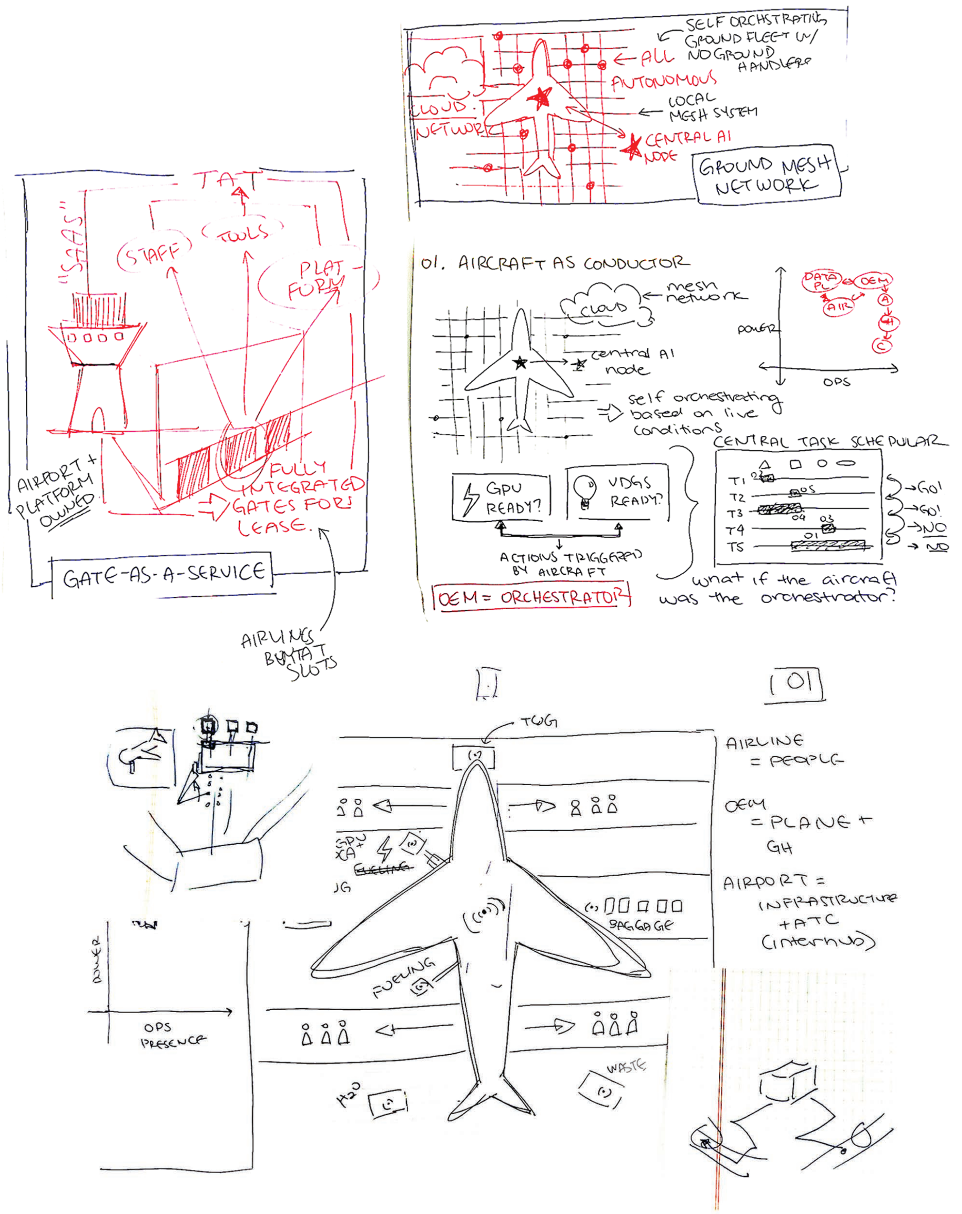
COMBINED IDEAS

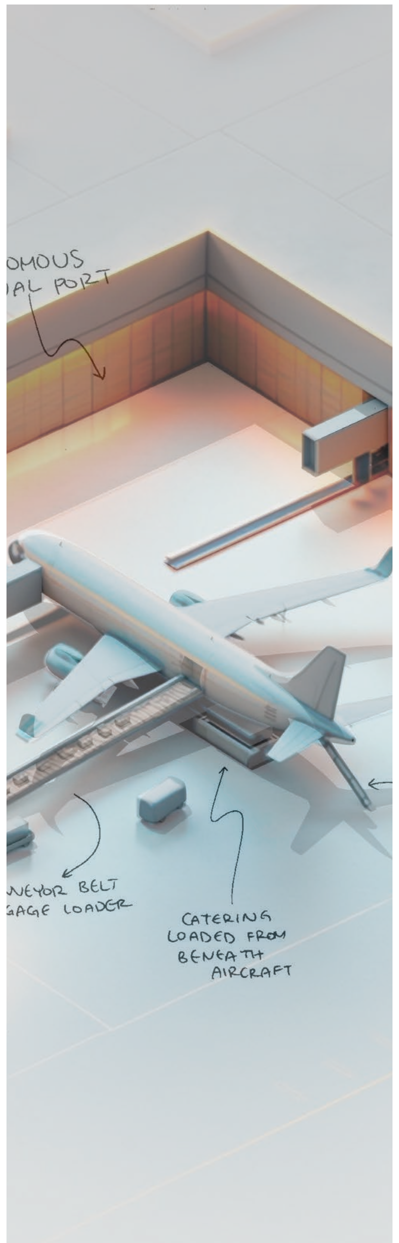
Combines autonomous coordination, centralized communication, and modularization themes, positioning the OEM as the active orchestrator within an autonomous operational loop.

Gate-as-a-Service
- What if gates were leased? So each gate was airport owned and fully integrated.

Ground Mesh Network
- What if the aircraft was a central node and everything around it happened autonomously? So it was self-orchestrating turnaround.

Aircraft as a Conductor
- What if the aircraft orchestrated all the tasks based on live conditions? So it alerted all stakeholders and was the owner of a central task schedular.





Concept 02: Airbnb for Aircrafts + Airports

Marketplaces replace planning. OEMs list aircraft. Airports list gates-as-a-service and turnaround packages. Airlines act like Uber: they coordinate passenger flow and stitch services together.

