

Human Factors for Reduced-Crew Operations

Luke Bolton

GE Aviation
Bishops Cleeve, Cheltenham, Gloucestershire,
UK
+44 1242 632442
Luke.Bolton@ge.com

David Mangion

Department of Electronic Systems Engineering,
Faculty of Engineering, University of Malta,
Msida, Malta
+356 2340 2072
dzmang@eng.um.edu.mt

Rabea Morrison

Aerospace Psychology Research Group
(APRG), School of Psychology, Trinity College
Dublin, Dublin, , Ireland
+353 18963567
rabea.morrison@tcd.ie

Neville Stanton

Transportation Research Group, Faculty of
Engineering and Environment, University of
Southampton, Southampton, UK
+44 2380593148
N.Stanton@soton.ac.uk

Stefano Bonelli

Deep Blue
Piazza Buenos Aires, 20
Rome, 00198 Italy
+39 06 85 55 208
stefano.bonelli@dblue.it

Nick McDonald

Aerospace Psychology Research Group
(APRG), School of Psychology, Trinity College
Dublin, Dublin, Ireland
+353 18961471
nmcdonld@tcd.ie

Linda Napoletano

Deep Blue
Piazza Buenos Aires, 20
Rome, 00198 Italy
+39 06 85 55 208
linda.napoletano@dblue.it

Katie Plant

Transportation Research Group, Faculty of
Engineering and Environment, University of
Southampton, Southampton, UK
+44 2380593148
N.Stanton@soton.ac.uk

ABSTRACT

The workshop will address the topic of Reduced-crew concepts (RCC), from the point of view of:

- Cockpit technologies,
- Human Factors methods for the design and evaluation of these concepts
- The impact of cockpit modifications on the overall system (including both aeronautic and Air Traffic Management domains).

The workshop is targeted towards academia, industry and regulatory bodies, and will be held by academic and

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HCI-Aero 2010, November 3-5, 2010, Cape Canaveral, Florida, USA.
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industrial representatives, all involved in the EU 7th Framework project ALICIA [1]. It is structured in a way that enables a coherent and systemic approach that takes a continuum of issues into account; from the cockpit through to the whole aviation system. Presentations of ideas will be interspersed with debate sessions. The debate and discussion points will be collated and disseminated to interested parties.

Keywords

Single crew, Human Factors methods, Design, cockpit technologies, ATM

INTRODUCTION

Reduced-crew concepts are one of today's most topical and widely debated themes related to civil aviation. A case in point is the controversy caused when the CEO of Ryanair, Michael O'Leary, expressed the wish to use only one pilot per flight in a 2010 interview with the Financial Times [2]. Proponents of single-crew cockpits advocate the potential for significant operational and cost benefits. The concept is

already being considered by aircraft manufacturers including Embraer [3].

With increasing numbers of passenger aircraft in the sky there are questions as to whether there will be a sufficient supply of trained pilots to meet the demand. Coupled with increased cost pressures on airlines and the ever-evolving capability of computer-based automation systems it seems likely that the trend for progressive reduction in crew numbers will continue.

A reduced-crew operation is a multi-faceted topic covering many disciplines, including; engineering, Human Factors (HF), airline operations and marketing. Human-computer interaction (HCI) considerations extend across most of these disciplines. This workshop will consider a selection of issues with the aim of drawing interest from a broad range of the aviation community, including; industrial technology developers, HF experts, academia, operators, interest groups and regulatory bodies.

This topic has been selected as it is currently relevant and has the potential to provide lively debate. It is impossible to have a fully considered view on future passenger aircraft operations without taking this topic into account. The aspirations for reduced-crew operations will dictate the near-term studies and R&D work required to get the correct operational infrastructure in place.

The organizers bring a depth of experience and are all currently involved in the EU 7th Framework project ALICIA [3] which is developing new and scalable cockpit applications which can extend operations of aircraft in degraded conditions. Understanding reduced crew issues is one of the project's key objectives.

GOALS

The workshop aims to present and discuss the controversial and complex topic of RCC from different perspectives by bringing together contributions from a variety of sectors of the aviation community. The workshop aims to generate a fruitful debate in several key areas of this topic that will have the potential to result in a range of outputs including position papers, research funding proposals and a collaborative network of interested parties.

