Aviator 2030 - Ability Requirements in Future ATM Systems

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‘Aviator 2030’ is a project at DLR on ability requirements for operators in future ATM systems. Several workshops have been conducted with pilots and air traffic controllers to learn how today’s aviation professionals see their jobs develop in future. Using separated workshops first, pilots and air traffic controllers were introduced to current developments within the context of Single European Sky SES, a large-scale program comparable to NextGen in the United States. Following the ‘future-workshop’ concept participants developed scenarios of future ATM from their professional background and experience. In a third workshop pilots and controllers met to exchange and discuss their concepts. Together they developed a shared view of future ATM systems, using role-plays and other forms of presentation. They also used the Fleishman Job Analysis Survey F-JAS in a special version to express their view on future ability requirements.

Improvements in air traffic management (ATM) and aircraft systems as well as organisational structures have become one of the key challenges of aviation in 21st century. This is especially important with regard to the considerable increase in air traffic. To allow maximum capacity and safety as well as minimum impact on environment and cost, Single European Sky (SES) will be implemented to coordinate the traffic in Europe.

The key question of the project ‘Aviator 2030’ deals with changes that will concern pilots and air traffic controllers introducing SES. Which modifications of operators’ tasks, roles and responsibilities can be expected? Will pilot or air traffic control trainees selected today ever work in the ATM system reflected in the current job analysis? If not, what ability requirements will change, what will remain?

Aviator 2030

Based on domain experts’ point of view, Aviator 2030 develops future scenarios of ATM. Key aspects of these scenarios are tested with human operators in low-fidelity simulators which combine on-board and ATC systems. Thus, potential changes in ability requirements for pilots and air traffic controllers will be identified prospectively and allow for timely adjustment of selection profiles (figure 1).

Figure 1. Flowchart of the project Aviator 2030

Workshops with experienced air traffic controllers and pilots have been conducted separately to obtain job incumbents expectations regarding their future tasks, roles and responsibilities. The first two-day
workshop was conducted with nine air traffic controllers of the Deutsche Flugsicherung GmbH (DFS GmbH) and the second involved ten pilots of Deutsche Lufthansa AG (DLH AG). Both workshops were designed correspondently using the future workshop concept. This technique developed by Jungk in the 1970s (Jungk & Muellert, 1987) enables a group of people to generate new ideas or solutions of mainly social or organizational issues. It has been used for the first time in a technical aviation context with good success.

Each future workshop started with an information session: Participants were informed about the general idea of the project, the goals of the ‘Vision 2020’ for European aeronautics and the Concept of Operations for the Single European Sky (SESAR CONOPS, Sesar 2007).

Participants and controllers were then asked for their criticisms about ‘Vision 2020’ and SESAR CONOPS. Both ATC and pilots emphasised the risk of single workplace replacing teamwork, shift of competencies or incapacitation and inappropriate system design. Upon collecting risk about future aviation, participants were asked for their ideas about future aviation. Visionary scenarios dealt with the process of negotiation of 4D-trajectory, tactical planning and operating of flights, improvements of human resource planning, first draft of a virtual workspace and a new approach to line and recurrent training. All scenarios consist of innovative approaches for handling possibilities and changes in the future. Finally, participants checked their scenarios with regard to further steps, workplace design and potential obstacles.

About four months later an integrative workshop with the same pilots and air traffic controllers was conducted to exchange the ideas and concepts. First, results of the future workshops were presented and discussed. Controller and pilots enjoyed sharing their future scenarios. Second, mixed groups consisting of controller and pilots elaborated several ideas: a concept of trajectory negotiation, procedures for operating flights in the future and an integrated training system for pilots and air traffic controllers. In general, participants developed future scenarios including ATC’ and pilots’ perspectives. Finally, participants derived future scenarios which should according to their background be simulated and tested in the ongoing project. A detailed description of the layout and the outcome of the workshops is provided by Bruder, Jörn & Eißfeldt (2008).

To receive a first impression on potential changes in ability requirements in a more standardised way, participants of the workshops were finally asked to rate the ability requirements for the future ATM system. To do so participants teamed up in pairs with always one of each background to enable a mutual understanding of scales to be rated and to support the exchange of views. Each participant then gave his rating for his professional role in the light of his understanding of the future ATM system.

Method

The Fleishman Job Analysis Survey F-JAS (F-JAS; Fleishman 1992) was used to depict ability requirements for the future ATM system. With the F-JAS job incumbents are asked to use a 1 to 7 scale to “rate the task on the level of the ability required, not the difficulty, time spent or importance of the ability” (Fleishman 1992b, p.7). The F-JAS has been used at DLR in a number of studies with good success, for instance in a simulator study at the DFS Research & Development Centre on the effects of ATM systems comprising datalink (Eißfeldt, Deuchert & Bierwagen, 1999).

The F-JAS Fleishman Job Analysis Survey (Fleishman 1992) is a survey measuring human abilities, providing detailed definitions and anchored rating scales for 72 scales covering the domains of cognitive, psychomotor, physical and sensory abilities as well as interactive/social and knowledge/skills scales, the latter being still under research. It comes together with a detailed ‘Administrators Guide’ (Fleishman & Reilly 1992a) and the ‘Handbook of Human Abilities’ (Fleishman & Reilly 1992b) providing some theoretical background and lists of validated tests measuring a certain abilities including reference data of test providers. In 1995 the F-JAS was republished with 52 scales covering cognitive, psychomotor, physical and sensory/perceptual abilities. In 1996 the F-JAS Kit Part 2 was published covering 21 social/interpersonal abilities (MRI 1996).

