Haiku

AI IN AVIATION

Highlights

The HAIKU viewpoint

Funded by Horizon Europe R&I Program

Haiku
Human AI teaming Knowledge and Understanding for aviation safety

AI IN AVIATION

Highlights

Funded by the European Union

This project has received funding by the European Union's Horizon Europe research and innovation programme HORIZON-CL5-2021-D6-01-13 under Grant Agreement no 101075332

INDEX

“WHAT HAVE WE LEARNED ABOUT HUMAN-AI TEAMING FROM THE SIX AI AVIATION USE CASES?”

WHAT HAVE WE LEARNED ABOUT HUMAN-AI TEAMING FROM THE SIX AI AVIATION USE CASES?

Artificial Intelligence (AI) is a powerful technology that **aviation personnel** can effectively and safely collaborate with in the near future.
The target areas for its application include both **complex high-workload scenarios** (to support and enhance human decision-making) and **routine operations** (to assist in repetitive tasks), perhaps starting with the latter type of application as a strategy to ease AI acceptance.
Overall, what really matters is the **tangible value** provided by the AI solution, avoiding adoption "driven by hype". AI solutions and the related Human-AI Teaming (HAT) concepts should be designed in a way that preserves - or even creates new - **meaningful human roles**. AI should convey a **sense of control and awareness** desired by the human end users, with AI either supporting or acting but **not overriding end-users' intentions and decisions**. Appropriate **regulations** will be key to avoid undesired usage and unsafe outcomes.

The **main recommendations concerning HAT** resulting from the use cases are as follows:

HUMAN-CENTRED DESIGN

AI solutions should be developed around **human needs**, with problem framing before algorithm development, and **end-user involvement** in all design stages. How to do so?

a. **User needs definition, in three strands:** Human needs and motivations relevant to the baseline CONOPS, key operational opportunities and pain points, and potential AI-driven enhancements. This needs to be developed for all stakeholders - analysing different perspectives and preferences - to ensure that the AI solution can address the full scope of operations.
b. **CONOPS definition:** Clearly define the concrete operational value Human-AI Teaming could bring to the CONOPS compared to traditional automation.
c. **Human-AI Teaming definition:** Define clear boundaries, roles, responsibilities and interaction modalities between the human and the AI system in the operational context, specifying AI limitations.
d. **Concept refinement:** Refine the concepts on the basis of regulation in an iterative way e.g. using the EASA Guidance framework as a foundation for assurance that technological systems adequately support human needs and maximize overall system performance. Define clear task allocation between humans and AI and extend the list of design and performance requirements to align with the regulation.
e. **Co-development:** Co-develop the solution step-by-step with users in representative scenarios, including different operational explainability (XAI) solutions to find the most suitable one for the specific application. Deliver robust support to humans according to the assigned roles, tasks and responsibilities. Run iterative validation activities, *e.g. go back to [c] to refine the HAT, and [d] to complete the concept specification.*

SKILLS DEFINITION & CRM/TRM TRAINING

In parallel to the design phase and before planning the deployment of an AI-based system:

a. Provide **AI literacy training**[1] (its potential, benefits and limitations) to all stakeholders to build understanding and trust, paving the way for its acceptance.
b. Analyse its **impact on** end-users' **competencies and skills**, adapting selection and training strategies accordingly.
c. Prepare for the shift from CRM/TRM to **AI-CRM/TRM training** where the concept of effective teamworking is extended to include Human-AI co-working.

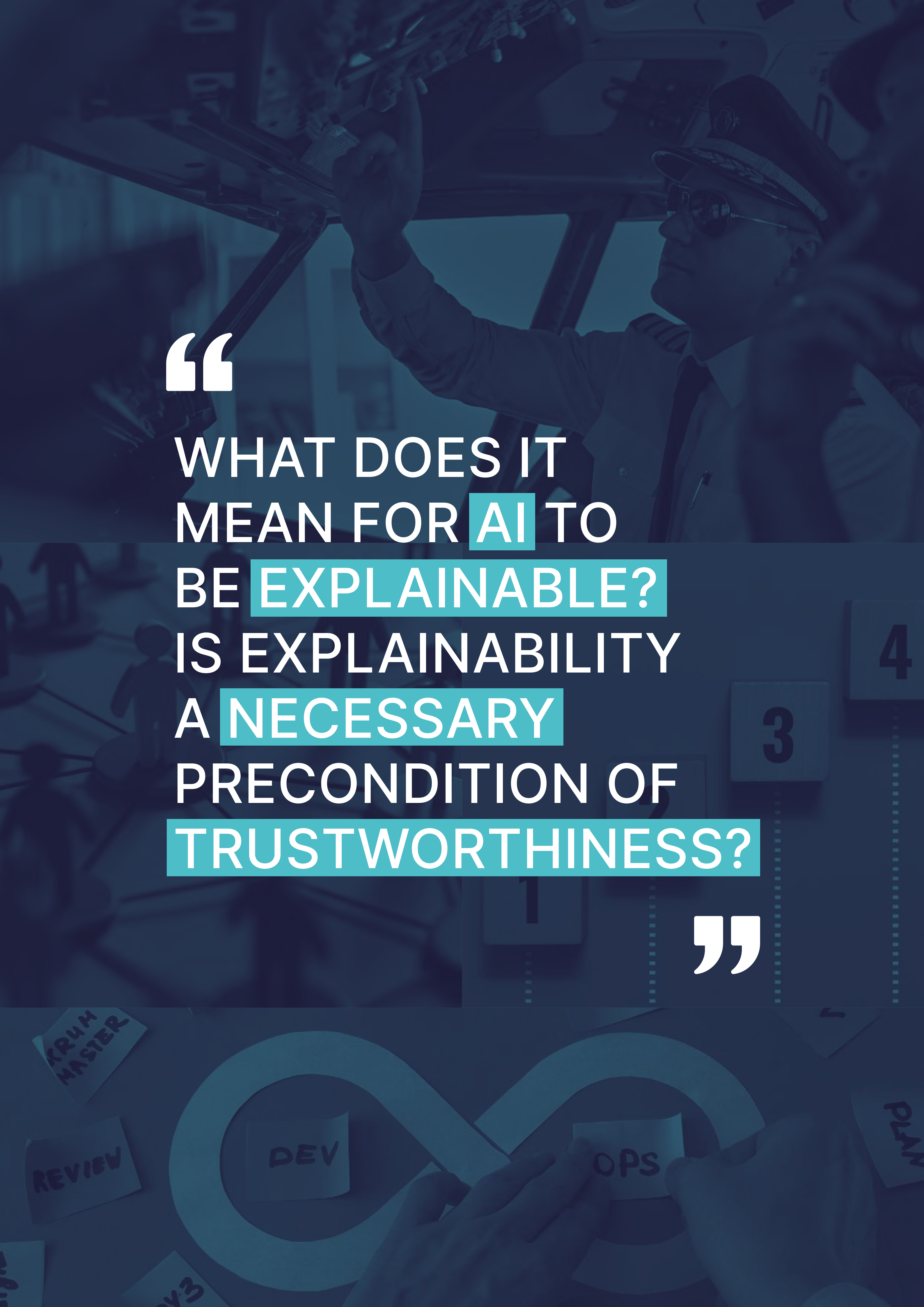
GRADUAL DEPLOYMENT

AI solutions should be deployed gradually - planning different releases - to ensure understanding, give time to develop trust and acceptance, and let the Human-AI team co-evolve[2] into optimal performance. There is no single approach suitable for all AI applications; the pace of deployment varies from situation to situation. How to proceed?

a. **Ensure reliability of the system and HAT** associated with it, with performance monitoring and testing of off-nominal conditions, and definition of clear acceptable boundaries of performance.
b. **Introduce AI in controlled stages:** from simulations to operational environments. Start with low-traffic environments in ATM before full operational use, wherever possible and suitable. Consider the possibility of running the new AI system in 'shadow mode', in parallel with the previous system (if existing).
c. After deployment **monitor the evolution of the human-AI partnership**, keeping a focus on joint human-AI performance.

