



FAST is a new way of thinking, a new approach to look at the future.

It is not revolution, but evolution that follows from what aviation professionals normally do.

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## Contents



- **Gather and define Areas of Change**
- **Prioritize Areas of Change**
- **Value of Areas of Change list**
- **Selection of Top Areas of Change**

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This presentation summarizes the results of the Phase 2 effort by the Future Aviation Safety Team.

A complete report can be found in the Phase 2 folder on  
<http://rudi.den-hertog.org/fast/website>

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## Background

- The first phase of activities led to the agreement in September 2000 on a
  - Generic methodology and on
  - List of nearly 150 on-going or future areas of change affecting the Aviation System.
- The purpose of the second phase was to
  - Prioritize and
  - Select,
  - Using the Analytical Hierarchy Process (AHP), the areas of change that will be analyzed to identify the potential hazards that they may generate.

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## Analytical Hierarchical Process

- The basic principle of the Analytical Hierarchy Process is to
  - divide the problem to be solved in smaller elements,
  - perform pair-wise comparisons and
  - synthesize the results.
- There are several ways to establish such a hierarchy. The following one was used:
  - Organize the list of areas of change into 11 categories (e.g. Aircraft, Air Navigation Services, etc.)
  - Perform pair-wise comparisons between those 11 categories using as a criteria their “importance” for Aviation Safety.
  - Perform pair-wise comparisons within each category using matrices of maximum 7 columns and 7 rows using same criteria as above.
  - Synthesize the above elements to achieve the complete prioritization.

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This second phase was conducted through three workshops of an expert panel with a broad scope of expertise.

The first workshop was dedicated to a presentation of JSSI and FAST (to set the scene) and to an introduction to; and practical exercises on the Analytical Hierarchy Process. It also defined a homework exercise to reduce the number of areas of change to be prioritised.

The second and third workshops were dedicated to perform the actual prioritisation and selection of areas of change.

Two other FAST meetings were necessary to perform a prototyping exercise and to draft this report.

## Example matrix

	AC16	AC19	AC21	AC28	AC29	AC30
AC16	1					
AC19		1				
AC21			1			
AC28				1		
AC29					1	
AC30						1

<b>AC16</b>	Unification of CAO and loss of influence of rules of the art not incorporated in the CAO	<b>Associated Wordings</b>
<b>AC19</b>	New higher energy propulsion and control systems	Advanced systems such as prop-fans and hydrogen-fueled aircraft and high-pressure hydraulic systems may be used in future aircraft. The introduction of very large engines for twinjet application may introduce special operational considerations. Increasing reliance on automation will increasingly remove the operator from immediate control of the power of a system.
<b>AC21</b>	Implementation of advanced supplementary cockpit weather information systems	When new cockpit weather information technologies are adopted, there may be more aircraft following the same favorable weather routes and traffic density will rise accordingly. Advanced training may be required for effective use of these new information sources.
<b>AC28</b>	Incentives to achieve fast track certification	Unusually fast certification, e.g. 36 month's from launch to certification base freeze to full certification, stressing the limits of design analysis, flight- & ground test analysis, necessary iterations and human communication capability. At the same time: a) safety should be improved and b) there will be increased pressure to validate certification approaches based on past certifications.
<b>AC29</b>	Requirement for coordination with a new generation of sport-flying devices.	In the past decade the number of hang gliders, paragliders and their motorized versions have been and are still increasing significantly. These devices are commanded frequently by people lacking the basic knowledge of the airspace structure
<b>AC30</b>	Major increase in the routine acquisition and analysis of aircraft FDR and other forms of hard data such as radar tracks (new item)	Many airlines and authorities have found that computer-aided scanning and analysis of FDR data on a routine basis to be a powerful safety tool by identifying exceedences or reduced margins and assisting the safety risk managers (domain experts and field practitioners) in understanding the causes. Recordings to assist in investigation of accidents and incidents (that may include flight deck video, CVR, etc.) are fundamentally different that the daily, routine monitoring and analysis of FDR data.

