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Report of the Joint Cognitive Human Machines System working group (JCHMS WG)

Presented by JCHMS

SUMMARY

The future influence of new technologies such as Machine Learning and Artificial Intelligence will pose new challenges to the working environment in Air Traffic Control.

Under the umbrella of IFATCA, a working group (JCHMS) of motivated people has started to discuss and do research on these challenges. This group has produced several conference papers and has finalised draft guidance material. The GM was presented to conference 2024.

The guidance material is stored under the digitalisation webpage of IFATCA. The members of the JCHMS working group have been invited to provide the IFATCA view on Artificial Intelligence (AI), Machine Learning (ML) and Digitalisation, in SESAR Projects, in Research conference and ATM conference. The GM is assisting the IFATCA representatives to argue the needs of the ATCOs.

1. Introduction

1.1. A group of dedicated professionals has started to tackle this important subject since 2022

1.2. Composed of Ms Nora Berzina (MUAC ATCO, EGATS), Dr. Anthony Smoker (EASA representative IFATCA, GATCO UK), Dr. Stathis Malakis (SESAR representative ATCO, Greece), Mr. Andrea Poti (EASA representative IFATCA, Italy), Mr. Tom Laursen (former EVP Europe, Denmark), Dalibor Jovanovic (ATCO, Slovenia), Gabriele Fabris (ATCO, Italy) and Sergio Velotto (Italy) have met 52 times since the start of the group. Mr. Marc Baumgartner (SESAR/EASA Coordinator, Switzerland) has acted as coordinator of the group.

1.3. Working paper 165 for Jamaica Conference 23 informed Directors that guidance material will be created. Andrea Poti, a member of the group, presented the paper.

1.4. The guidance material was presented at Conference 24 in Singapore as information paper.

1.5. In the two SESAR PJ IFATCA is part of the Consortia CODA and AWARE and as well when preparing the calls for the new Wave 3 of SESAR Calls (see Agenda Item B.6.1./C.4.1. benefit from the Guidance Material which has been elaborated by the JCHMS are a great help to the representatives.

1.6. Further the clarification needed in the Commission Expert Group on the Human Dimension in Single European Sky (CEGHD) on the definition of the Human-AI teaming was assisted by the Guidance Material to come to an acceptable definition and understanding of the future roles IFATCA envisages with regard to any form of AI or ML assistant.

1.7. Members of the JCHMS have started to look into the Legal Liability issues related to the new technologies. Scientific articles are being finalized on this topic.

1.8. As members of the JCHMS WG exchange and interact with different institutions on how best AI and ML, but as well virtualization of Infrastructure it is being realized, that maybe the Research Expectations in AI are too ambitious with regard to the core tasks of the ATCOs, separation and efficiency. AI in ATC has potential in two basic domains:

- Better prediction thanks to the possibility to correlate massive amounts of data (meteo, flow predictions)
- Treatment of signals/data (Voice and Image)

Despite the success of Large Language Model (LLM), such as Chat-GPT or similar, the reality of application which can be used, regulated and provide advantage to the management of air traffic, might be a bit blurred.

1.9. Further reflections are ongoing on the discrepancy between the expectations raised by LLM and the reality of the operational environment.

2. Discussion

2.1. The message of the Guidance Material

2.2. Integration into controller workflow

IFATCA proposes that AI tools must be designed and certified as elements of a Joint Cognitive Human–Machine System (JCHMS) that explicitly supports core controller cognitive functions such as steering (goal setting), sensemaking, maintaining a common operating picture, coordination, managing change, and the planning–doing–checking cycle. Tools should be embedded into existing team structures and procedures as “assistants” that enrich environmental, traffic and sector-load information (e.g. weather, turbulence, sector configuration support), while leaving controllers and supervisors in charge of strategy and final decisions.

To achieve genuine ease-of-use, designers must move away from “left over” design strategies where automation handles routine tasks and hands rare, complex situations back to humans, toward socio cognitive designs that are co-developed with practitioners and preserve common ground between designers, regulators and users. Integration must therefore be validated not only on technical performance, but also on how well it supports real time adaptation, handovers, and coordination in operations rooms, including during abnormal and degraded modes. i.e. any AI/ML output must presented as information to the ATCO and not the other way around.

2.3. Workload versus safety

Automation and AI often increase information volume and coordination demands with-out adequate support for sensemaking, which can raise workload and reduce margins for managing uncertainty and surprise. IFATCA therefore argues that any workload increase from new tools is acceptable only if it is matched by tangible improvements in safety and resilience, measured in terms of better prediction, monitoring, and response to disturbances rather than narrow throughput or delay indicators.

From a resilience engineering perspective, tools should enhance the four potentials of resilient performance—knowing what to do, what to look for, what to expect, and what has happened—rather than merely optimizing local efficiency. This implies that safety assessments and performance schemes must move beyond lagging indicators and include proactive and predictive metrics that show how tools affect adaptive capacity at individual, team, organizational and network levels (e.g. from ADEP to ADES)

2.4. De skilling, out of the loop, and tool failure

IFATCA’s work cautions that designs which distance controllers from real time control, or restrict them to rare interventions, erode the very adaptive skills needed to handle novel events and “fundamental surprises.” De skilling is expected where tools take over sensemaking, conflict management or sector configuration without maintaining controller engagement in mental modelling, strategy setting and continuous monitoring.