Looking further ahead, the aviation industry may consider developing **personalized solutions**, assessing benefits but also the potential risks for a highly standardised and proceduralised industry. What could be the boundaries of this type of application to ensure its effective and safe usage in such a safety-critical industry? This is a challenging perspective that still needs to be explored by future research studies.

[1] EU AI Act (Article 4: AI literacy).
[2] In aviation, as of today, this co-evolution can only occur during the design phase, not in operational settings, where feedback from operations are key to enable progressive design improvements.



WHAT DOES IT MEAN FOR **AI** TO BE **EXPLAINABLE?** IS EXPLAINABILITY A **NECESSARY** PRECONDITION OF **TRUSTWORTHINESS?**

WHAT DOES IT MEAN FOR AI TO BE EXPLAINABLE? IS EXPLAINABILITY A NECESSARY PRECONDITION OF TRUSTWORTHINESS?

When approaching AI-based solutions, aviation end-users primarily want something that works and works well for them. They also want to have a **sufficient understanding** of the AI-based system to know they are in control of the situation, because they are responsible for flight crew and passenger safety.

There are three ways to build sufficient understanding of AI-based system functionalities:

a. **Beforehand** via **training** (general on AI basics and system-specific);
b. **During operations** with context-based **explainability**;
c. **After** training/operations during **debriefing** to explore what happened and why, and to consider what-if scenarios (i.e. what could have happened).

Training is an appropriate means for all contexts, while the usefulness of explainability during operations depends on the case and tends not to be suitable for time-critical situations. Indeed, the first step to design Explainable-AI (XAI) is to find the right balance between the need for real-time understanding of what AI is doing and the time required to go through and digest the information.

In HAIKU, AI is considered explainable when its explanations resonate with those of the end users, meaning its internal model aligns with the human's mental model. A set **of key recommendations to design XAI systems** are provided below:

USER-DRIVEN XAI

Explainability should target **different user groups distinctly** (operational users, supervisors, post-ops users, developers, and designers), deriving **tailored sets of XAI requirements.**

STRUCTURED EXPLAINABILITY LEVELS

XAI should provide appropriate **levels of explanation** at the right time and in the right place to the right user. To keep a coherent approach, HAIKU has adopted a XAI framework derived from **Construal Level Theory (CLT)**[3], where the quantity and depth of information and the time required to process it drive the XAI design choices. Conceive explainability as a **dynamic concept** as XAI needs may decrease as user familiarity and trust increases.

[3] Construal Level Theory for designing operational explainability for Human-AI Teaming interfaces in aviation contexts,. Venditti, R. et al., 2025

ITERATIVE XAI DESIGN

XAI should be the result of a **constant dialogue between AI developers and operational users** through iterative developments, exploring different design alternatives.

An interesting avenue for future research studies, not explored in HAIKU, is the concept of **XAI as a dialogue process** where a human seeking understanding can query the system until fully satisfied.

“HOW TO TRAIN AI TO ASSIST HUMANS IN SAFETY CRITICAL TASKS WHEN TRAINING DATA ARE INSUFFICIENT?”

HOW TO TRAIN AI TO ASSIST HUMANS IN SAFETY CRITICAL TASKS WHEN TRAINING DATA ARE INSUFFICIENT?

Data availability is a crucial asset for the development of AI-systems. As early as possible, it is essential to conduct a **preliminary feasibility assessment** by addressing the following key question: *Given the available data, can the AI model be adequately trained? This question does not have a simple black-and-white answer, as it varies from situation to situation.*

To help navigate this critical aspect, the **following insights** are provided below:

LOOK BEYOND DATA ASSOCIATED WITH NEGATIVE EVENTS

There is a tendency to focus AI training on data related to events that should be avoided. Fortunately, such cases are relatively rare in the aviation industry. However, this means data scarcity for AI aviation applications. To address this challenge, it is important to consider that AI can also **learn from data associated with positive outcomes**. While this approach increases complexity and requires resources - i.e. effort intensive labelling - it can be a way to expand the training set.

CONSIDER DATA AUGMENTATION STRATEGIES

Expanding the training dataset through **synthetic data generation** or **simulated environments** is currently being explored. It is a research avenue worthy of further investigation, as it may have the potential to enhance model performance and robustness.

ADAPT AI'S ROLE BASED ON DATA AVAILABILITY

When targeting **safety-critical tasks**, and finding that data are insufficient, **AI** should be used **to support processes and data analysis** rather than decision-making. In addition, **data-driven approaches** can be **combined with traditional rule-based AI** - acting as a safeguard to ensure that AI doesn't go beyond its depth.

DON'T GET "CAUGHT UP IN THE HYPE"

Use AI only if you can train it with the right data and ensure real added value; otherwise, **seek alternative solutions**.

Overall, when developing an AI-based system, design with the understanding that unknowns will always exist for both humans and AI. Therefore, the Human-AI system should embrace a **dynamic approach based on the principle of constant co-evolution**, with humans and AI trained to recognise when they are treading in unexplored situations.

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WHAT ARE THE MAIN CHALLENGES IN VALIDATING AI-BASED SYSTEMS?

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WHAT ARE THE MAIN CHALLENGES IN VALIDATING AI-BASED SYSTEMS?

As AI becomes an integral part of aviation operations, the validation of AI-based systems must evolve accordingly. HAIKU introduces a **user-centred**, **risk-based Validation Framework** to assess AI-enabled systems throughout their development lifecycle. This integrated approach encompasses Safety, Human Performance, Security, and Liability (SHS-L) within a **unified assurance model** built around system maturity.

The HAIKU Validation Framework follows an **iterative process**, with different steps. It begins with scenario-based modelling through **Operational Sequence Diagrams (OSDs)** and **HAZOP workshops**, capturing real-world human-AI interactions and critical decision points. These scenarios feed into **cross-disciplinary analyses** structured around **four interdependent Key Performance Areas (KPAs)**: Safety, Human Performance, Security, Liability.

For each KPA, HAIKU has identified a set of key risk categories, transversal to all the Use Cases, in a way representing the typical challenges of Human-AI systems:

- for **SAFETY**: Preparedness, Predictability, and Operator Overreliance;
- for **HUMAN PERFORMANCE**: Interface Usability, Communication, Situational Awareness, Trust, and Training Readiness;
- for **SECURITY**: Data integrity, Biases, and Adversarial Threats;
- for **LIABILITY**: Product, Organisational, and Personal Responsibility.