## AHP Rating Scale

Intensity of Importance	Definition	Explanation
<b>1</b>	Equal Importance	Two activities contribute equally
<b>3</b>	Weak Importance of one over another	Experience & Judgment slightly favor one over another
<b>5</b>	Essential or Strong Importance	...Strongly favor one over another
<b>7</b>	Very Strong and Demonstrated	...Strongly favored and its dominance demonstrated in practice
<b>9</b>	Absolute Importance	Evidence favoring one over another is of the highest possible order
<b>2,4,6,8</b>	Intermediate values between adjacent scale values	When compromise is needed

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## Home work assignments

- The homework assignment was set up to reduce the total to two more manageable groups by asking the workshop members to rank each Area of Change under the following criteria:
  - Anything ongoing or very soon
  - Affecting the whole system
  - Very rapid changes
  - Many interactions
  - Effects not well understood
- Conditions:
  - If most met: rank 1
  - If some met: rank 2
  - If few met: rank 3
  - No opinion: rank N/A
- We reminded each workshop member that:
  - Changes are not hazards and that hazards are not risks
  - Propose duplication in categories only when really necessary;



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## Area of Change - overview



Category (abbreviation)	Number of changes per category
Aircraft (AC)	27
Maintenance, Repair & Overhaul	6
Operations (OP)	12
Crew (C)	18
Passenger (P)	7
Organisation (O)	6
Authority (AUTH)	4
Air Navigation System (ANS)	23
Airport (AP)	7
Environment (E)	31
Space Operations (S)	4
<b>Total</b>	<b>145</b>

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## Value of Area of Change (AoC) list

- Provides a standard reference to look towards the future
- When included in an online database see <http://www.nlr-atsi.nl/fast/search.php> you can
  - Do a quick word search: check “new AoC” is already there or not
  - Synthesize new futures by combining AoC’s
  - Search for interactions
- It is an easy tool to communicate with other future practitioners
- It is one way, but not the only way to decompose the future

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## AHP quality

- To address concerns about normalization of matrices, the following was performed after seeking advice of AHP experts:
  - Perform a second time the pair-wise comparison of the categories when a better understanding of their contents was achieved.
  - Use weighting criteria to take into account the fact that the matrices used within each category were of different sizes.
  - Check that all areas of change were considered during the AHP process.

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## Workshops

- 3 workshops were held
  - Amsterdam – Jan 4/5 2001
    - Explain AHP, Rank 11 AoC categories
  - Brussels - Feb 6/7/8 2001
    - Agree on a 86 AoC list & prioritize them
  - Brussels – March 6/7/8 2001
    - Agree on a prioritised list of areas of change. A “top 20” list was agreed by FAST.
    - Discuss how to address interactions between areas of change.

## Workshop participants

- An expert panel with a broad scope of expertise was achieved.
- Participation can be summed up as follows:
  - Authorities: UK CAA (also representing the Research Committee); Hungarian CAA; RLD; ENAC-Italy; DGAC-F; FAA.
  - International Organisations: European Commission (DG Tren and Joint Research Centre); EUROCONTROL; Central JAA; International Federation of Airworthiness.
  - Aircraft Manufacturers: Airbus, Boeing, Bombardier; AECMA/ Fokker Services.
  - Operators: Continental Airlines; Air Transport Association of Canada; AEA/Swissair; IAOPA.
  - Research organisations: ERAA/ NLR; NASA.
  - Passengers association: IAPA
- Crew associations were invited and the European Cockpit Association (ECA) nominated representatives but unfortunately their participation failed to materialize.
- However several members of FAST (including the Secretary from European Space Agency (retired) are practicing pilots.

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## **Top 20 Areas of change #1**

1. Increasing reliance on flight deck automation (AC-13)
2. Emergence of new concepts for airspace management (ANS-1)
3. Introduction of new technologies with unforeseen human factors aspects (C-1)
4. Proliferation of heterogeneous aircraft with widely-varying equipment and capabilities (AC-11)
5. Discrepancies in pace and approach in development and implementation of airborne versus ground-based technology systems (OP-5)
6. Increasing number of aviation operations (ANS-2)
7. Introduction of new technologies with unforeseen human factors aspects (ANS-7)
8. Variation of sophistication of hardware and software within an individual aircraft type (AC-10)