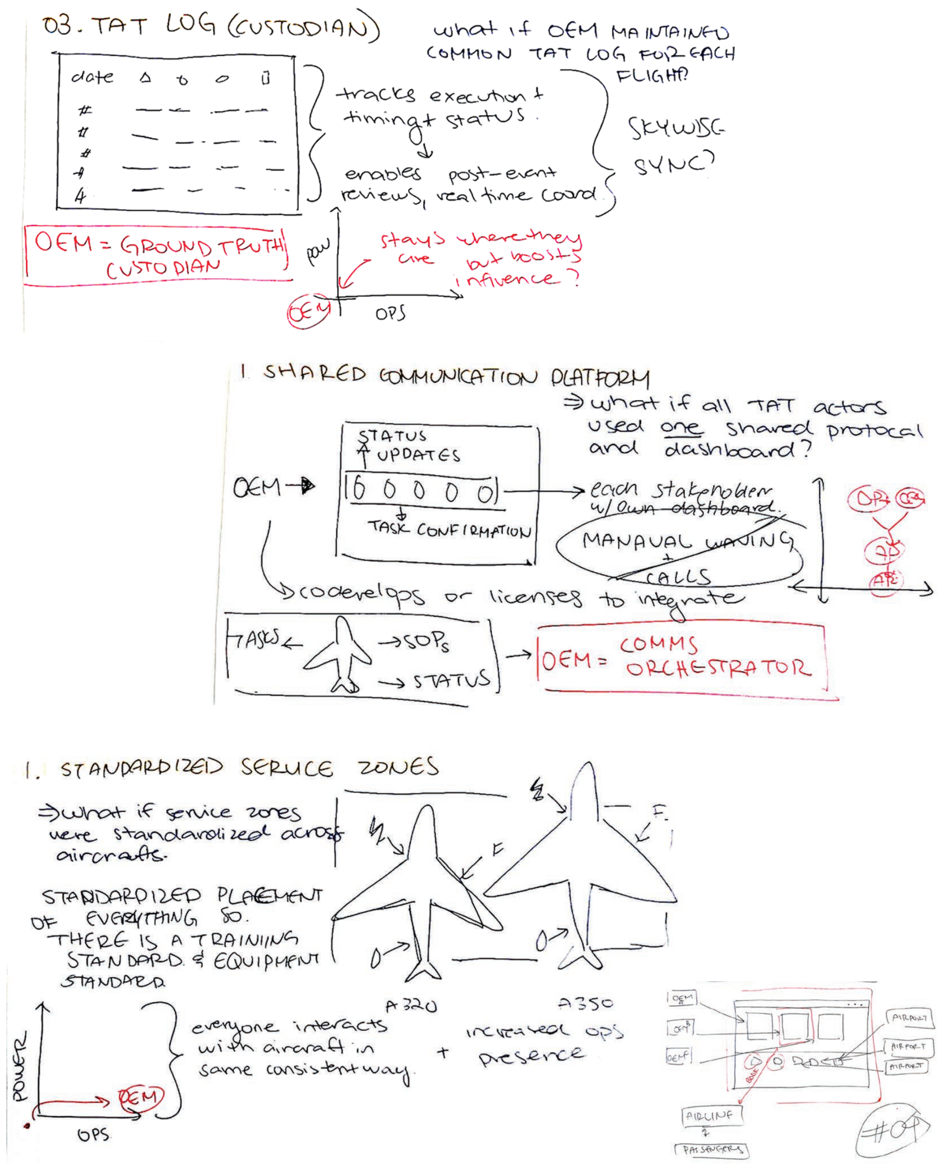
COMBINED IDEAS

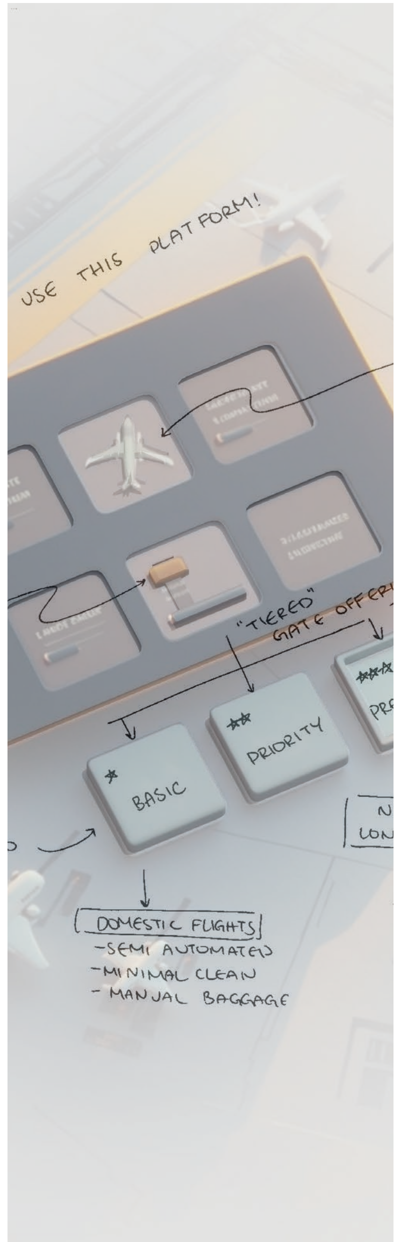
Merges gate integration and platformization concepts to create a dynamic marketplace where airports and airlines flexibly allocate and lease operational resources.

TAT Log (Custodian)
- What if OEM maintaned a common TAT log for each flight? Tracking execution + timing and then enabling post-event reviews.

Shared Communication Platform
- What if all TAT actors used one shared protocal and dashboard? Essentially the OEM was an orchestrator or developed the plaform

Standardized Service Zones
- What if service zones were standardized across airports? So a single platform organized everything and you had ranking/tiers for standards based on flights?





Concept 03: Turnaround Conveyor

Turnaround is a linear flow. Airport has multiple TAT "lanes" like a car wash or baggage carousel - it becomes a factory. Aircraft itself is modular and as it moves through each module: deboarding, waste, fueling, boarding, parts are swapped out.