Through this Framework, HAIKU advocates for validation approaches that embrace **iterative, cross-disciplinary analysis** to facilitate the seamless integration of AI into aviation. **Key recommendations** include:

ITERATIVELY EVALUATE INTERACTION RISKS INVOLVING END-USERS

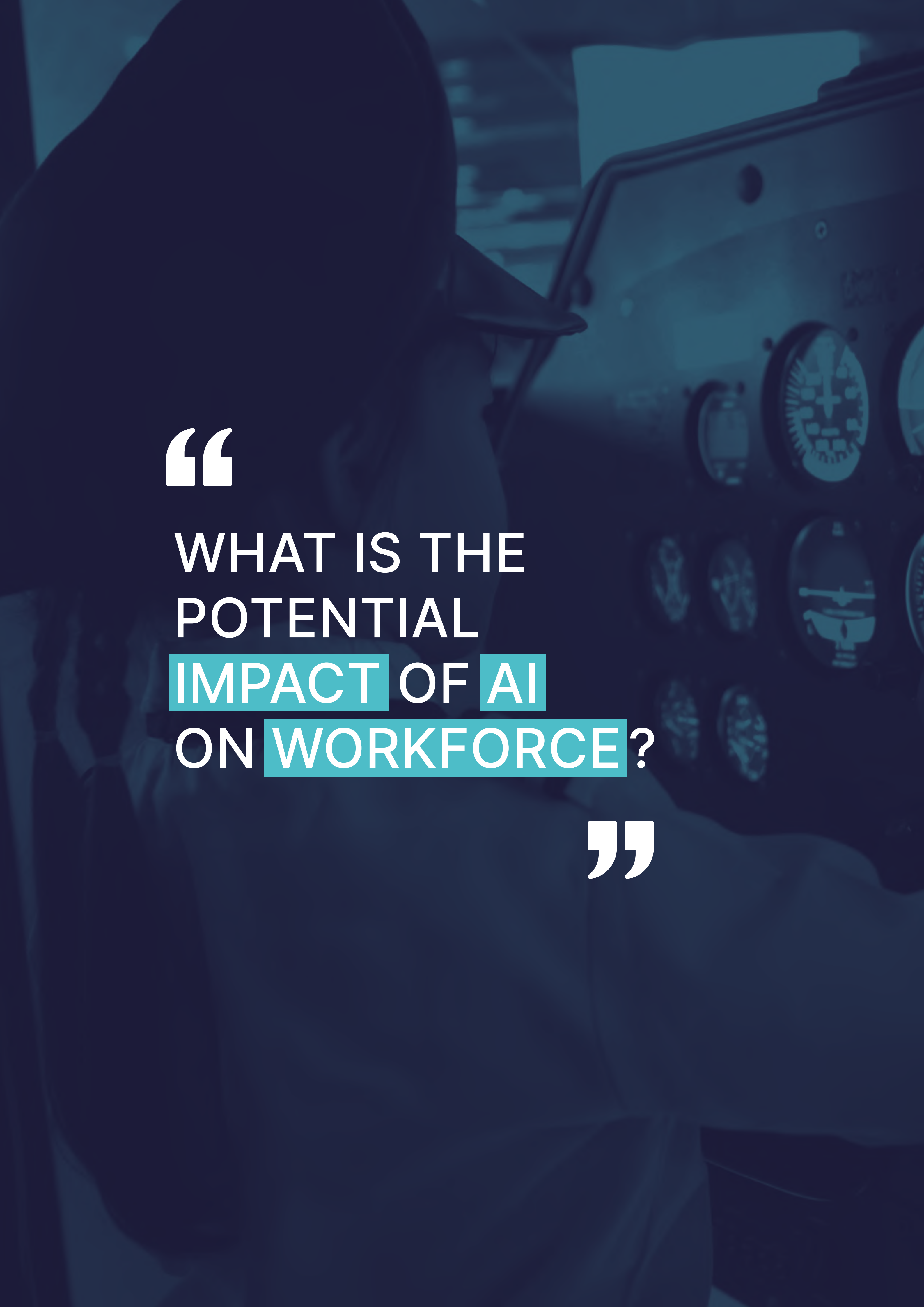
Use methodologies such as HAZOP to surface hidden hazards, ambiguous authority transfers, and performance bottlenecks in critical workflows.

ADOPT LEGAL-BY-DESIGN PRINCIPLES

Embed legal foresight across the development process to clarify liability distribution and support future certification.

PROMOTE CROSS-KPA RISK AWARENESS

Avoid siloed analyses by jointly assessing Safety, HF, Security, and Liability, and embrace a systems-thinking perspective to identify emergent vulnerabilities, such as trust erosion due to AI-based system unpredictable behaviours.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WHAT IS THE POTENTIAL IMPACT OF AI ON WORKFORCE?
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WHAT IS THE POTENTIAL IMPACT OF AI ON WORKFORCE?

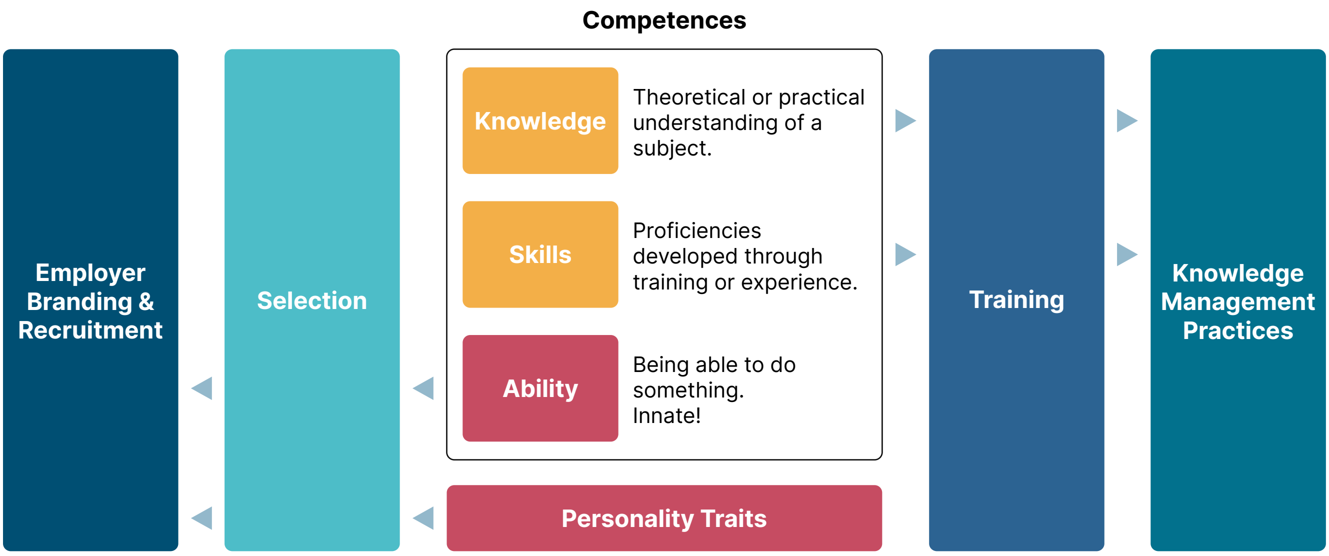
By 2050, AI is envisaged to **gradually become part of the teams across all aviation segments**. A roadmap is foreseen starting in 2025 with humans performing the majority of tasks, solving problems and making decisions towards 2050 where humans will rather monitor the operation and team-up with AI for off-nominal situations.

