Manual Operations for 4th Generation Airliners

Concept and objectives

While aviation is an extremely safe mode of transport, there has recently been a steady rise in the number of accidents that are attributed to limited manual handling skills by pilots. From the accident data gathered over the past decade, the majority of these accidents and incidents occurred in a phase of flight where the automatic systems were disengaged. Modern, 4th generation, aircraft are extremely safe, and there is a particularly low chance of an accident when operating these aircraft. Automation clearly plays a very positive role in enhancing aviation safety and preventing accidents. However, without a set of skills that also include the ability to manually control an aircraft, to manage the automation systems effectively, always maintain an acceptable level of situational awareness, and remain in control of the aircraft, these accidents will continue to occur.

The single largest cause of fatalities in commercial aviation is Loss of Control – In Flight (LOC-I). Invariably, during the chain of events that leads to the accident in a LOC-I situation, the pilot is unable to maintain control of the aircraft by applying manual operation skills to prevent or recover from the situation that lead to the LOC-I. Such instances have occurred in the highly augmented 4th generation aircraft, as well as conventional aircraft, and with experienced pilots fully trained to current standards. These accidents are often due to a combination of the crew not managing the aircraft systems effectively after an unexpected event, and being unable to apply appropriate manual handling skills.

Man4Gen aims to identify the common thread behind the events that lead to these accidents, and to recommend short-term changes to operational procedures, training and aircraft systems technology in order to mitigate this threat to aviation safety. By engaging the key members from the industry, research and academia, and applying the two leading facilities for such research, the deliverables of Man4Gen will lead to a much deeper understanding of the root causes of losing situational awareness in highly augmented and automated aircraft, and how this can be improved through both design and procedures.

Problem Statement

The following problem statement has been defined by the consortium partners for the project:

> ***Despite the substantial and proven safety benefits of automation systems in 3rd and 4th generation aircraft, evidence indicates that when faced with unexpected and challenging situations, pilots sometimes have difficulties in quickly responding to situations which require a rapid transition in their activity from monitors of very reliable systems, to active and authoritative decision-makers exercising manual control of the aircraft.***

The project will address this statement by investigating the following focus points. These points have been proposed as research areas by the initial knowledge and evidence from industry experience and analysis and will form the basis for the initial research in the project.

1. Develop understanding of the underlying causes and contributory human factors in relation to unintended aircraft states in 4th generation commercial transport aircraft. Examples of specific research areas that could be included in this research are:

   a. In monitoring a highly reliable system, pilots sometimes have difficulties with interpreting the situation, managing the flight-path and making decisions. Proposed research can investigate this tendency and the effects on the ability to maintain a safe aircraft state, reacting appropriately to unexpected events.
   b. Pilots can become accustomed to using a very limited set of instruments, parameters, and controls to manage the flight path flight guidance, flight management, auto throttle/auto thrust, electronic system monitoring. These narrow channels can lead to a loss of the "big picture". Proposed research should investigate the extent to which this is true, and the effects on being able to reliably maintain a safe aircraft state when faced with unexpected events.
2. From the analysis of available data, determine mitigation strategies to guide the future development of operations procedures, training and cockpit design with respect to 4th generation commercial transport aircraft.
3. Whilst recognising the benefits of automated systems in 4th generation aircraft, the aim is to provide guidance solutions to assist the pilot, in preventing the loss of aircraft state awareness and where necessary therefore to enable potential rapid transition to assume full and effective manual aircraft control where necessary.
4. Predict the validity effectiveness of mitigation strategies through development of trial programs and the collection of relevant operations and training data.
5. The management of serious events, which include elements of "startle", unexpected or even unforeseen occurrences, whilst coping with stressful situations (including physiological and/or emotional responses) should also be investigated. Research should focus measuring the impact of these events on performance.

The deliverables of Man4Gen will include:

- Recommendations for improved mitigation strategies and procedures to better handle abnormal situations.
- Recommendations for enhanced training to prepare pilot's better to maintain, and if necessary regain control in unexpected events.
- Recommendations to raise the level of situation awareness through improving the information presentation in modern flight decks.

Consortium

NLR, DLR, IDT, Linköping University, Boeing, Vienna University, Medical University of Vienna, Global Training Aviation, Airbus

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Summary description of work package structure

Work package 1 (Research and Analysis) brings together the analysis of existing studies and reports relating to manual operation of 4th generation aircraft. Drawing on the findings of international working groups such as CAST and ICATEE and a review of the industry experience it uses an analysis framework to identify the key issues for development. The analysis will be carried out from a cognitive perspective to identify the processes that can lead to a loss of control as well as from the perspective of situational awareness.

Work package 2 (Operational evaluation) investigates the outcome of this analysis in a test environment under operational conditions. Scenarios are developed that enable the critical conditions susceptible to the loss of situational awareness to be studied in an experimental setting. The evaluation includes tests in research flight simulators and test aircraft under operational conditions to investigate how the crew-automation systems function in these environments. Experiments are also developed and conducted to investigate the loss of situational awareness from a neurological perspective.

Work package 3 (Concept Development) takes the results of the operational evaluation to identify the shortcomings in the current operations and consequently the areas of improvement that are required to reduce the accident rate. The analysis will focus on the three areas of development – procedures, training and technology. By evaluating the development potential of the findings from the first phase of the project, the development areas that are applicable in the short-term will be identified. Recommendations for the medium and long-term are identified, but the focus is on short-term developments that can start to have an impact in the next 5 years.

Work package 4 (Recommendation development) develops the recommendations that can be implemented by the industry in the short and medium term. Modifications and additions to the procedures and monitoring strategies used by the crews and airlines are developed not only to prevent the loss of control/SA but also to assist crews in identifying and recovering. Training methods are identified to improve the preparedness of crews to operate 4th generation aircraft manually when required. Modifications to the cockpit system technology that are either currently available – but not (widely) used – or are not yet fully implemented will be developed for testing. This will include the associated training and procedures required for these systems.

Work package 5 (Test & Evaluation) evaluates the recommendations that have been developed in the project. The scenarios that were developed in WP2, and research methods from WP1 are applied to the evaluation in the operational environment. The focus of the experiments will be in flight simulators where the experimental conditions can be reproduced reliably. Additional validation checks will be carried out in the aircraft and training simulator environment.

Work package 6 (Definition of Guidelines) takes the results of the recommendation evaluations to produce the final Man4Gen recommendations. The improvements in the procedures, training and in technological developments are explained and presented based on the analysis of the project, and the evaluation of the end-user partners. These are presented in terms of guidance material that can be used by the industry. The areas for improvement on a medium and long term basis, and the report of the research methods developed in the project will be presented for future use in research and development. The outcomes of Man4Gen will be presented to industry and the research communities.

Work package 7 (Exploitation and Dissemination) coordinates the output from Man4Gen during the project. Due to the significance of the research and tests being carried out to the industry, this work package will ensure that there is a continuous engagement with industry, the regulators and working groups. The results of the Man4Gen development and experiments will be presented so that they can form a basis for industry guidance material, and will be coordinated with ICAO to meet the international standards expected.