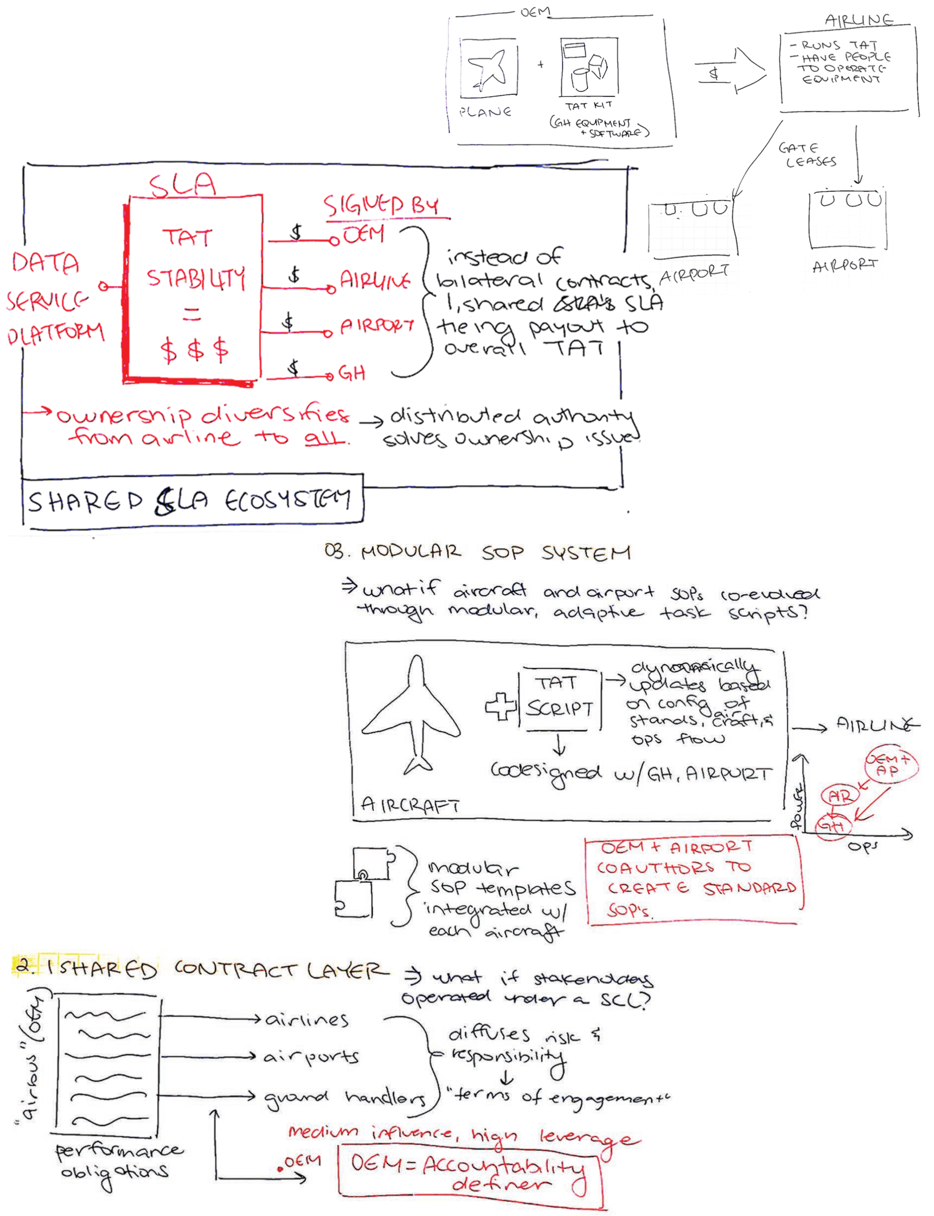
COMBINED IDEAS

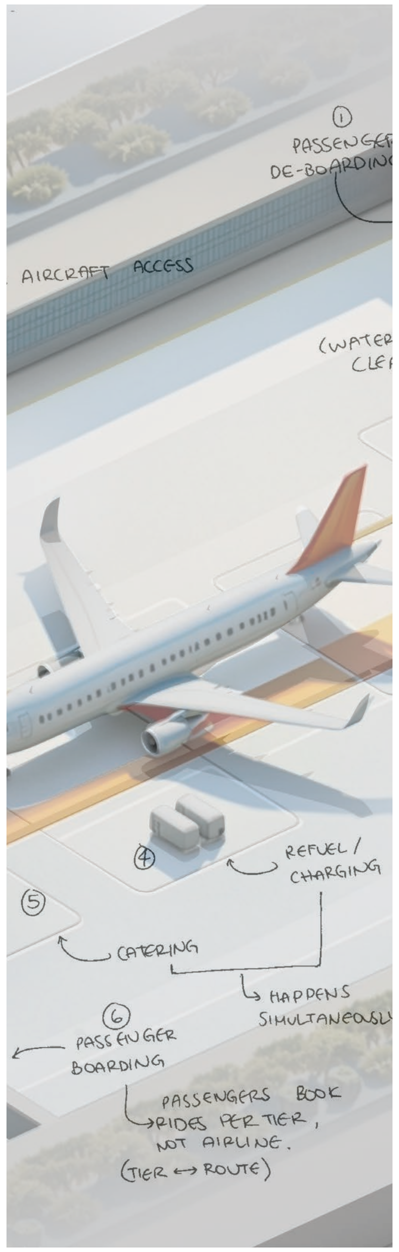
Integrates elements of modularization, shared responsibility, and autonomous coordination, creating a linear, automated, and highly structured operational flow managed centrally by airport infrastructure.