Workforce development should go hand in hand with the evolution of technology, anticipating these changes and reflecting them in the Human Resource Management practices to ensure safe operation in the future.

BUT HOW CAN THIS BE ACHIEVED?

A **set of recommendations** has been outlined for both **practitioners** and **researchers**. These consider the dual nature of the human role in future systems: on one hand, elements such as knowledge and skills can be developed through training and should therefore be incorporated into future training and knowledge management approaches. On the other hand, traits like cognitive abilities and personality are largely innate, which means they should be carefully considered in recruitment, selection, and employer branding strategies.

*The figure below collects recommendations for **HF Practitioners** and **Researchers** from **Employer Branding** to **Knowledge Management Practices**. Starting from the level of competences, recommendations differentiate between **Knowledge (K)** and **Skills (S)** as trainable aspects of individuals and **Abilities (A)** and **Personality (P)** as mostly innate human characteristics.*



HF Practitioners		HF Researchers
Initiate **strategic internal communication** and AI literacy training well in advance to foster employee understanding of AI, clarify its potential and limitations, and **build a foundation of trust** for its successful integration.	**Employer Branding**	Conduct further research on **how Employee Value Propositions should evolve as AI transforms roles** across the aviation industry. Focus on **strategies to attract and retain future candidates** by understanding their evolving expectations, values, and motivational drivers.
Revise the recruitment strategy to provide a **clear and comprehensive introduction to all aspects of future roles**. This will help candidates **develop realistic expectations**, thereby reducing dropouts and turnover.	**Recruitment**	Conduct longitudinal research to examine how the **needs and expectations of the current and future aviation workforce** are evolving, and to identify the key factors motivating individuals to pursue a career in this field.
Anticipate role evolution and **start revising selection criteria accordingly**. Future roles may favor lower Extraversion and higher Openness to Experience and Emotional Stability.	**Selection**	Conduct validation studies to **scientifically assess whether the revised selection criteria reliably and fairly predict** future success and performance.
Competences	K S A P	
Prepare for a shift **from traditional CRM and TRM training to AI-augmented CRM and TRM training**. To maximize effectiveness, make sure that training materials are **tailored to the specific** characteristics and culture of the **organization**.	**Training**	Develop a **universally accepted theoretical framework and ontology to study Human-AI teamwork**. Additionally, generate **empirical evidence** through scientific research to inform and enhance Human-AI teaming training programs.
Develop a **structured organizational strategy to proactively capture and manage knowledge generated by AI-based team members**. Emphasize utilizing tacit knowledge gained through learning-by-doing to enrich formal training programs and optimize interface design for better human-AI teaming.	**Knowledge Management**	Explore **how AI can enhance knowledge management**, with a particular focus on its ability to **generate new, relevant explicit knowledge from existing explicit knowledge**, thereby helping operators see what goes beyond their natural capacity to observe and elaborate.


"WHAT IS THE
POTENTIAL IMPACT
OF AI ON SAFETY
CULTURE?"

WHAT IS THE POTENTIAL IMPACT OF AI ON SAFETY CULTURE?

The pilots' point of view

*AI might have a **positive impact on Safety Culture**, but only if **properly regulated** to avoid undesired usage and unsafe outcomes.*

WHAT PILOTS WOULD SAY TO...

MANUFACTURERS

"I don't care whether it's AI or advanced automation - what matters is that it gives me a true **sense of control**."

"AI is a powerful technology that I would welcome on board, but only if it **does not override my intentions and decisions** and **can be switched off** whenever necessary."

"When designing an AI-based system, don't start from the assumption that *"pilots always do things right"*. Instead, focus on ensuring that **humans operate as they are supposed to.**"

AI EXPERTS

"Can AI really be **trained on Safety Culture**?"

"**Active monitoring** is a cornerstone of safety culture. As Pilot Monitoring I wonder: how to perform it safely when AI becomes another "crew member" to oversee and cross-check actions with?"

"AI may be a valuable support to prevent and detect **human errors**, supporting in recovery. But will it be also capable of helping me in preventing, detecting and recovering from its own errors?"

WHAT IS THE POTENTIAL IMPACT OF AI ON SAFETY CULTURE?

The pilots' point of view

Pilots' **openness to adopting AI onboard** *may depend on the aircraft they are used to flying. Those accustomed to highly automated systems are likely to be more inclined to embrace it.*

WHAT PILOTS WOULD SAY TO...

AIRLINE COMPANIES

"Don't ask me if I would feel safer with AI - It is impossible to say right now. Guide me towards its acceptance by **involving me in its design** and **introducing it gradually**, starting with AI solutions that handle the **tasks I find boring**."

"To enhance our understanding and start fostering AI acceptance, airlines should start **training us on AI literacy** today."

"I already **speak up for safety** today but not all pilots do it as reporting requires extra-time. I bet the introduction of AI could actually **help increase reporting**... though only if the added value of pilots' work continues to be sustained and recognised."

FUTURE PILOTS

"When AI will be in operation, current recurring training will no longer be sufficient to **retain technical skills**, which I feel increasingly becoming an **individual responsibility**."


HOW CAN AI SUPPORT PILOTS IN EFFECTIVELY HANDLING STARTLING AND SURPRISING EVENTS IN THE COCKPIT?

USE CASE #1

HOW CAN AI SUPPORT PILOTS IN EFFECTIVELY HANDLING STARTLING AND SURPRISING EVENTS IN THE COCKPIT?

THE **“FOCUS”** INTELLIGENT ASSISTANT (FLIGHT OPERATIONAL COMPANION FOR UNEXPECTED SITUATIONS)

SHORT DESCRIPTION

The FOCUS assistant aims to support pilots during startling and surprising events in the cockpit. These events sometimes provoke “freeze” reactions, delay in response time or inappropriate cockpit inputs and can lead to accidents.
To tackle this, FOCUS helps pilots manage Stress and regain Situational Awareness. It offers real-time assistance, detecting startling events and aiding in quick recovery from complex situations.

Promotional video | Demo video

CLASSIFICATION

EASA Level 2A: Human and AI-based system cooperation
FOCUS shows how AI augmentation can complement human expertise, fostering a cooperative and trustworthy human-AI interaction. The pilot always remains in control and can easily activate or deactivate FOCUS whenever needed.

USE CASE #1 TEAM

ENAC
DFKI

TRL

FOCUS is a complex agent composed of 3 main building blocks: (1) Startle detection function (2) Stress regulation support (3) Situation Awareness Augmentation. Most of them started from TRL1 and reached TRL4 at the end of the project.

SEP ’22

- M1 – **TRL1:** CONOPS formulation
- M6 – **TRL2:** Prototype specifications definition (through end-users interviews and design meetings)
- M16 – **TRL3:** Prototype Version 1 Validation
  - Laboratory test for (1) (startle and surprise fundamental experiment)
  - Aircraft simulator test with end-users for (2) and (3) on first iteration of FOCUS
- M28 – **TRL4:** Prototype Version 2 Validation
  - AI Training with new datasets and testing with data collected in the simulator for (1)
  - Laboratory tests for (2) (vibrotactile experiment)
  - Aircraft simulator test with end-users in a relevant operational scenario for (2) and (3) for iteration two of FOCUS
- M36

AUG ’25

RECOMMENDATIONS FROM HAIKU USE CASE #1 FOR FUTURE RESEARCH

1. **Balance operational explainability and Human-AI Teaming with available time:** due to time criticality together with the pilot's altered mental state, operational explainability emerges not to be an effective way to build trust and understanding in this Use Case.

