
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

- **Study of Top Area of Change**
- **Interactions between Area of Changes**
- **Recommendations**
  - **Up till Future near (1 - 5 years)**

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This presentation summarizes the results of the Phase 3 effort by the Future Aviation Safety Team up until Recommendations for the Near Future [1-5 years].

A complete report can be found in the Phase 3 folder on

http://rudi.den-hertog.org/fast/website

### AC13 Hazard Development

- FAST development of hazards
  - Inherent hazards that could result from the top area of change = AC13 Crew Reliance on Cockpit Automation and
  - Interaction hazards with 34 area's of change
- Process methodology
  - List of standard questions
  - Brainstorming
  - Technology watch items
  - Synthesis

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Design and certification make aircraft resistant to multiple failures.

Accidents are more and more due to accumulation of and interactions between non-correlated events.

FAST was permitting to highlight importance of interactions, their role in accidents and the necessity to predict accident scenarios for a more efficient prevention.

Therefore, more resources, development of engineering methods and associated propagation analysis techniques look necessary to address:

- Origins of hazards,
- Propagation paths, aggravating factors [e.g. Sneak Path analysis].
- Probability and severity of resulting events.

## Interaction assessment between AC13 and all other AoCs:

- This is specific to the FAST process, which, for each AoC, considers all interactions between this AoC and all other AoCs. This methodological originality confers to the FAST process a
  - “Systemic dimension” as all elements of the analysis (here AoCs) are considered in relation to the rest of the system. FAST members were asked to identify by a Yes or a No if they believed that there was an interaction with AC-13 for the 157 interactions. 15 members replied.
- Again a prioritization system featuring a voting system was used in order select the most important AoCs interacting with AC13:
  - The basic idea was to retain the Areas of Changes that have been identify as interacting with AC-13 by two-thirds of the replies.
- 34 AoCs were selected, while the other ones were put in a watch list.
- These 34 AoCs can be found in the Phase 3 report section 5.5, page 22

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In addition, the recommendation exercise showed that establishing a precise interaction scenario will allow to:

• Tag precise facts and avoid wide scope general statements

• Measure Efficiency of recommendation. (Difficult when concerning accident that will never happen if prevention works).

• Therefore make better recommendations.

FAST Interactions need a Total System approach based on Systems Management and corresponding Systems Engineering background from experts involved. The same comment applies to Industrial Organization expertise.

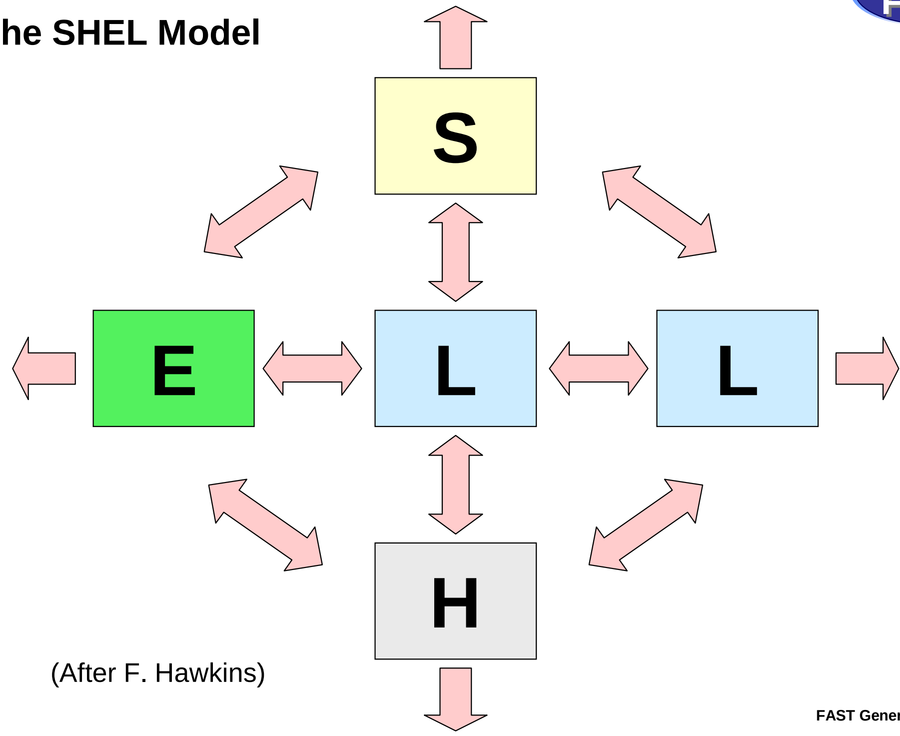
Future work must address the link between past, present and future to be mediated via the notion of paradigm.