Shared SLA Ecosystem
- What if instead of bilateral contracts, everyone had a shared SLA and payout was tied to overall TAT?

Modular SOP System
- What if the aircraft and airport SOPs co-evolved through a modular kit? So aircrafts were modular and airports architecture was built for modularity.

Shared Contract Layer
- What if stakeholders operated under a shared SCC? So the OEM was the accountability definer and difuses risk & responsibility.





Appendix D

Recommendation Ranking

Levers

Potential Lever	Defintion	Systemic Leverage Potential	Status in Thesis	Why Not Included as Primary
Interface Standardization	Physically redesign aircraft-GSE interfaces for compatibility, ease of training, and plug-and-play modularity.	Medium	Absorbed into readiness	It's upstream, slow to impact, and harder for Airbus to pilot short-term.
SLA Realignment	Redesign SLAs to reflect aircraft capability logic (e.g., timelines, required preconditions).	Medium	Absorbed into readiness	Not a strategy in itself. SLA design is a mechanism, not a standalone strategy. It belongs under readiness + logic.
Predictive Analytics	Use aircraft-side telemetry and historic turnaround data to forecast ground task sequences and delays.	Low	Not central	Covered by 3rd parties.. This overlaps with what companies like Assaia already do. Airbus is better positioned to feed the data, not build the tool (although Airbus has Skywise but I've never seen traction)
Training/ Simulation Ecosystem	Create an Airbus-certified training platform and GSE integration simulation tools for airports/handlers.	Medium	Inside readiness	Too granular alone. Sits well under "Decentralize Ground Readiness."
Cross-Stakeholder Consortium	Airbus co-leads a cross-stakeholder working group (airlines, airports, OEMs, GSE, tech providers) to co-develop standards and coordination protocols.	High	Mentioned but not pursued	Hard to scope. Too abstract to test, and hard to scope a recommendation around.

Criteria/Ranking

Shortlist Criterion	Weight	Scoring Logic	Result
Systemic Leverage (does it move the quadrant?)	40 %	High = shifts both coordination execution axes	Only Design for Interoperability and Decentralize Ground Readiness scored "High"
Pilot-time Feasibility (≤ 3 yrs to first live trial)	30 %	Uses existing Airbus data assets & partner channels	Both short-listed levers can piggy-back on Skywise + existing training partners
Strategic Viability (aligns with Airbus growth thesis & IP)	30 %	Strengthens services revenue and aircraft pull-through	Each lever reinforces Airbus as an orchestrator, not an operator

Scores

Potential Lever	Viability (strategic fit & long-term value for Airbus)	Feasibility (resources, partners, time-to-pilot)	Desirability (pull from airlines, airports, handlers)	Rationale for Scores
Interface Standardization	2 (Med)	1 (Low)	3 (High)	• Fits aftermarket & service-rev play but ROI ≥ 7 yrs • Requires aircraft redesign + cert cycles → slow • Airports & GSE teams actively ask for it
SLA Realignment	2 (Med)	3 (High)	2 (Med)	• Improves service stickiness but small direct €€ • Template & clause library can be released in < 12 mo • Airlines mixed: some welcome, some fear legal lift
Predictive Analytics	1 (Low)	3 (High)	2 (Med)	• Market already served by Assaia/ INFORM; dilutes Skywise focus • Technically easy (Airbus owns the data) • Stakeholders like it, but not specifically from Airbus
Training / Simulation Ecosystem	2 (Med)	2 (Med)	3 (High)	• Modest recurring revenue; good brand equity • Needs content build & LMS partner, 18-24 mo • Ground teams hungry for better training formats
Cross-Stakeholder Consortium	1 (Low)	1 (Low)	3 (High)	• No clear P&L owner; hard to sustain • Heavy governance, multi-year alignment needed • Everyone likes the idea, no one funds it