2. **Explore different interaction modalities:** a transition to voice-based interactions could help reduce cognitive workload. As such, it is advisable to investigate this interaction modality as a potential approach for effectively incorporating operational explainability into this use case.

3. **Go beyond operational explainability:** don't overlook the potential of training as it emerges to be the most effective way to enable pilots' familiarisation with and understanding of the system in such a time-critical context.

4. **Explore solutions to align AI reasoning with that of the pilots:** incorporating decision-making frameworks in the AI system is expected to improve Human-AI cooperation.

5. **Look into the realm of personalisation:** this has the potential to enhance Human-AI cooperation, with AI providing support to pilots considering specific flying patterns and preferences.

6. **Explore how AI and Human-AI Teaming can assist in managing startling and surprising events in a 2-pilots configuration:** HAIKU Use Case 1 focuses on one-to-one interactions, demonstrating how FOCUS can offer valuable support to a single-pilot. But how can this concept translate to a crew setting? This is a research question for further exploration.

> HOW CAN WE ENHANCE PILOT-INTELLIGENT ASSISTANT COLLABORATION BY USING HIGHER LEVEL INTERACTION LANGUAGE BASED ON OPERATIONAL INTENTIONS?

USE CASE #2

HOW CAN WE ENHANCE PILOT-INTELLIGENT ASSISTANT COLLABORATION BY USING HIGHER LEVEL INTERACTION LANGUAGE BASED ON OPERATIONAL INTENTIONS?

THE “**OLIVIA**” INTELLIGENT ASSISTANT
(OPERATIONAL INTENTIONS ADVISER FOR AVIATION)

SHORT DESCRIPTION

OlivIA is an AI-based decision-support tool designed to assist flight crews in managing en-route threats and selecting alternate flight plans. Its purpose is to reduce pilot cognitive workload, enabling more effective, mission-focused decisions in complex scenarios.
OlivIA suggests flight plan adjustments that are prioritized and evaluated according to operational intentions. It also benefits the Operations Control Center by improving coordination and reducing response times.

Promotional video | Demo video

CLASSIFICATION

EASA Level 1B: Human cognitive assistance in decision and action selection
OlivIA demonstrates how AI can proactively support pilots in exploring the solution space, offering suggestions that align with their operational intentions. It enhances the decision-making process without autonomously executing actions.

USE CASE #2 TEAM

THALES, EMBRAER, CATIE, BORDEAUX INP

TRL

OlivIA builds on a Bidirectional Communication concept previously validated in the military domain. Its design and development started at TRL1 and successfully advanced to TRL5 by the end of the project.

SEP '22

- M1 — **TRL1:** Military Communication concept assessment and OlivIA high-level concept definition for regional segment
- M6 — **TRL2:** Concept prototypes development (Assistive, Cooperative and Collaborative)
- M16 — **TRL3:** Concept prototypes evaluation with end-users (6 pilots) and selection of the most appropriate one (assistive)
- M22 — **TRL4:** Prototype (assistive) development with iterative evaluation (3 test pilots)
- M24 — **TRL4:** Integration of OlivIA with real Flight Management System (FMS200 - THALES)
- M29 — **TRL5:** Prototype validation (10 pilots using a representative system, the FlytX cockpit by THALES)

AUG '25

RECOMMENDATIONS FROM HAIKU USE CASE #2 FOR FUTURE RESEARCH

1. **Do not isolate users, aviation is a collaborative job:** when designing an Intelligent Assistant for a complex system like aviation, effectively managing its impact and maximizing its benefits requires considering stakeholders, understanding the network of collaboration.

2. **Adopt an iterative design approach from the concept stage:** involve end-users and other relevant stakeholders from the outset to determine the most desired and acceptable level of support (assistive, cooperative, or collaborative) before development begins. Base your approach on user needs, considering varying expertise levels and workload scenarios. Understanding how each user profile would benefit in different contexts is essential to effectively define the solution's scope and objectives.

3. **Use XAI to ensure end-users adequately understand the system and feel in control:** design the HMI to balance clarity with completeness, avoiding information overload. Implement a multi-layered XAI approach to deliver the appropriate explanation level of abstraction at each stage of the decision-making process.

4. **Establish effective Human-AI communication:** effective communication between humans and AI fosters true teamwork, enabling both to recognize, understand, respond to, and anticipate dynamic flight conditions. The ability to negotiate and align decision-making processes supports coordinated operations, ultimately enhancing safety and efficiency of operations.

5. **Always strive to improve Situational Awareness:** regardless of the specific tasks supported by the Intelligent Assistant, improving situational awareness should remain a key objective. OlivIA was recognized for its ability to do so by presenting alternative solutions within an integrated information environment, rather than isolated options.



HOW CAN AI SUPPORT HUMANS IN MANAGING U-SPACE OPERATIONS?

USE CASE #3

HOW CAN AI SUPPORT HUMANS IN MANAGING U-SPACE OPERATIONS?

THE **“DUC”** INTELLIGENT ASSISTANT
(DIGITAL ASSISTANT FOR UAM COORDINATOR)

SHORT DESCRIPTION

The DUC is an AI-based conceptual system designed to support the safe and effective management of U-space operations, working in collaboration with a newly defined human role: UAM Coordinator. As a collaborative teammate, the DUC offers real-time tactical and strategic support in both normal and emergency scenarios. It adapts to varying operational contexts, assisting with high-level tasks, fostering shared situation awareness, diagnosing issues, and supporting problem-solving.

Promotional video | **Demo video**

CLASSIFICATION

EASA Level 2B: Human and AI-based system collaboration
DUC operates under a shared authority model with the UAM Coordinator. It autonomously manages routine functions - such as flight authorization, tracking, geofence monitoring, conformance monitoring, and conflict resolution -,while the UAM Coordinator maintains partial authority, ensuring oversight and enabling effective human-AI collaboration.

USE CASE #3 TEAM

TRL

DUC is a complex system comprising 3 main building blocks: (1) UAM Coordinator Working Position (2) the HMI (3) the back-end, which includes AI components. Development began at TRL1, reaching TRL4 for components (1) and (2) and TRL2 for component (3) by the end of the project.

SEP '22

- M1 – **TRL0:** Preliminary feasibility assessment of IA concepts in UAM
- M12 – **TRL1:** Initial ConOps definition for (1) and (2)
- M18 – **TRL2:** Prototype specifications definition for (1) and (2) (through workshops, end-users interviews and design meetings)
- M24 – **TRL3:** Proof of concept prototype version 1 Validation for (1) and (2) (laboratory test with ATCOs)
- M29 – **TRL1:** Initial ConOps definition for (3)
- M31 – **TRL4:** Prototype Version 2 Validation for (1) and (2) (laboratory test with ATCOs)
- M31 – **TRL2:** Prototype specifications definition for (3)
- M36

AUG '25

RECOMMENDATIONS FROM HAIKU USE CASE #3 FOR FUTURE RESEARCH

1. **Adopt a human-centred design approach:** involve end-users from the outset and throughout all stages of the design process to ensure AI solutions are developed around human needs and expectations, aligned with operational requirements, and grounded in a clear understanding of the problem before algorithm development begins.