To counter this, the JCHMS approach calls for human in control architectures in which controllers remain actively involved in core control loops, with automation providing recommendations, explanations, and transparency rather than opaque decisions. Tool failure and degradation must be explicitly designed for via graceful extensibility: controllers need clear modes, fall back procedures, training for degraded configurations, and interfaces that support rapid re appropriation of tasks when automation[1] is unavailable or misleading.

2.5. Trustworthiness and responsibility

[1] See chapter 1.2. Automation what does it mean? https://ifatca.org/wp-content/uploads/IFATCA-JCHMS_6_1.pdf

Trust cannot be prescribed; it must be earned through reliable behaviour, transparency about limitations, and alignment with controller mental models and work practices. Hidden biases, brittleness and non intuitive behaviours of AI systems in complex, safe-ty critical environments mean that these tools should be treated as powerful but fallible partners that require continuous human oversight and calibration of trust, not as infallible authorities.

Regarding responsibility, IFATCA stresses that controllers cannot reasonably be held fully accountable for errors originating from opaque or poorly integrated automation whose design, validation, and performance envelopes they cannot influence. Responsibility must be distributed across designers, manufacturers, regulators, ANSPs and operators in a way that reflects actual control and knowledge, and legal and regulatory frameworks should be updated to recognize the joint nature of human–AI decision making in ATM[2].

2.6. Connectivity

For reasons of safety and security many of the current ATM system can be described as closed circuit systems. New technology requires a constant amount of connectivity to train the algorithms and therefore a new challenge is to manage the safety critical systems being trained, maintained and updated in a secure manner. Infrastructure challenges, like cloud-based system, open training software, connectivity will have to be addressed in order to maintain the integrity of the ATM system of the future.

2.7. European Union AI Act

With the publication of the European Union (EU) Artificial Intelligence (AI)Act the has laid down harmonised rules on artificial intelligence. Adopting a risk-based approach, the EU AI Act has identified four (4) categories of risk. Aviation legislation is included in the high-risk AI systems; thus aviation will have to comply with certain rules. Providers and suppliers have obligation prior to deploy High-Risk AI systems. EASA has taken a proactive approach and has published Roadmaps and Guidance material to foster unified understanding for the aviation community. The EASA Scientific Committee worked together with the EASA AI Taskforce to structure the approach around the levels of Automation resulting in the publication of the Artificial Intelligence Roadmap 2.0. – A Human-centric approach to AI in aviation and is in the midst of the so-called consolidation phase, where a rulemaking taskforce has worked towards the publication of a Notice of Proposed Amendment.

[2] See chapter 1.1. https://ifatca.org/wp-content/uploads/IFATCA-JCHMS_6_1.pdf

The introduction of AI into ATM operations is often framed in terms of performance gains, capacity support, and efficiency. For ATCOs, however, the impact is rarely "AI" in the abstract; it is the specific socio-technical reconfiguration created when new functions, responsibilities, and accountabilities are introduced into an already cognitively complex work domain. From a Joint Cognitive Systems (JCS) perspective, the unit of analysis is not the "AI tool" or the "human user" in isolation, but the joint cognitive system of people, practices, procedures, and artefacts that must maintain control under uncertainty and surprise (Malakis et al., 2022; Laursen et al., 2022). Regulation is therefore not external to operations: it becomes a design constraint that shapes work-as-done in the operations room, through requirements for human oversight, transparency, monitoring, and accountability.

2.8. Work Program for the JCHMS WG 2026/2027

- Continue to participate to SESAR PJ via the Consortia of AWARE and EHRA.
- Continue to provide advice via Stakeholder consultation in the Framework of Fly AI, SESAR, EASA and CEGHD
- Create educational material for Members of IFATCA on new technologies, including AI/ML and Digitalisation
- Engage with regulatory body at global and regional level where requested

The JCHMS has focussed on creating Guidance Material, publish scientific articles, organise digitalisation conferences and exchange with science. The active membership is mainly European based but includes as well a global participation. Any interested Member Association are invited to join the working group. The work is carried mainly online.

3. Conclusions

3.1. With the advent of new technologies Aviation and Air Traffic Management are facing challenges to grasp what the impact of these new technologies will be.

3.2. IFATCA created the JCHMS Working Group in 2023 to face this challenge.

3.3. Deliverables of the JCHMS are multi faceted and include:

- Digitalisation conferences
- Guidance Material
- Scientific Papers
- SESAR Research involvement
- Publications in the controller magazine
- Participation at scientific and aviation conferences

4. Recommendations

That this report is accepted as information paper.

5. References

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Malakis, S. et al. (2023). A Framework for Supporting Adaptive Human-AI Teaming in Air Traffic Control. In: Harris, D., Li, WC. (eds) Engineering Psychology and Cognitive Ergo-nomics. HCII 2023. Lecture Notes in Computer Science(), vol 14018. Springer, Cham. https://doi.org/10.1007/978-3-031-35389-5_22

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The END

1. **CONCLUSION**

1.1. The ENV Working Group has met online exclusively
1.2. Members of the ENV WG are participating to various Research and regulatory bodies activities in Europe
1.3. In the quest to learn from others IFATCA has been presented by information from CANSO, Eurocontrol and WMO
1.4. IFATCA will be able to work further on the ENV thanks to the SESAR Research project Zenitia.
1.5. Educational material for all the members is envisaged to be produced in the coming year.
1.6. Interested members from any of the Member Association are welcome to join the Working Group.

2. RECOMMENDATIONS

It is recommended that this working paper is accepted as information material.

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