Chosen Levers

Strategic Lever	Viability Strategic fit / long-term value	Feasibility Ability to pilot ≤ 3 yrs	Desirability Stakeholder pull	Systemic Leverage (Quadrant-shift power)	Rationale
Design for Interoperability (CHOSEN)	3	3	3	High	Directly monetises Airbus data layer, simple API pilot, strong demand from airlines & platform vendors. Shifts Defined → Dynamic axis.
Decentralize Ground Readiness (CHOSEN)	3	2	3	High	Uses existing training partners; moderate build effort. Airports & handlers actively seek clearer readiness benchmarks. Shifts Centralised → Distributed axis.

Recommendation Scores

#	Rec	Execution Scope (1-5)	Ownership Shift (1-5)	Systemic Leverage (1-5)	Why
R1	Partner instead of build(shared coordination API with existing vendors)	4 – inserts a new logic layer that multiple tools can call	3 – API is neutral; airline still decides whether to use it	5 – creates a common language for all later digital plays	Opens a neutral "rail" that every stakeholder can ride; small footprint but big network effect.
R2	Publish open spec libraries	3 – alters planning & analytics, not live ops	2 – libraries are voluntary reference docs	4 – standardises data so other tools predict better	Low-cost, high-reach way to harmonise timelines & readiness events across fleets.
R3	Enable passive integration(plug-in APIs, not dashboards)	2 – least visible change to day-to-day flow	2 – airline still owns the UX layer	3 – necessary plumbing for future modularity	Good hygiene item; raises technical ceiling but impact is slower & indirect.
R4	Co-develop a readiness framework (modular certification "passport")	4 – inserts a new gating check before entry-into-service	5 – shifts readiness assurance from Airbus PDF ➔ shared registry	5 – closes a root-cause delay; decouples certification from OEM bottlenecks	High-gain move that redistributes who can prove capability and when.
R5	Launch a shared training/ spec portal	3 – changes how training is consumed, not how ramp is run	3 – material owned/ updated by Airbus + partners	4 – lifts the floor on human factors, speeds adoption of new ground tech	Tangible benefits but slower feedback loop (people must complete courses).
R6	Integrate MRO + ground-team feedback loops	5 – turns one-way doc flow into continuous data loop	4 – pushes some validation to operators & vendors	4 – injects real-world ops data back into aircraft design & next-gen tooling	Highest operational change; makes readiness a living metric, not a static sign-off.

Appendix E

The Project Brief

DESIGN FOR our future

TU Delft

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	Kumar	IDE master(s)	IPD ☐ DfI ☐ SPD ☐
Initials	SBK	2nd non-IDE master	
Given name	Sarika	Individual programme *(date of approval)*	
Student number	[redacted]	Medisign	☐
		HPM	☐

SUPERVISORY TEAM

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

Chair	Euiyoung Kim	dept./section	DOS
mentor	Arno van Leeuwen	dept./section	HCD
2nd mentor			
client:	Airbus North America		
city:	Atlanta	country:	Georgia
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 Feb. 10, 2025   Signature

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Name student Sarika Kumar   **Student number** [redacted]

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title Systemic Instabilities in Aircraft Turnaround

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)

Efficient aircraft turnaround processes are essential for airline profitability, on-time performance (OTP), and customer satisfaction. However, turnaround inefficiencies remain a persistent challenge due to regional airport management differences, aircraft-specific complexities, and airline operational trade-offs.

This project, conducted in collaboration with Airbus, TU Delft, and Georgia Tech, aims to identify systemic inefficiencies in Airbus long-haul aircraft turnarounds by analyzing operations at Schiphol (AMS), Portland (PDX), Atlanta (ATL), and Incheon (ICN). The study aligns with Airbus's SESAME initiative, which focuses on sustainable and efficient air travel, by fostering a collaborative ecosystem across airlines, airports, and manufacturers.