2. **Integrate attention guidance mechanisms into operational interfaces:** these mechanisms play a key role in supporting operators' situational awareness and reducing workload by automatically guiding their focus to critical areas or information - such as through a 'take me there' function - thus enabling faster access to what matters most with reduced cognitive effort.

3. **Use multiple explanation formats to support diverse needs:** just as effective human communication requires adapting to the audience and context, AI systems should likewise offer personalized and varied formats - such as storytelling, text-based explanations, or spoken messages - to suit different user preferences and situational demands.

4. **Integrate AI systems into training environments:** to promote acceptance, trust, and recognition of AI as a team member rather than just a tool, training initiatives - including CRM programs - should go beyond teaching humans how to collaborate with AI, incorporating AI as an active component of the training process itself.

5. **Explore operator readiness for AI-based teammates:** operators often perceive AI systems as tools rather than collaborative partners, even when designed for teamwork. This indicates that deeper cognitive and cultural factors shape these perceptions. Future efforts should focus on training, interface design, and integration strategies to foster the acceptance of AI as an active team member.

6. **Explore the role of AI soft-skills in shaping team perception:** HAIKU Use Case 3 highlighted the need to investigate how AI's soft skills - such as timing, tone, phrasing, and interaction style - affect human perception, as these elements may play a crucial role in whether AI is accepted as a teammate rather than just a tool.

> "HOW CAN **AI** ENHANCE AIR TRAFFIC CONTROLLERS' **DECISION-MAKING PROCESS** AND OPTIMISE **RUNWAY UTILISATION** IN SINGLE-RUNWAY AIRPORTS?"

USE CASE #4

HOW CAN AI ENHANCE AIR TRAFFIC CONTROLLERS' DECISION-MAKING PROCESS AND OPTIMISE RUNWAY UTILISATION IN SINGLE-RUNWAY AIRPORTS?

THE "**ISA**" INTELLIGENT SEQUENCE ASSISTANT

SHORT DESCRIPTION

The Intelligent Sequence Assistant (ISA) aims to support and enhance decision-making for TWR ATCOs by optimising runway utilisation in single-runway airports. It provides sequence suggestions for both arriving and departing aircraft, aiming to streamline operations and improve efficiency. The system is tested via integration with a simulator that replicates the Alicante-Elche Airport in Spain.

Promotional video | Demo video

CLASSIFICATION

EASA Level 2A: Human and AI-based system cooperation
ISA shows how AI can assist humans by fostering cooperative human-AI interaction, while leaving full control and authority in human hands.
In this cooperative model, ISA autonomously analyzes data and suggests the optimal sequence to the ATCO, who remains responsible for executing the task. This is a "directed" model, as defined by EASA, where the end-user actively monitors ISA's actions, verifies its suggestions, and can intervene at any time.

USE CASE #4 TEAM

skyway · deepblue · Suite5 We Deliver Intelligence

TRL

ISA design and development started at TRL1 and successfully advanced to TRL6 by the end of the project.

SEP '22

- M1 — **TRL1:** Concept formulation
- M12 — **TRL2:** Prototype specifications and requirements definition (through expert consultations and user research)
- M18 — **TRL3:** Proof of Concept and first prototype
- M24 — **TRL4:** Human-in-the-Loop 1st Validation in the simulator with ATCOs
- M28 — **TRL5:** Full prototype
- M30 — **TRL5:** Full prototype components -Technical validation in relevant environment
- M33 — **TRL6:** Full prototype human-in-the-loop validation in the simulator with ATCOs
- M36

AUG '25

RECOMMENDATIONS FROM HAIKU USE CASE #4 FOR FUTURE RESEARCH

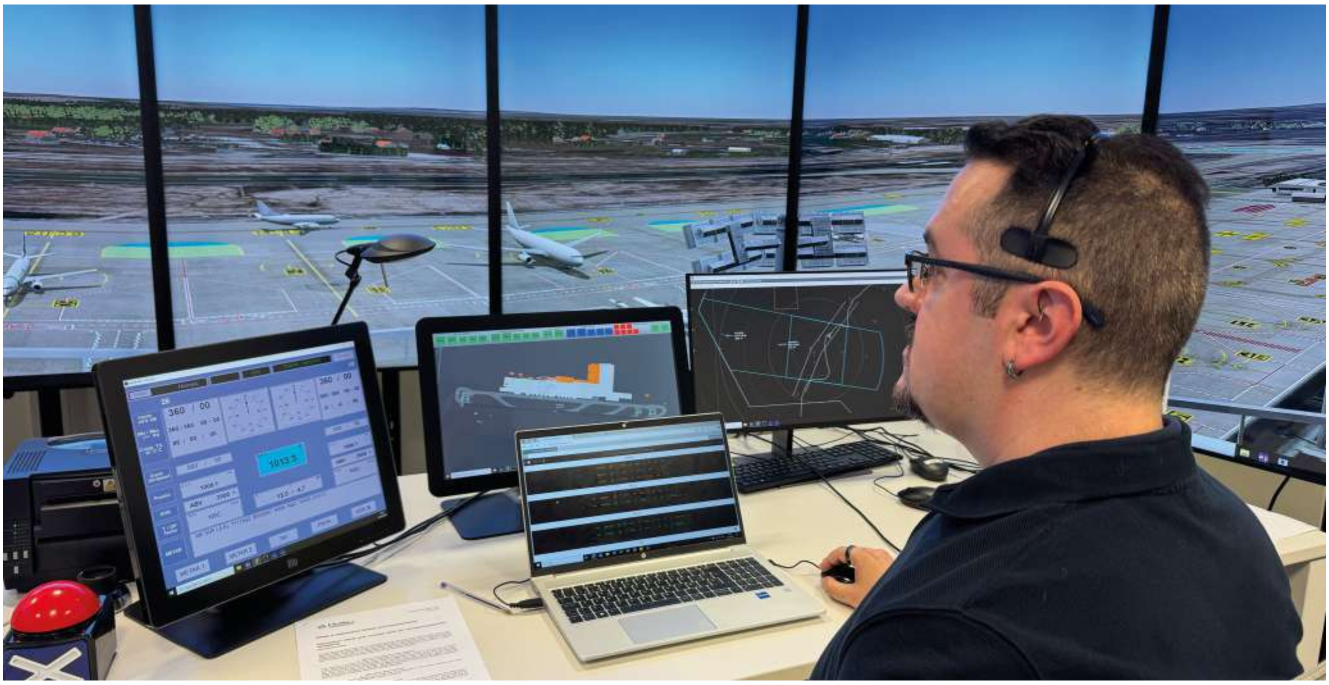
1. **Build AI systems as additional safety nets:** AI systems should be designed to serve as an extra layer of safety. ISA achieved this by offering effective visual alerts for potential conflicts and unsafe situations, reinforcing the human operator's ability to detect and respond promptly.

2. **Design dynamic XAI:** explainability should be adaptive, responding to changes in workload and operational tempo. In high-stress situations, it should deliver concise visual or multimodal cues; in lower-pressure moments, it can provide more detailed, contextual explanations. Interfaces must be fast, intuitive, and designed for seamless interaction, always minimizing humans' cognitive load.