With the Aviator 2030 project a special version of the F-JAS was developed including not only the original scale material but anchors representing requirements of current pilots and air traffic controller jobs in addition. These mean ratings reflect the results of prior studies with air traffic controllers of
Deutsche Flugsicherung GmbH (N = 88; Eißfeldt & Heintz, 2002) and pilots of Deutsche Lufthansa AG (N = 141; Goeters, Maschke & Eißfeldt, 2004). In this special F-JAS aviator version the mean rating for air traffic controllers of DFS is depicted in a blue box on the left, the mean rating for pilots of DLH in a yellow box on the right side of the central scale. Figure 2 shows an example for a scale as used in the project Aviator 2030 with integrated anchors for air traffic controllers and pilots.

| 1. Oral Comprehension | This is the ability to listen and understand spoken words and sentences. |

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<thead>
<tr>
<th>How Oral Comprehension Is Different From Other Abilities</th>
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<tr>
<td>Oral Comprehension: Involves listening to and understanding words and sentences spoken by others.</td>
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- Requires understanding complex or detailed information that is presented orally, contains unusual words and phrases, and involves fine distinctions in meaning among words.
- Requires understanding short or simple spoken information that contains common words and phrases.

Figure 2. Example scale F-JAS aviator: Oral comprehension with added anchor scales for air traffic controllers and pilots. Adapted from Fleishman (1992), with permission.

To integrate these anchors graphically on the scale better allows interpreting results as increasing or decreasing requirements compared to today. In an earlier study this was achieved by working the F-JAS twice: First to obtain the ratings for the everyday job experience as air traffic controller and second, after days of training and simulation in a new datalink environment to collect the ratings for the new system (Eißfeldt 1999). Due to time constraints this approach was not possible for the Aviator project; however the special experience of this unique group of aviation professionals after 4 days of dealing with issues of future ATM demanded the use of scientific standardized material. After some first trials it was decided to integrate the anchors as numerical values in coloured coding directly on the scales. The F-JAS aviator version proved to be easy to work with, a total of 15 sets of ratings (8 pilots, 7 air traffic controllers) were collected. Although this sample does not reach a size allowing for strong interpretation, the combination with larger existing data sets (141 pilots, 88 air traffic...
controllers) should enable interpretation of ratings obtained from workshop participants. However, it has to be considered that these results are preliminary.

Results

In the following only the results for the cognitive abilities of the F-JAS aviator will be discussed. As Figure 3 shows many of the scales in the cognitive domain were rated very similar for the future ATM system as for the current job requirements. For air traffic controllers, strong increase was found with ‘problem sensitivity’ and ‘speed of closure’; strong decrease was rated for ‘originality’, memorization’ and ‘spatial orientation’. For pilots a strong increase was indicated for ‘deductive reasoning’ and a strong decrease in ‘number facility’. Given that ‘Abilities with mean ratings of four or greater are generally considered to be important for the job (Fleishman & Reilly 1992, p.10)’ the impression is that the profile of cognitive ability requirements will not change essentially with future ATM concepts for both professions, with some minor adjustments being proposed.

**Aviator 2030 F-JAS Cognitive Abilities**

![Graph showing cognitive abilities for aviators and controllers](image)

Figure 3. F-JAS Cognitive Abilities for pilots and air traffic controllers in Aviator 2030

A second look concerns the similarity of ratings for pilots and controllers: in the domain of cognitive abilities most of the ratings are not much different for the two groups. Only two of the cognitive scales showed significant differences between pilots and air traffic controllers: ‘spatial orientation’ and ‘visualization’.

Looking at the pattern of results for ‘visualization’ in both groups there was a slight increase with the future ATM concepts, as was seen with a lot of the cognitive abilities. Also ‘oral comprehension’, ‘oral expression’, ‘problem sensitivity’, ‘deductive reasoning’, ‘inductive reasoning’, ‘category flexibility’, ‘speed of closure’, ‘perceptual speed’ and ‘time sharing’ all showed a slight increase with the future ATM concepts for both professional groups.

With ‘spatial orientation’ it was different; there was an increase in relevance for the pilots and a
decrease for the air traffic controller group. A similar but only slight tendency was found in the ratings for ‘selective attention’ and ‘information ordering’. There was not a single cognitive ability showing the opposite pattern of decrease of relevance with pilots and increase with future ATM concepts for air traffic controllers.

In a third pattern of results the relevance of abilities decreased with the future ATM concepts for both professional groups. ‘Written comprehension’, ‘written expression’, ‘originality’, ‘memorization’, ‘problem sensitivity’, ‘mathematical reasoning’, and ‘number facility’ all showed decreasing relevance with future ATM concepts as discussed in the Aviator 2030 workshops.

Discussion
To follow up the changes in ability requirements of core aviation professions remains a never ending task for those dealing with aviator selection. Especially the introduction of new automation has to be controlled for effects on tasks, roles and responsibilities, and in consequence on selection profiles (Eißfeldt 1991). However, when cognitive abilities are focussed, there seems neither relief nor much intensification of ability requirements to be stated. What can be foreseen are pilot and air traffic controller profiles assimilating with regard to cognitive abilities mostly linked to the tasks of airborne separation issues.

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References


