iFly

Safety, Complexity and Responsibility based design and validation of highly automated ATM

Work package 2. Human responsibilities in autonomous aircraft operations

Project Mid-Term Review
22 May 2007 – 28 September 2009

Initial contributors

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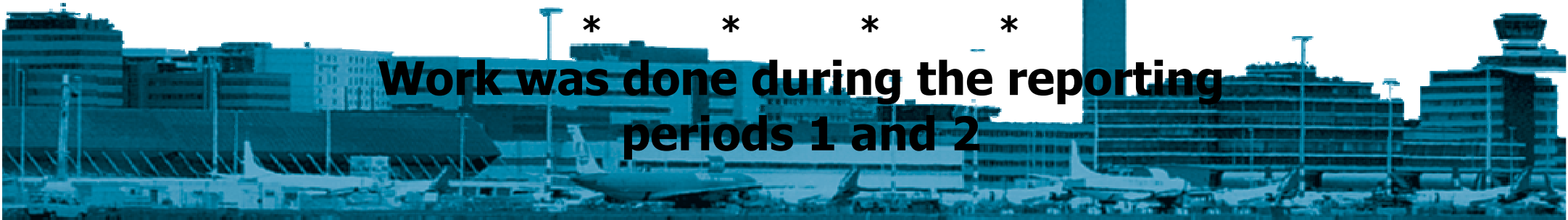## Tasks

Part 1. Airborne responsibilities
– as a feedforward to the design process

WP2.1 To identify current and new responsibilities of the cockpit crew during the en-route phase of the flight (D2.1)

WP2.2 Situation awareness (SA), Information, Communication and Pilot Tasks (D2.2)

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Work was done during the reporting periods 1 and 2

The Contents of D2.1 and D2.2

- **Tasks of WP2.1 have been addressed in deliverable D2.1** Description of airborne human responsibilities in autonomous aircraft operations **(2007)**

- **Tasks of WP2.2 have been addressed in deliverable D2.2** Situation awareness, information, communication and pilot tasks of under autonomous aircraft operations **(2009).**

- **As a result of the D2.1 new and changing pilot tasks and responsibilities were identified.**

- **These pilot tasks served as an input for detailed analysis of situation awareness issues in the cockpit and pilot tasks related to them in the D2.2.**

- **The results of D2.2 were used in the D2.3 for critical analysis of the A³ ConOps specified in WP1 D1.3, mainly from the angle of providing and maintaining adequate situation awareness of the cockpit crew.**

Contributors to D2.3 and D2.4

- **John A. Wise – Honeywell**

- **Claudia Keinrath – Honeywell**

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Tasks (continued)

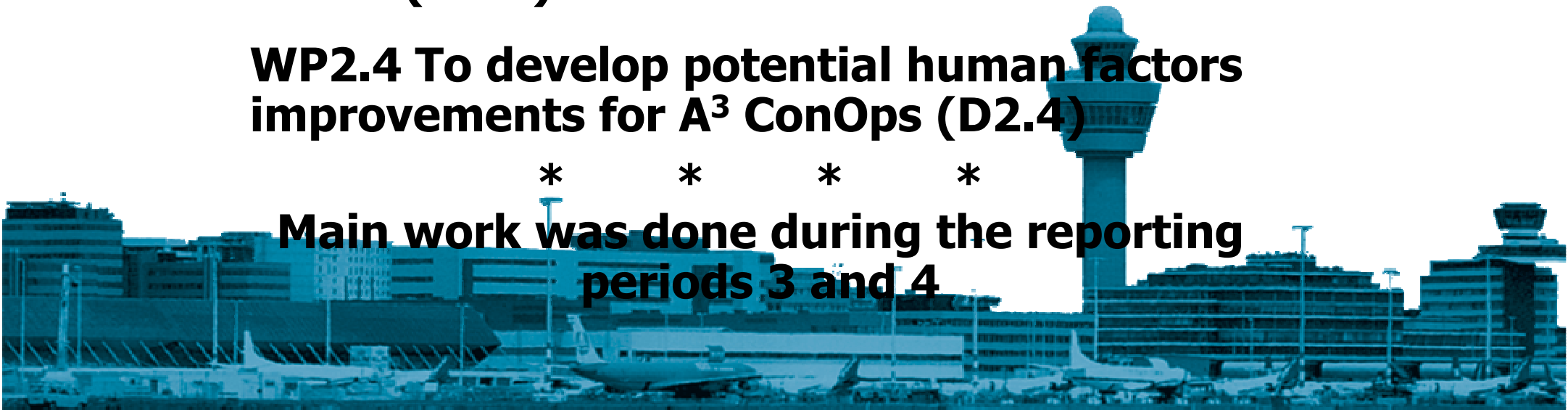### Part 2. Bottlenecks and solutions
– as a feedback to design process