•As far as we are facing evolutions, we can fairly well predict the future on the basis of past and present data. Precursor analysis will find an outstanding place here.

•But when we address revolutions, truly prospective studies are needed.

- All hazards (Inherent; potential; due to interactions) were put in the 4 groups of the SHEL model:
  - Software (E.g. procedures; training, etc.)
  - Hardware (Include also computer software
  - Environment (In a very wide sense)
  - Liveware (People)

## The SHEL Model




(After F. Hawkins)

## Prioritized Hazards

## Development of Prioritised Hazards List

- After agreeing on guidelines each member classified each item (almost 400 items) for
  - "Criticality", according to 25.1309
  - "Time scales"
- Four categories were established
  - Current (up to one year)
  - Future-near (1 - 5 years)
  - Future-medium (5 - 10 years)
  - Future-long (more than 10 years)

Development of Prioritised Hazards List

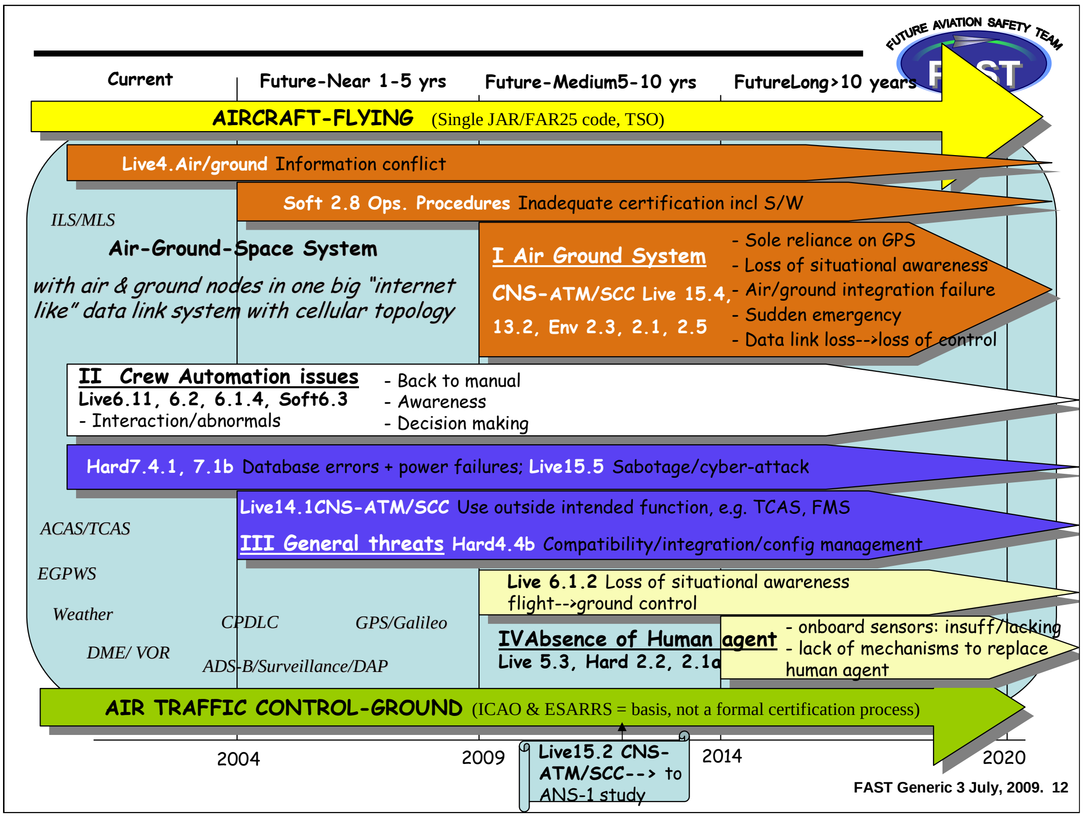
- **Two steps in the prioritisation exercise**:
  - – First Step: FAST members to evaluate each Hazard/problem statement using criteria containing two elements:
    - Time frame (Near, Mid, Long Term)
    - Severity ( JAR 25-1309 like)
  - – Second Step: FAST members ranked to arrive at the Top -21 hazards using a grid, only taking Catastrophic and Severe for priority, e.g. using the “10 votes out of 19” method.