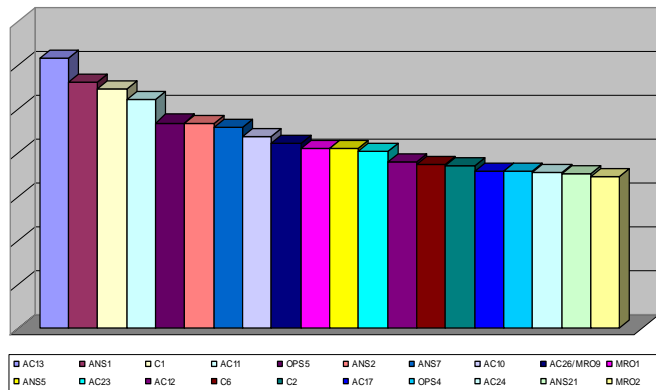
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## Top 20 Areas of change #2

9. Ageing avionics, power-plants, electrical and mechanical systems, and structures (AC-26)
10. Decreasing numbers of qualified maintenance personnel (MRO-1)
11. Decreased separation standards (ANS-5)
12. Increasing pressure for outsourcing of maintenance/modifications of aircraft (AC-23)
13. Increasing lack of standardization in cockpit controls, displays, and automated systems interfaces among aircraft (AC-12)
14. Shift in responsibilities for collision avoidance from ATC to crew (AC-12)
15. Increasing level of information inequality in shared decision-making contexts (C-6)
16. Increasing Reliance on active flight controls ( AC-17)
17. Increasing numbers of aircraft operations at lower altitude and/or in adverse weather conditions (OP-4)

## Top 20 Areas of change #3

18. Increasing need for maintenance of complex integrated aircraft (AC-24)
19. Discrepancies in the pace and direction of development of ground versus in-flight CNS systems (ANS-21)
20. Decreasing maintenance expertise (MRO-2)



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### **Four Major Safety Theme Areas**

1. Introduction of new air, ground, and satellite-based automated systems
2. Increased heterogeneity of: aircraft types & flight capabilities, equipage & software, airspace utilization approaches, and development directions & timelines for airborne, ground, and space-based aviation support systems
3. Increase in absolute numbers of aviation operations and corresponding reduction in safety margins as a result of: increased demand, decreased separation and more frequent operation in or near adverse weather conditions
4. Ensuring adequate maintenance of air- and ground-based systems in an environment of increased outsourcing of work, increased complexity of hardware, firmware & software, and a shortage of qualified maintenance personnel

## Scope of work for AC-13 and ANS-1 (2001)

### AC13 - Reliance on Flight Deck Automation

- The reason we rely on Flight Deck Automation is that there is an upper limit to the ability of the flight crew to handle tasks related to their four key responsibilities:
  - Aviate
  - Navigate
  - Communicate
  - Manage Systems.
- With the increasing complexity of modern aircraft and operational environments, the automation must be relied upon to handle the additional tasks which would “initiate” the crew.
- Automation may be capable of increasing the quality and quantity of tasks performed by the flight crew.

### ANS1 - Emergence of new concepts for Airspace management

- The emerging concepts for airspace management may be described as follows:
  - To remove as many restrictions as possible
  - To allow pilots to choose routes, speed and altitude if possible.
  - To move towards shared responsibility between air and ground for separation assurance.
- To redefine the roles of controllers and pilots The foreseeable implementations are:
  - Free routing
  - Free flight

# **Any Questions?**

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## Acronyms

- ADREP ICAO Accident/Incident Data Reporting System
- AoC Area of Change developed by FAST
- AGS Air Ground Space System
- ANSP Air Navigation Service Provider
- ATC Air Traffic Control
- AWOS Automatic Weather Observation System
- CAST Commercial Aviation Safety Team (North America)
- CICTT CAST/ICAO Common Taxonomy Team
- ConOps In FAST context: Eurocontrol's Concept of Operations for 2011
- ConOps General: air traffic providers concept of operations
- ESSI European Safety Strategy Initiative
- ECAST European Commercial Aviation Safety Team (EuroCAST)
- ECCAIRS European Co-ordination Centre for Aviation Incident Reporting Systems

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## Acronyms - continued

- FAST Future Aviation Safety Team
- GTG Gate-to-Gate
- ICAO International Civil Aviation Organization
- JAA Joint Aviation Authorities (Europe)
- JSSI JAA Safety Strategy Initiative
- JSAT Joint Safety Analysis Team (CAST)
- JSIT Joint Safety Implementation Team (CAST)
- JPDO Joint Planning and Development Office (part of NGATS in USA)
- NGATS Next Generation Air Transportation System (USA)
- SESAR Single European Sky ATM Research Programme
- TCAS Traffic Collision Avoidance System
- TAWS Terrain Avoidance Warning System