Human-AI Teaming for Cockpit Assistance

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Abstract. This presentation reports ongoing work in HAIKU project, regarding development of an Human-AI Teaming (HAT) assistant concept for pilot decision support in re-route due to weather threat or need to divert, due to destination airport unavailable. The case is described and current, on-going, methodological exploration avenues reported.

Context

This contribution focuses on the current findings regarding the exploration of Human-AI teaming (HAT) (EASA, 2024) for development of an assistant to support pilots in adjusting their route due to a meteorological event in cruise or decide of an alternate airport selection. The concept explores the enhancement of bidirectional communication through operational intentions as high-level shared abstractions, thus improving and accelerating the decision-making process (Hourlier, et al., 2022).

HAIKU (2022-2025) is a European funded project aimed at developing Human Factors guidelines for the development of human-centric intelligent assistants for aviation (HAIKU, 2022). The project has six different use cases (UC), distributed across cockpit (2 cases), Air Traffic Management ATM (1 case), Urban Air Mobility (UAM, 1 case), Airport Safety Management (1 case) and Airport Passenger (1 case).

Approach

In the Haiku Use Case 2, the Human-AI teaming (HAT) was defined as System of Interest (SoI). I.e., both the human and the AI assistant are considered as part of the SoI. The goal is improving decision-making quality by providing operational intention based support (Figure 1).

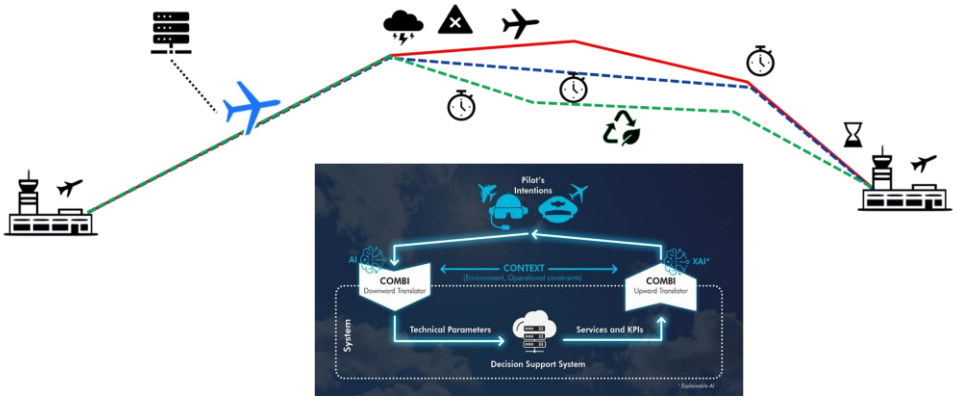

Figure 1 Use Case 2 concept: AI assistant to support re-route or alternate decision supported by operational intentions.

A requirements framework reflects this approach, enabling the study and trade-off of different team architectures. By placing the human within the SoI, the issues of human–machine regarding situational awareness, communication, operational explainability are identified, studied, and detailed in a more flexible and human-centric way then when the human component is considered as a "fixed" interface for the assistant.

In a teaming concept, a strong dependency coupling between human and machine is expected at higher cognitive level. Thus, the realization of team safety, effectiveness, efficiency, and other emergent qualities, are dependent on a proper definition of roles, responsibilities, transparency, task allocation, authority dynamics, among others. Applicable EASA (EASA, 2024) objectives were identified and detailed for the specific use case Figure 2) .

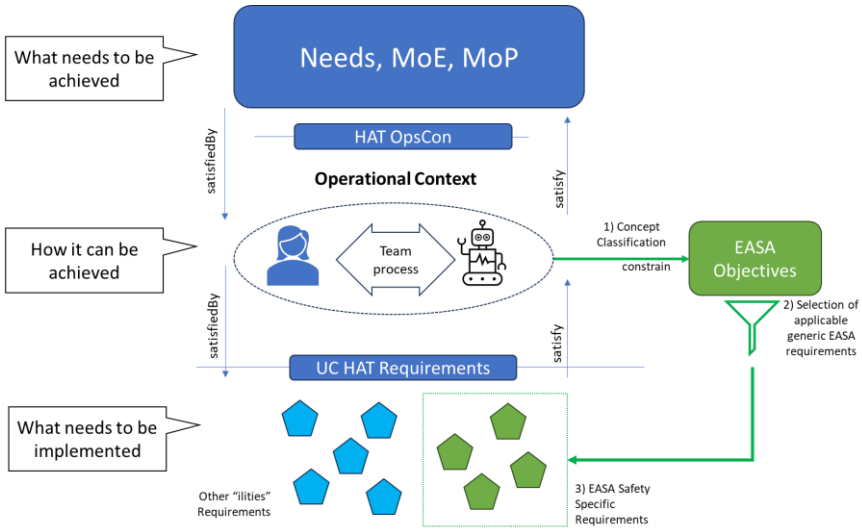

Figure 2 Requirements structure, high level representation.