## Time frame

| | |
|---|---|
| • Current: | 2004 |
| • Future near: 1-5 years | 2009 |
| • Future medium: 5-10 years | 2014 |
| • Future long: > 10 years | 2020 |

## 4 Themes

- Theme I
  - Air Ground Space system
- Theme II
  - Crew automation issues
- Theme III
  - General Threats
- Theme IV
  - Absence of human agent




Detailed analysis of the future hazards developed from the study of the initial Area of Change, (Increasing reliance on flight deck automation), led to the following four themes of recommendations:

Theme I: Global Air-Ground-Space System Issues

Theme II: Flight Crew-automation Interactions Issues

Theme III: General Threats

Theme IV: Absence of Human Agent (On Board)

Details on these themes can be found in the Executive summary of Phase 3 paragraphs 7.2 through 7.5 while 7.6 provide a summary

A graphical overview, including the timing in which these hazards are estimated to appear is provided here

## From Hazards to recommendations

## Recommendation score

- Each of the 94 proposed recommendations was evaluated by 3 factors:
  - importance
  - power
  - confidence
- Total number of points received by multiplying them together

## Definitions

- Importance
  - defines the relative importance that the FAST team gave the respective related hazard
- Power
  - effectiveness of the specific recommendation in reducing the likelihood of a specific accident had the recommendation been in place and operating as intended
- Confidence
  - level of confidence that you have that this specific recommendation will have the desired effect if implemented properly

## Recommendation score

- Total scoring: multiply
  - importance - fractional value from 0-1 [generated Nov 2002 FAST meeting in Madrid, added for consistency]
  - power - ordinal value from 0-6
  - confidence - ordinal value from 0-6

- Total number of recommendations: 27

**Current & Future near**

Today - 5 years

# Theme II Crew automation recommendations

| | Score |
|---|---|
| 6. MANUFACTURERS: Manufacturers should decrease the number of different auto flight system modes and increase the integration of systems involving autopilot functionality. | 18.0 |
| 7. MANUFACTURERS: Manufacturers should ensure aircraft type technical ground courses and operational training provide an adequate understanding of the processes of automation. | 10.8 |
| | |
| 8. OPERATORS: Operators should ensure that aircraft type technical ground courses and operational training adequately cover a good understanding of the processes of automation. | 10.8 |

## Justification

- Glass cockpit technology has shown:
  - flight mode confusion
  - complexity/percieved complexity of straight forward flight crew tasks
- Contributory factors of many loss of control accidents :
  - display info not sufficient, obvious & unambiguous (CAST SE-34)
- Changed training
  - minimal manual training & initially on light aircraft
- Predominant use of automation may cause crew trouble:
  - manual switch over to other runway, override A/P in tight situation
  - Loss of control in unusual attitudes [upsets, traffic avoidance, etc]
- Design changes
  - expensive, long incorporation time, long time to have effect (CAST SE-36)

## Justification

- FAST recommendations 6, 7 & 8 acknow-ledge this situation by:
  - asking for supply of good information
  - emphasis on training
  - As long as modifications can or will not be available

## Recommendations

- The presentation of recommendations concerning incidents and accidents that already happened is already a difficult exercise.
- Convincing the aviation community to accept preventative measures for events that never happened yet, require a specific approach that has resulted in a set of recommendations grouped by
  - Actor,
  - Time frame
  - Priority.