WP2.3 To identify bottlenecks in responsibility issues (D2.3)

WP2.4 To develop potential human factors improvements for A^3 ConOps (D2.4)

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Main work was done during the reporting periods 3 and 4

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The Contents of D2.3 and D2.4

- **Tasks of WP2.3 were adressed in deliverable D2.3 Identification of human factors for improvement of the A^3 ConOps (2009)**

- **Tasks of WP2.4 were adressed in deliverable D2.4 Potential human factors improvements for A^3 ConOps (2009).**

- **WP2.3 identified potential human factors issues in D1.3, which need elaboration for improvement of the A^3 ConOps.**

- **The goal of WP2.4 was to develop potential human factors improvements for the A^3 ConOps to be taken into account for the refinement of A^3 within WP8.**

D2.3 Identification of human factors for improvement of the A^3 ConOps - I

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- **Most of HF issues reviewed in the WP1 D1.3 are related to A^3 system design and only a few to A^3 system applications**

- **Main A^3 human factors issues found in D2.3:**
  - Ground support issues
  - SWIM-related issues
  - Minimal operational requirements
  - Transition issues
  - Human/ automation relationships issues
  - HMI and communication issues
  - FOC/ flight crew relations issues

D2.3 Identification of human factors for improvement of the A^3 ConOps - II

- **Ground support issues**

- For the normal self separated flights in normally functioning Self Separating Airspace the role of ground support described in A^3 ConOps is appropriate. But the special role of ground support may rise in vague or ambiguous, non-normal and emergency situations.

- Some examples of possible vague or ambiguous situations are related to dynamic allocation of airspace boundaries, possible military operations in SSA, transitions from/to SSA to/from TMA, use of voice communication channel and the need for renegotiations if flow management constraints will not be met.

- In above mentioned situations the needs for ground support may grow, especially in the emergency, when leaving the SSA may be the only option for A^3 aircraft and its crews. These issues need attention at further stages of A^3 ConOps development.

D2.3 Identification of human factors for improvement of the A^3 ConOps - III

- ## SWIM-related issues

- SWIM will be an important agent in the future air traffic system and in A^3 ConOps because it provides the necessary information to support the adequate situation awareness of the flight crews, which is needed for handling their new responsibilities. Until the concept of SWIM is under development, the A^3 needs to SWIM should be formulated, to get the necessary information support at necessary occasions.

- ## Minimal operational requirements

- Defining the minimal operational requirements, which enable the A^3 system to operate in Self Separating Airspace, is needed.

- This will minimize vagueness in some aspects of the A^3 ConOps, may facilitate the acceptance of the concept, helping to open the scene for further discussions and elaboration.

D2.3 Identification of human factors for improvement of the A^3 ConOps - IV

- ## Transition issues

  - Although the transitions from SSA to TMA and vice versa are out of the scope of A^3 ConOps, the limited introduction of transition operations proves that these issues are important.

  - From HF point of view the transition operations are safety-critical, because besides the high task load and high demands to situation awareness of the flight crews they have to hand over their self separation responsibility to ATC in transitions from SSA to TMA and take the responsibility over from ATC while leaving TMA. For the flight crews these processes are real transitions, which need time and situation awareness for preparation and cannot be accomplished momentarily.

D2.3 Identification of human factors for improvement of the A³ ConOps - V

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- ● **Human/ automation relationships issues**

- ● Automation must be implemented in a smart way to improve situation awareness, since both the level of automation and the kind of automation are crucial for situation awareness and safety. Implementing more automation does not necessarily mean that it effectively assists to gain an appropriate level of situation awareness.