3. **Evolve from a real-time Intelligent Assistant to a predictive system:** once the real-time Intelligent Assistant performs reliably, the next step is to advance toward a predictive system. ISA-Advanced should focus on leveraging trajectory forecasting and contextual awareness to provide proactive, preventive solutions.

4. **Pursue strategies to make AI adaptable to individual working styles:** even in highly standardized industries like aviation, each individual has its own working style. To maximise the effectiveness of AI solutions, optimise Human-AI Teaming, and boost operational efficiency, AI systems should be able to adapt to - and learn from - each worker's ways of working.

5. **Explore how AI and Human-AI Teaming can support ground operations:** HAIKU Use Case 4 focuses on optimising sequencing and runway utilisation. But how could this concept be extended to ground operations? This is a promising research avenue, with the potential to enhance route guidance and conflict detection, supporting safer and more efficient operations during adverse weather and emergency situations.



> HOW CAN WE **LEVERAGE HISTORICAL DATA** TO GENERATE ACTIONABLE SAFETY INTELLIGENCE FOR IMPROVING DAY-TO-DAY **AIRPORT OPERATIONS** AND SAFETY PERFORMANCE?

USE CASE #5

HOW CAN WE LEVERAGE HISTORICAL DATA TO GENERATE ACTIONABLE SAFETY INTELLIGENCE FOR IMPROVING DAY-TO-DAY AIRPORT OPERATIONS AND SAFETY PERFORMANCE?

THE “**ASW**” INTELLIGENT ASSISTANT
(AIRPORT SAFETY WATCH)

SHORT DESCRIPTION

The Airport Safety Watch (ASW) assistant aims to enhance the daily safety of airport operations by using both historical and real-time data to minimise the risks of safety events and incidents on the airfield.
ASW assists the airport duty-holder (London Luton Airport - LLA) and other principal airport users, in reducing the risks of three key incident types: pushback error, hold-point busts and incorrect taxiway selection.
ASW uses data science (AI) to determine causal and contributory factors, presenting insights in a multi-layered dashboard to drive actionable safety improvements and reduce risk.

Promotional video | Demo video

CLASSIFICATION

EASA Level 1A - Human augmentation
ASW provides enhanced information to airport safety personnel, augmenting their ability to identify actionable safety insights from complex data patterns.

USE CASE #5 TEAM

TRL

The design of the ASW started from scratch and reached TRL9 at the end of the project.

SEP '22

- M1 — **TRL1:** CONOPS formulation
- M6 — **TRL1:** Basic principles definition
- M9 — **TRL2:** Application formulation
- M12 — **TRL3:** Proof-of-concept
- M15 — **TRL4:** Functional verification
- M19 — **TRL5:** Breadboards (reduced scale) verification in relevant environment
- M23 — **TRL6:** Dashboard demo in LLA and Luton Safety Stuck
- M27 — **TRL7:** Dashboard testing in LLA systems
- M30 — **TRL8:** Dashboard in use for LLA airside safety officers briefing
- M36 — **TRL9:** Dashboard Integrated into LLA safety management infrastructure

AUG '25

RECOMMENDATIONS FROM HAIKU USE CASE #5 FOR FUTURE RESEARCH

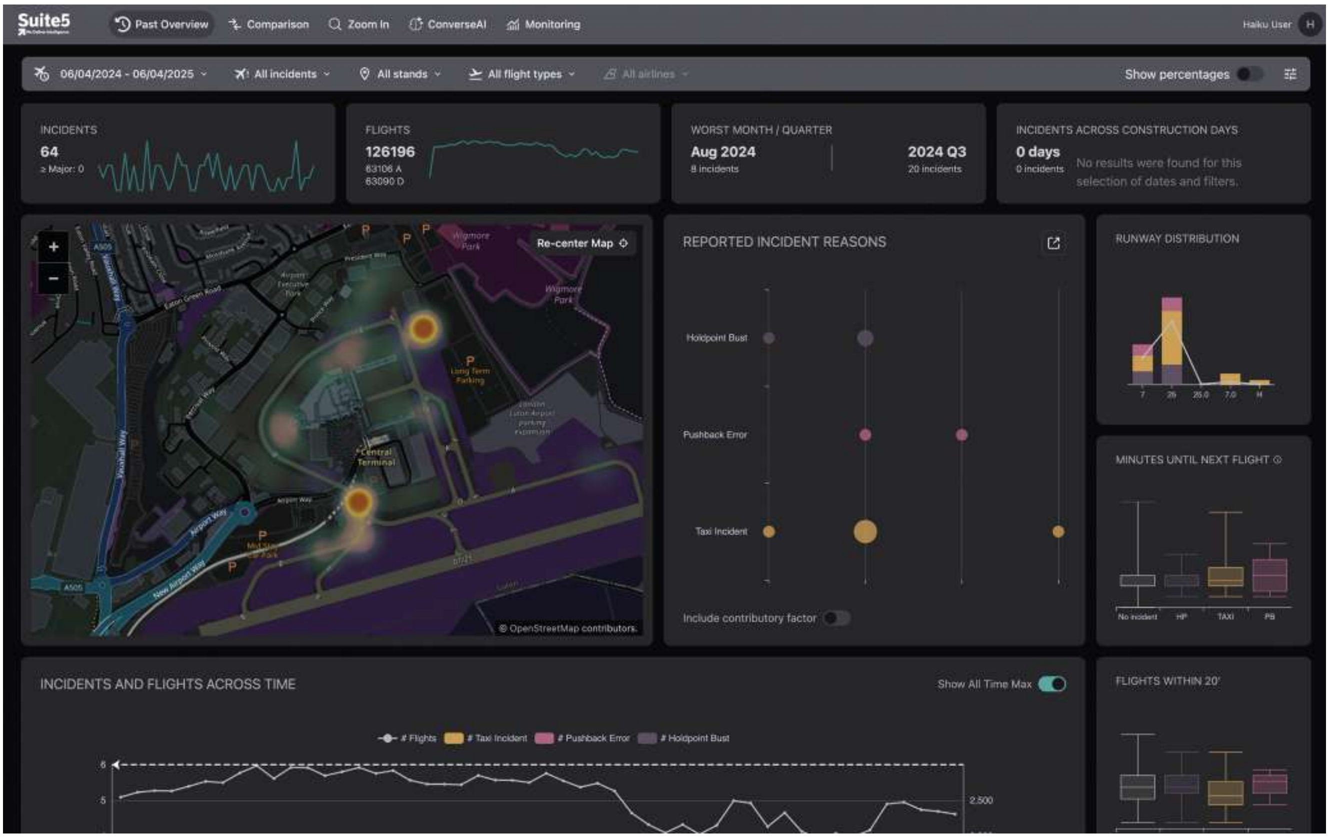
1. **Adopt a user-centric design approach:** going beyond primary users and involving a broad range of stakeholders throughout all stages of the ASW design proved essential in delivering a more effective and impactful solution.

2. **Go with a gradual deployment strategy:** this was a successful way to engage airport users in an effective co-constructive process, fostering trust and acceptance and allowing a seamless integration into LLA's safety management system.