# Theme III: General Threats recommendations

| | Score |
|---|---|
| 1. REGULATORS: Regulatory agencies should ensure that organizations updating databases have an adequate system to validate updates and check the changes incorporated. The complete chain of the data base production and update process should be made visible, incl. checking routines, not only for the FMS, but also EGPWS, that is from land measurement all the way till on aircraft data base loading. Eurocae/RTCA efforts in this respect should be verified. Database software systems including those in the total AGS system should be looked at throughout the total life cycle, i.e., initial design through production to the ultimate updating and upgrading to the next generation. | 19.2 |
| 9. RISK MONITORING: Reporting, tracking, evaluating of cyber attack/sabotage anomalies and take appropriate action in a global system. | 13.1 |
| 4. RESEARCH COMMUNITY: Conduct research to identify methods to harden [RF] aircraft systems against cyber attack, robust encryption technology) and to improve integrity through better detection of deviation from initial performances. | 12.3 |
| 5. RESEARCH COMMUNITY: Research into secure transmission and reception capabilities. Learning from military experience. | 12.3 |
| 2. REGULATORS: Ensure functional and S/W design assurance with respect to security; therefore establish new set of requirements with respect to identified threat (combination of Integrity, availability, reliability, continuity). | 9.8 |
| 3. REGULATORS: Require standards developed by standardization bodies (ARINC, RTCA, EUROCAE, etc) or equivalent, be used in datalink applications. | 9.2 |

## Justification

- Use of systems outside intended use - not designed nor certified
  - FMS - sole means to determine decision speeds, sole means of navigation
  - TCAS - to maintain separation
  - TAWS - primary means of navigation
- Reasons
  - designers make it possible to do so
  - operators under pressure to do for efficiency reasons
  - Pilots perceive the technology as so compelling that they may use ad-hoc procedures
  - Regulators allow it, e.g. FMS for PRNAV in the TMA under TGL 10.
- FAST recommendations aim to ensure correct functioning
  - these systems maybe last line of defence

## Justification

- Databases
  - Not only in FMS, also EGPWS, TCAS, AFCS, EICAS/ECAM/MFDS and ATC systems, etc
  - curently only in infancy, exponential increase towards 2020 for CNS/ATM
  - Errors/malfunctions
    - loss of situational awareness
    - misleading and/or incorrect infomation
    - plain human overload
  - Right information is given at the right time, but
    - simply not processed or
    - incorrectly processed due to above situation

## Justification

- Database integrity,
  - "end-to-end aeronautical data integrity" starts at the beginning, e.g., two DME's (4 nm apart) were given the same identifier and then processed through the system into the FMS. Other issues: how is certification maintained after incremental uploads?

- Examples:
  - 1. Where an Authority upon checking an EGPWS in a simulator could not find the highest obstacle (>100M) next to the airfield because it was not in the database.
  - 2. One operator regularly comparing a 28-day FMS revision cycles with the previous edition using software tools finding numerous errors.

## Justification

- Sabotage/cyber attack
  - computer S/W in many aerospace applications
    - on board
    - on the ground
  - Connections with the “outside world”
    - Loading in the shop: intial program load on the chip/EPROM
    - physical on board S/W loading using floppy or cable
    - logical through data link or wireless network (data link, gate loading)
  - Today cyber attack risk is minimal, but tomorrow under the future aerospace paradigm of Theme I, with many aircraft and ground systems in a multi-agent distributed air-ground system (AGS)
    - ever more critical information will be transmitted via data link
    - it is considered a serious threat

# Any Questions?

## 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 |

## 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