CONTENTS

The workshop will present and discuss three key areas related to RCC. The three modules within the workshop are: technologies for RCC, HF Methods for the development and the evaluation of RCC and the potential impact these technologies will have in changing the operational environment i.e. how the transformation of processes affects not only the cockpit (e.g. pilots tasks), but the overall system processes.

All the contents and materials produced in preparation of the workshop and as a result of workshop discussions will be disseminated through a mini website realised by Deep Blue. Workshop presentations and debate will be captured and shared as video/audio podcast.

The organization of the workshop is summarized in the table 1:

<i>Introduction</i>	Operational challenges and rationale for implementing Reduced Crew Operations (University of Malta)
<i>Module One</i>	Technology for Reduced Crew Cockpits (GE Aviation)
<i>Module Two</i>	HF Methods for Developing & Evaluating Reduced Crew Concepts (University of Southampton)
<i>Module Three</i>	RCC impact on the wider operations ecosystem (University of Dublin, Trinity College)
<i>Conclusions</i>	Final outcomes of the debate (University of Malta)

Table 1: Workshop's contents structure

The objectives, contents and outcomes for the three modules are presented in the following paragraphs.

Module One: Technology for Reduced Crew Cockpits

Objectives: the objective of this module is to promote open sharing of opinions and expertise surrounding the potential technologies available for RCC.

Contents: This module will cover technologies for reducing crew workload, reducing complexity and reducing scope for human error in the cockpit. These include new input technologies such as touch technology, direct voice interaction and other means of multimodal interaction e.g. haptic (tactile) feedback. The module will also take a wider view of the technologies that are required to replicate the actions of additional crew members and technologies that facilitate increased interaction with functions based on the ground. These include intelligent knowledge-based systems, decision support systems, crew monitoring and autonomous action prioritization. Potential questions to be addressed include:

- Are touchscreens the future for flight decks? Can they effectively reduce workload for reduced crews?
- What technologies are required to provide real-time ground-based support to reduced crews?
- What performance is expected of air-to-ground data links to support this functionality and what new systems will provide this capability?
- What is the state of the art for artificial intelligence in the flight deck?

Outcomes: It is anticipated that the output from the debate will be a snapshot of the current thinking amongst key players as to the technologies required to successfully implement reduced-crew cockpits. The discussion may also produce comparative visions of what these systems will

look like and how the system functionality is shared between crew, autonomous aircraft systems and systems on the ground. These outputs will be captured and distributed amongst attendees.

Hosted by: GE Aviation

Module Two: Human Factors Methods for Developing & Evaluating Reduced Crew Concepts

Objectives: The objectives of this session are to consider the application of Human Factors methods to designing, developing and evaluating RCC. It is anticipated that a range of methods will be presented which deal with different aspects of the problem domain. Potential questions to be addressed include:

- How will tasks and functions be distributed in new crew concepts?
- Which combination of methods produces the greatest insights?
- How well can the methods anticipate emergent properties of reduced crew concepts?
- What will be the acceptance criteria for a concept, and how will the methods provide the evidence?
- What is the evidence for the reliability and validity of the methods?
- Where are the methods appropriate in the design life cycle?

Contents: A range of Human Factors methods and methodology will be presented and explored. It is expected that the methods will cover the physical, cognitive, social and organizational activities associated with RCC across a range of normal and emergency scenarios. These analyses will be used to compare the baseline of the traditional two crew cockpit with reduced and displaced crewing options. The methods are likely to produce analyses of possible changes to tasks, functions, error potential, situational awareness, decision making, workload, trust, communications, risk, safety and system performance.

Outcomes: It is expected that the debate over the application of Human Factors methods to reduced crew concepts will result in a core of plausible approaches that can be used for designing, developing & evaluating RCC. These methods templates and frameworks will be shared with all in attendance and distributed amongst a wider network of interested parties.

Module Three: RCC impact on the wider operations ecosystem

Objectives: Module three seeks to identify the overall system re-organizing (lifecycle), shift in responsibility and accountability and the system performance parameters for evaluation of the RCC.