3. **Strive to improve how risk intelligence can be used in day-to-day operations:** ASW has not only enhanced the efficiency of safety operations but also transformed the way safety people do their job and make decisions, and inform all airside users on day-to-day risks.

4. **Explore more advanced AI techniques when more data is available:** the application of more advanced AI techniques would enhance future incidents forecast and should be further explored, evaluating feasibility according to data availability.

5. **Explore applicability of ASW approach to other contexts:** HAIKU Use Case 5 focuses on London Luton Airport, a single-runway airport, demonstrating how AI and data visualisation can enhance airport safety by providing insights into past incidents and contributing to risk reduction. However, would this approach be effective for airports with different operational characteristics? This is a research question for further exploration.



“HOW CAN AI HELP **PASSENGERS** MAKE INFORMED **DECISIONS** ABOUT AIRPORT VISITS WHILE ENSURING **SAFETY** AND **REDUCING INFECTION** RISK?”

USE CASE #6

HOW CAN AI HELP PASSENGERS MAKE INFORMED DECISIONS ABOUT AIRPORT VISITS WHILE ENSURING SAFETY AND REDUCING INFECTION RISK?

THE “**COVAID**” INTELLIGENT ASSISTANT (COVID-19 AID)

SHORT DESCRIPTION

The COVAID Intelligent Assistant is designed to support passenger routing within airports while minimising the risks of virus transmission. It is an Android application that leverages near-real-time camera data and passenger preferences to identify the least crowded routes and areas. Powered by AI algorithms, COVAID also provides insights into potential infection risks. Passengers interact with the system through a chatbot that delivers clear, explainable messages.

Promotional video | **Demo video**

CLASSIFICATION

EASA Level 1B - Human cognitive assistance in decision and action selection

COVAID demonstrates how AI can enhance passenger experience in crowded environments like airports by offering routing assistance (recommendations), while leaving full authority with the human user.

USE CASE #6 TEAM

HELLENIC INSTITUTE OF TRANSPORT CERTH / HIT

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

TRL

COVAID design and development started at TRL1 and achieved TRL5 by the end of the project.

SEP '22

- M1 — **TRL1:** Initial concept definition
- M9 — **TRL2:** Initial laboratory implementation of subsystems and first prototype
- M16 — **TRL3:** First prototype validation with passengers interactions
- M28 — Second prototype
- M30 — **TRL4:** Second prototype validation with multiple passengers at the Amygdaleona airport (Kavala, Greece)
- M36 — **TRL5:** Further technical tests and final prototype

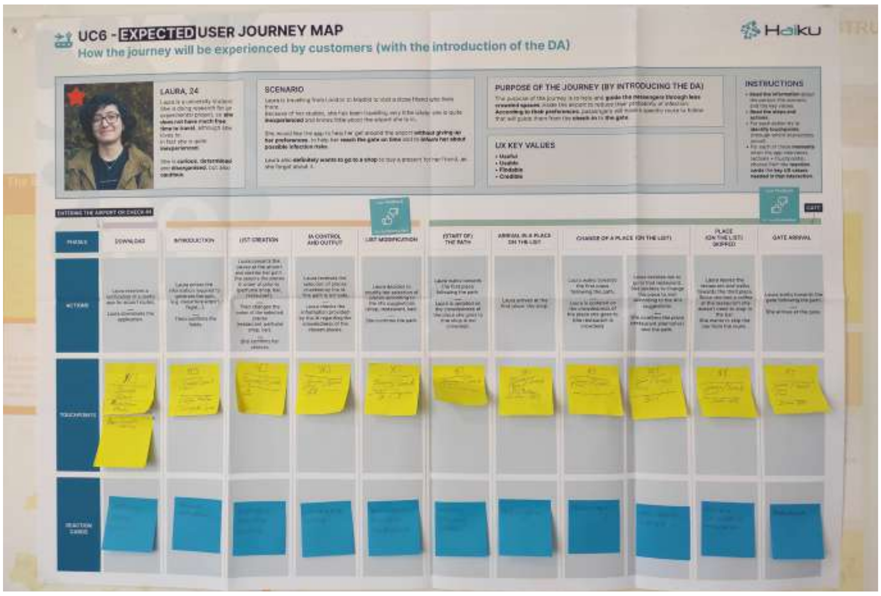
AUG '25

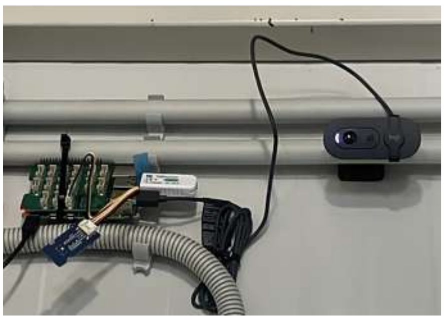
RECOMMENDATIONS FROM HAIKU USE CASE #6 FOR FUTURE RESEARCH

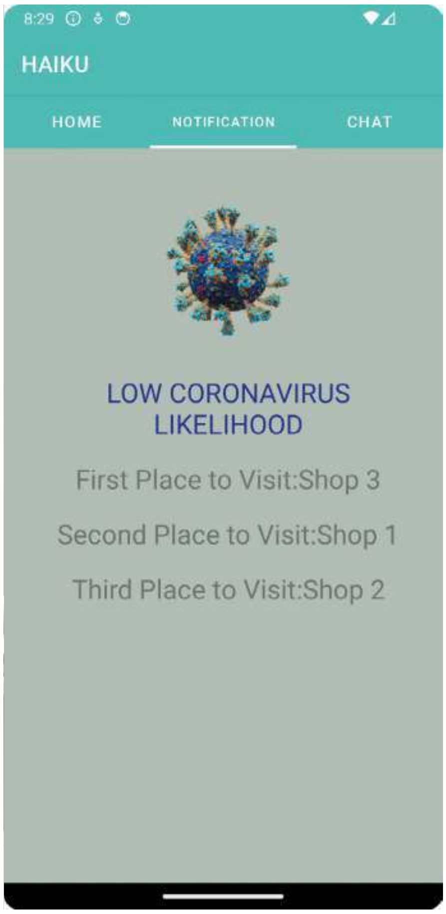
1. **Adopt a passenger-centric approach:** when considering the use of AI in aviation, the focus should go beyond operational end-users to include the ultimate beneficiaries: the passengers. HAIKU Use Case 6 illustrates a successful application of AI aimed at enhancing the passenger journey.

2. **Pursue the integration of local data into Large Language Models:** in HAIKU Use Case 6, IoT data is integrated into a retrieval-augmented generative AI chatbot, demonstrating the potential for incorporating local, context-specific data into a Large Language Model, which would improve the answers of the chatbot. This opens the door to more tailored and situationally aware AI systems.

3. **Explore how to design explainability for public users in transport systems:** HAIKU Use Case 6 focuses on passenger routing within airports. Could this approach be beneficial for passengers in other transport systems and environments (e.g. railway stations, cruise ships, etc.)? This is a research question for further exploration.







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We are **15 Partners** from 10 different countries, bringing together **Human Factors** expertise, domain's key **end-users** and **technology** suppliers of excellence.

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ADVISOR

Haiku
Human AI teaming Knowledge and Understanding for aviation safety

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This project has received funding by the European Union's Horizon Europe research and innovation programme HORIZON-CL5-2021-D6-01-13 under Grant Agreement no 101075332