- ● It is appropriate to think of the airborne system as a joint (man-machine) cognitive system, where the function congruence between man and machine would be the aim of the automation. This means that the level of automation may need to vary as a function of environment and the crew workload, being supportive, not burdening.

- ● In some occasions the information presented to the crew may also need to be provided with a tag about its origin and accuracy for its reliability and validity estimation.

D2.3 Identification of human factors for improvement of the A³ ConOps - VI

- **HMI and communication issues**

- Although at the present level of A³ concept it is premature to discuss HMI and communication human factors issues in detail, some of them have been risen in the review process.

- The HMI for many new systems and components should be worked out in an integral way. Different modalities for display of information should be considered, the voice channel in normal situations among the others.

- It also has to be considered, how far the crew will be involved or even informed about the information exchange between different actors in the SSA.

- In the case of conflict detection, processing and resolution the manoeuvering options should be presented to the crew in an cognitively intuitive way, so that they can understand the options and can act within the time limits.

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- **FOC/ flight crew relations issues**

- In the A³ ConOps FOC will provide extensive support to the flight crews, especially by the processes of preparing the flights. Several issues, like in-flight traffic monitoring, communication with the crews in normal and non-normal situations, participating in renegotiations if the aircraft has failed to meet the flow management constraints etc. will remain to be solved within the FOC and crew communications during the flights.

- **Issues related to A³ system applications**

- Training of all actors involved will be a serious issue, but definitely manageable even without expensive in-flight trainings. Aircrews will have to build trust in all new onboard tools as well as in their "controller abilities" without becoming "believer pilots". It would be desirable to focus on training issues already during the early stages of the system development to get a better idea of specific issues which will remain to be solved at the stage of A³ system implementation.

- A³ concept will support a change in the reporting culture in the A³ environment. Most probably it will become more difficult and will need specific tools. These possible changes in reporting culture may need special attention and specific tools.

D2.4 Potential human factors improvements for A³ ConOps - I

- In every system design process humans are involved as designers as well as potential users of these systems. Although the conscious and systematic application of knowledge about the human in the system design has its available history, in every new system design all this knowledge has to be reapplied as a new. Human capabilities, needs and limitations must be considered early and throughout the whole process of system design and development. The attempt of the possible seamless integration of humans into the design process from various perspectives has come to be called human-system integration (see Pew, Mavor, 2007).

- As it has been always difficult to establish effective communication between system designers and human-system domain experts, in the abovementioned book there are some valuable recommendations for overcoming these difficulties:

    - To include human-system integration contributions during early development and continue this throughout the development life cycle.

    - To integrate across human-system domains as well as across the system life cycle.

    - To adopt a risk and opportunity-driven approach to determining needs for human-system integration activity.

# D2.4 Potential human factors improvements for A^3 ConOps - II

- The recommendations just described have been followed in the iFly project and the D2.4 deliverable can be considered as a step towards this advisable integration. In D2.3 several human factors issues were raised, which could be considered helpful for further development of A^3 ConOps.

- Possible suggestions were given from a human factors point of view independently of the project life cycle. As a result there are suggestions, which may be applicable in the second design cycle in the time scale of the present iFly project and those, which may be applicable to later, follow-up, design cycles.

- In WP2.4 the differentiation of abovementioned human factors issues was made on the basis of possible time scale of their applicability in A^3 ConOps. Most of the human factors issues, identified in D2.3, belong to those, for which human-system integration activities remain beyond the iFly time and development scope.

D2.4 Potential human factors improvements for A^3 ConOps - III

- ## Results

- Most of the human factor issues identified during an analysis of D1.3 and presented in D2.3, are such which could be taken into account during later stages of A^3 ConOps development.

- There is a comparatively small number of human factors issues identified in D2.3, which can be taken into account during the immediate course of A^3 ConOps improvement, planned for WP8 of the present iFly project.

- The report gives general recommendations for integrating human factors and automation issues, which are applicable both to the iFly stage as well as to the later stages of A^3 ConOps development.
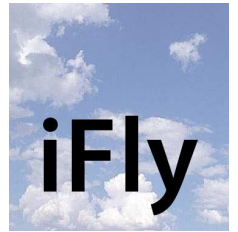
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Thank you for your attention!