Content: This module will explore the challenges and opportunities that RCC put to the wider operations ecosystem. Changing an operational concept for the cockpit

will directly or indirectly impact on several system processes, not only in the operational domain but also in the whole lifecycle, i.e. design considerations. There will be a discussion about the business drivers in operations and design that are behind the exploration of reduced crew concepts. Potential questions for discussion include:

- What is driving the RCC vision?
- Who are the stakeholders across the aviation lifecycle?
- What would be the impact on their processes and how those deliver the expected outcomes such as safety, efficiency or cost?

Outcomes: This module aims to put local operational change in the cockpit into a wider system picture to fully appreciate cost-benefit of the new operational concept, as well as its safety implications. The outcome of the discussion will be shared with all in attendance and distributed amongst a wider network of interested parties.

Conclusions

During the concluding session, the key debates and discussions from each module will be presented. There is also the scope to merge the outputs from the three modules in order to derive a final deliverable.

TARGET AUDIENCE

This workshop aims at drawing interest from a broad spectrum of the aviation community:

- Academia (e.g. HF, psychology, engineering and management domains)
- Industry (e.g. operation, design, safety and different business models: cargo, business jet, low cost, etc.)
- Interested groups (e.g. unions)
- Regulatory bodies

The workshop is keen to seek the involvement of participants from both Europe and the USA, to gather and compare experiences and strategies of the two regions.

EXPECTED CONTRIBUTIONS

We expect position papers from both the academic and industrial domains. Participants should submit a position paper describing the contents of their contributions, suggesting views, examples and approaches relevant to the chosen module. The organisers of the workshop will select the most relevant contributions on the workshop topics. It is expected that two to four contributions per module will be chosen. Page limits and a reference structure for the position papers will be provided to participants.

Contribution to Module one: examples of technologies or studies about technologies (or comparison of different technologies) that are enablers for RCC. The topic can

include, but is not limited to, technologies for reducing crew workload, complexity and scope for human error in the cockpit, replicating the actions of additional crew members and methods of facilitating increased interaction with functions based on the ground.

Contribution to Module two: studies on HF methods (or combination of methods) for designing, developing and evaluating reduced crewing concepts.

Contribution to Module three: studies on the impact of the reduced crew concept "outside" the cockpit, on the wider operations ecosystem.

WORKSHOP SCHEDULE

The workshop is expected to last a whole day. In line with the conference session times, the workshop will consist of two sessions; 9.30-12.00 and 14.00-17.00. Each module is expected to last an hour and 45 minutes (55 minutes for presentations and 50 minutes for discussion). Each module will be introduced with a presentation from the facilitator (a member of the ALICIA project), followed by speakers selected from the submitted position papers. The remaining time will consist of moderated discussion and debate. This is a potential schedule, changes may occur based on volume and quality of contributions

WORKSHOP OUTPUTS

Overall workshop outputs will depend on the nature of the discussions; however the following are potential outcomes:

- Map of key issues and the known places (e.g. collaborative projects, industry initiatives, standardization groups) where they are being addressed based on the input provided by the workshop participants. This output is likely to inform future directions of RCC research in the ALICIA project
- Position paper summarizing the discussion and debate, either from each module or whole workshop (depending on volume of material). The intention is for this paper to be submitted for publication in a relevant research journal.
- Application for research funding
- Collaborative network of interested parties

Based on the contributions received, a less linear structure and a more interactive approach could be implemented.

ORGANIZERS

The workshop is organized by representatives of the ALICIA project and includes partners from three Universities, one Industrial partner and one Subject Matter Expert.

University of Dublin, Trinity College

Nick McDonald: 1972-75 Research Assistant Department of Psychology, TCD. 1972-75 Lecturer (part-time) Dublin College of Speech Therapy. 1976-77 Research Associate Department of Human Sciences, Loughborough University of Technology, Loughborough, U.K. 1978-93 Lecturer

Department of Psychology, TCD. 1993- Senior Lecturer Department of Psychology, TCD. 1994 -1996- Head of Department Department of Psychology, TCD. 1989 - Founder member and chair of the Aerospace Psychology Research Group (APRG). The APRG has been working for over 20 years on what goes wrong in organisations that manage safety critical systems. The original focus was in aviation but also in process industries, manufacturing and other transport modes. The research program has been developed through ten European framework projects (from FP4 to FP7), many co-ordinated by TCD, including HILAS (a large IP with 40 partners) tasked to develop a new framework for Human Factors in aviation. This research has spawned a network of collaboration of over 100 industrial partners, across Europe and globally. Overall this represents an investment in R&D of around 200 million euro, about 7% of which was spent in Ireland. The APRG's research income over the last five years has been approximately five million euro.