Key stakeholders include:
Airlines (seeking profitability and OTP improvements),
Airport operators (balancing efficiency with passenger experience),
Ground handling crews (responsible for execution of turnaround tasks),
Regulatory bodies (influencing airport management models), and
Passengers (impacted by delays and disruptions).
Aircraft Manufacturers (such as Airbus, which designs aircraft with operational efficiency in mind and can influence future improvements in turnaround processes)

Opportunities lie in leveraging AI-based turnaround optimization, improving stakeholder coordination, and developing design-driven intervention strategies. However, challenges include balancing airline-specific priorities (profitability vs. connectivity), regional operational constraints, and the complexity of implementing new frameworks across multiple airports.By analyzing airport-specific bottlenecks and stakeholder interactions, this project will develop scalable interventions, such as AI-assisted coordination tools, operational frameworks, or Airbus-specific process innovations, to reduce systemic inefficiencies in long-haul aircraft turnaround operations.

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

Personal Project Brief – IDE Master Graduation Project

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)

The aviation industry continues to face systemic inefficiencies in aircraft turnarounds, despite existing technical research aimed at improving operational efficiency. Factors such as regional variations in airport management (e.g., common-use gates in Europe with 6.4-minute delays vs. airline-specific gates in North America with 3.2-minute delays), aircraft-specific challenges, and airline strategies contribute to delays, reduced gate utilization, and passenger dissatisfaction. Narrow-body aircraft turnarounds vary significantly between regions (59 minutes in Europe vs. 77 minutes in North America), and wide-body aircraft face prolonged delays, particularly in long-haul operations.
Existing technical solutions have failed to fully address these inefficiencies, suggesting deeper systemic issues. These may stem from communication gaps, misaligned stakeholder priorities, regulatory discrepancies, or inadequate frameworks. As an industrial design student, I aim to address these inefficiencies through a systemic design thinking approach, focusing on whether the root cause lies in processes, frameworks, or technology adoption. This perspective allows for a holistic analysis of the ecosystem, including human and operational factors, while leveraging my background in creating frameworks and scalable solutions.
This project presents an opportunity to align stakeholders' diverse needs by developing practical, collaborative, and sustainable solutions. By integrating design thinking and AI-driven optimization, this research aims to provide Airbus with practical, scalable strategies to improve turnaround efficiency across different airport ecosystems.

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:

What are the critical factors causing systemic instabilities in aircraft turnarounds, and how can Airbus mitigate these through new technologies and design frameworks?

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)

To address this challenge, I will adopt a design-centric, systems-thinking approach. The project will begin with field observations and stakeholder interviews at ATL and AMS airports to understand disruptions and inefficiencies in turnaround activities. I will analyze processes across narrow-body and wide-body aircraft, comparing European and North American operational models.

Using micro-to-macro analysis, I will study individual turnaround tasks, such as baggage handling or boarding efficiency, and evaluate their systemic impact on broader airline operations. Data from tools like Assaia (ApronAI) and Flighty will inform these analyses.

Design thinking frameworks will guide the synthesis of insights into actionable solutions. I will prototype process innovations, create scalable frameworks, and simulate the impact of AI-powered technologies on efficiency. By incorporating stakeholder feedback and iterating solutions, the aim is to develop practical and collaborative strategies to address systemic inefficiencies in turnaround processes.

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	Feb 10
Mid-term evaluation	April 9
Green light meeting	May 22
Graduation ceremony	June 26

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	

Comments:

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)

I want to develop my ability to design practical, data-driven solutions for large-scale challenges and learn how to work effectively with diverse stakeholders. This project offers an opportunity to improve my skills in field research, stakeholder collaboration, and applying tools like AI to solve complex problems. I see AI and emerging technologies as critical to modern innovation, and I aim to become more comfortable using them to address systemic inefficiencies.

Beyond the project's objectives, I have personal learning ambitions. First, I want to expand my capacity to think big and address large-scale, complex systems. Second, I aim to improve my confidence and efficiency in conducting field research and stakeholder collaboration. Third, I want to learn how to synthesize technical and qualitative findings into frameworks that are both practical and scalable. Fourth, I wish to strengthen my ability to balance detailed technical work with broader strategic decision-making. Finally, I hope to grow as a systemic thinker, bridging the gap between technology, design, and process innovation to create sustainable solutions.

This project allows me to explore these ambitions while tackling a critical aviation challenge and building skills that will help me address similar problems in the future.