The development method is thus iterative and interactive, coupling the team architecture design with subject matter experts' interviews and trials with low-fidelity prototypes to stress key team anchoring concepts.

An operational and system architectural description is developed, coupled with a control architecture from STPA, where focus is placed upon the teaming mechanisms between user and assistant. This will expand upon the approach from (Andrew Kopeikin, 2024).

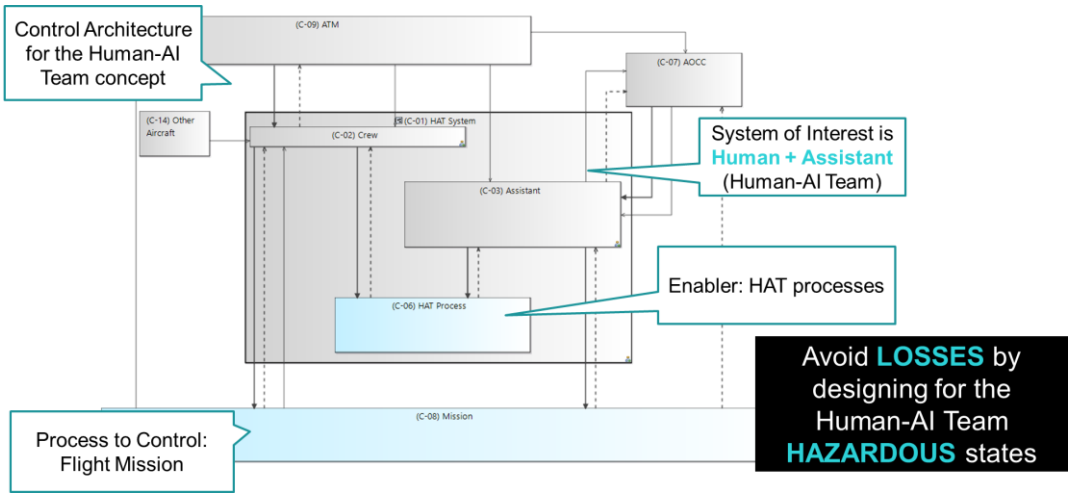

Figure 3 STPA control structure for UC2 assistant.

Currently the projet is exploring different trade-offs on roles and responsibilities allocation through exploratory, human in the loop (HITL) simulations, while STPA supports identification of hazardous scenarios. From this a final concept is developed and trialed in a high-fidelity. The key methodological hypothesis is STPA is supporting the design process while providing base material for the future certification process. To support the analysis the STPA add-on on the Arcadia/Capella software is being used.

Closing Remarks

Currently the project is mid-execution. Final detailing of the STPA analysis and integration with the scenario exploration is needed. Evaluation of the methodology from engineering workflow perspective is expected by end of the project.

Acknowledgements

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Biography

Ricardo Reis (PhD, ASEP). works in RD at Embraer, in the domain of Flight Autonomy, developing conops, requirements and architecting. He has been technical leader for various Embraer collaborations in European projects, namely in future aircraft configurations and aviation safety. Increasingly focused on Human Systems Integration, her actively contributes to Incose HSI WG. He holds a PhD in Turbulence Simulation and High Performance Computing and co-leads the emergent INCOSE chapter in Portugal.

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Théodore LETOUZE holds a PhD in Cognitive Sciences and is a research engineer at the Cognition and Human Engineering (CIH) team of the IMS Laboratory (UMR CNRS 5218) at Bordeaux INP-ENSC. His work focuses on human factors, cognitive sciences, and ergonomics, particularly in industrial and aeronautical contexts. His research explores collective cognition and Human-Autonomy Teaming (HAT), studying the cognitive and organizational mechanisms enabling collaboration between humans and autonomous systems.

Turkan Hentati is a Human Factors Engineer at CATIE, specializing in user-centered design and cognitive workload assessment. She applies laboratory research to real-world applications, integrating cross-analysis methodologies to have optimal solutions. Her work mainly focuses on aeronautics, learning, and healthcare, optimizing human-system interaction and enhancing user experience in complex environments. Passionate about Humans factors, cognitive psychology and bridging research and practice, she collaborates with industry and academia to develop innovative solutions.

Charles Alban is a human factors and cognitive sciences engineer, specialized in the field of aeronautics. His professional activities include the integration of human factors in the design of complex systems, human-IA collaboration and the optimization of decision-making in critical environments. He has participated in several European research projects and publications. He has a master’s degree in Avionics Engineering and Cognitive Sciences.

Jaime DIAZ PINEDA has a PhD in Telecommunications from the Polytechnic University of Valencia (Spain). Starting his career in human-centered design in fields such as automotive and healthcare, he currently works in Artificial Intelligence and Cognition at THALES, where he develops pilot decision support systems for civil and military aviation. In 2022 he received the European Defense Innovation Award from the EDA (European Defense Agency) for HAT (Man Machine Teaming) topics, with the COMBI concept (Bidirectional Communicator between humans and machines). Today, he leads the HAT Engineering team in THALES flight avionics business line.