Rabea Morrison obtained her degree in Psychology (Dipl. Psych) in Germany in 2003 and has since worked with the APRG in TCD on a series European framework projects in the aeronautics domain such as TATEM, HILAS, and most recently ALICIA, as well as on a national project (TRIP) researching transportation safety.

University of Southampton

Professor **Neville Stanton** holds a Chair in the Human Factors of Transport in the Transport Research Group within the School of Civil Engineering and the Environment at the University of Southampton. He has published over 150 peer-reviewed journal papers and 17 books on Human Factors and Ergonomics. In 1998 he was awarded the Institution of Electrical Engineers Divisional Premium Award for a co-authored paper on Engineering Psychology and System Safety. The Ergonomics Society awarded him the Otto Edholm medal in 2001 and The President's Medal in 2008 for his contribution to basic and applied ergonomics research. In 2007 The Royal Aeronautical Society awarded him the Hodgson Medal and Bronze Award with colleagues for their work on flight deck safety. Professor Stanton is an editor of the journal Ergonomics and on the editorial board of Theoretical Issues in Ergonomics Science. Professor Stanton is a Fellow and Chartered Occupational Psychologist registered with The British Psychological Society and a Fellow of The Ergonomics Society. He has a BSc (Hons) in Occupational Psychology from the University of Hull, an MPhil in Applied Psychology and a PhD in Human Factors from Aston University in Birmingham.

Katie Plant graduated from the University of Bath in 2008 with a BSc (Hons.) in Psychology. After graduating Katie worked in local government as a data analyst for road traffic collision data. Katie joined the Transportation Research Group at the University of Southampton in November 2009 as a Research Assistant in Human Factors integration. She works on the EU Alicia project, which will involve developing a new cockpit application to extend

operations of aircraft in degraded conditions whilst delivering enhanced situation awareness to the crew and simultaneously reducing crew workload and improving overall aircraft safety. Katie is also studying part-time for a PhD. Her research applies Schema Theory to human error and considers the methodologies necessary to do this.

University of Malta

David Mangion is professor at Department of Electronic Systems Engineering, Faculty of Engineering of the University of Malta.

GE Aviation

Luke Bolton works in the Advanced Technology group of GE Aviation Systems Ltd. He joined the company in 1996 with an MSc in Optoelectronic and Laser Devices. During his time with the company he has worked on several UK and EU funded projects covering the topics of fibre optic and wireless communications, digital data networks and digital video distribution. Since 2009 he has been the company's Engineering Project Manager on ALICIA investigating multimodal interaction technologies for the flight deck.

Deep Blue

Stefano Bonelli works in Deep Blue as Human Factors since 2008. He achieved a master degree (2008), with specialisation in Human-Computer Interaction. He has been involved in evaluation with end-users, HMI assessment and design, and dissemination activities in EU funded projects

such as FLYSAFE (2005-2009), ALICIA (2009-2013) and EUROCONTROL funded projects such as CRISTAL MED (2005-2009).

Linda Napoletano holds a Ph.D. in Human Computer Interaction. She has 8 years experience on EU co-funded projects aiming at designing and validate humans' integration into technology innovation processes. She has been working in Deep Blue since 2008 as human factors, validation and training expert in EU, EUROCONTROL and ENAV funded projects, among others Caats2 (2006-2009), ALICIA (2009-2013), BEMOSA (2009-2012) and VIRTUAL LIFE (2009-2011), and training on HF fundamentals for the IANS. Linda is Associate Researcher in HCI at the University of Sassari and Siena.

ACKNOWLEDGEMENTS

The ALICIA project has been co-funded by the EC under the FP7. The authors would like to thank all the consortium of the project for the valuable research conducted.

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