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Proceedings of the First EUROCONTROL Selection Seminar - "Current and Required Future Selection Work and Methods in the ECAC Area"

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Abstract

The European Air Traffic Management Programme (EATMP) Human Resources Team (HRT) has initiated the organisation of the First EUROCONTROL Selection Seminar, which was held in Luxembourg in May 1999. The theme of the seminar was "Current and Required Future Selection Work and Methods in the European Civil Aviation Conference (ECAC) Area".

This report contains the proceedings of the seminar. It includes the presentations of the keynote speakers, the presentations of the speakers at the Open Forum, the seminar's conclusions and its evaluation.

Keywords

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EXECUTIVE SUMMARY

The European Air Traffic Management Programme (EATMP) Human Resources Team (HRT) has initiated the organisation of the First EUROCONTROL Selection Seminar. The goal was to establish a network where practitioners and experts in the selection of Air Traffic Controllers (ATCOs) can learn about and exchange information on actual and future trends in selection research and development and on current implementation activities and problems.

The expectation for this seminar was that by creating a basis for a common understanding of the consequences of future Air Traffic Management (ATM) systems on recruitment and selection, participants will come up with possible solutions, and discuss shared undertakings within recruitment and selection.

This report is the proceedings of the First EUROCONTROL Selection Seminar entitled "Current and Required Future Selection Work and Methods in the European Civil Aviation Conference (ECAC) Area". The seminar was held on 17-19 May 1999 at the EUROCONTROL Institute of Air Navigation Services (IANS) with 72 participants from 27 States (including five States outside the ECAC area).

From the papers presented and the discussions followed, the current issues and concerns in ATCO selection are:

- to integrate Manpower Planning (MP), marketing, recruitment, selection, training and licensing within an overall MP of the Human Resources Management (HRM) system;
- to assure that selection and training work “hand-in-hand” to decrease a still high failure rate;
- to integrate a pre-selection stage to save resources and time and to increase the selection ratio;
- to enhance marketing efforts (e.g. job information sessions) to attract and obtain more suitable applicants for the ATCO job;
- to identify common selection methods that could possibly work in different States, by e.g. conducting cross-national selection and validation;
- to follow up more closely the great diversity in selection tests and methods;
- to monitor the ever increasing coaching of applicants and develop countermeasures.

Few ways for how we could possibly tackle the concerns and questions were mentioned.

This report contains the texts of the presentations of the keynote speakers given during the first day plenary session in Chapter 2, the texts of the presentations of the speakers at the Open Forum given during the second day in Chapter 3, the seminar’s conclusions in Chapter 4, the results of the analysis of the evaluation forms in Chapter 5, the list of participants in Annex A and a list of abbreviations and acronyms.

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1. INTRODUCTION

Within the Human Resources Domain (HUM) of the EATMP, the Manpower Sub-programme is in charge of initiating, developing and supporting integrated and pro-active approaches and concepts in HRM which lead to effective and efficient HRM practices in ATM organisations. Its main activity covers recruitment, selection, MP and staff development [1].

1.1 Scope

The EATMP HRT has initiated the organisation of the First EUROCONTROL Selection Seminar. The goal was to establish a network where practitioners and experts in the selection of ATCOs can learn about and exchange information on actual and future trends in selection research and development and on current implementation activities and problems.

The expectation for this seminar was that by creating a basis for a common understanding of the consequences of future ATM systems on recruitment and selection, participants will come up with possible solutions, and discuss shared undertakings within recruitment and selection.

1.2 Purpose

This report is the proceedings of the First EUROCONTROL Selection Seminar entitled "Current and Required Future Selection Work and Methods in the ECAC Area". The seminar was held on 17-19 May 1999 at IANS with 72 participants from 27 States (including five States outside the ECAC area). The seminar was followed by a Study Session of selection and recruitment experts composed in its majority by members of the former European Air Traffic Harmonisation and Integration Programme (EATCHIP) Selection Task Force (STF) II where first conclusions were discussed.

1.3 Technical Notes

After a short introduction to the seminar, six keynote speakers presented different recent research findings concerning the selection of *ab initio* trainee controllers. These in-depth presentations attempted to give a wide overview of European and non-European experience in constructing and validating pre-selection procedures and test batteries for *ab initio* trainee controllers. The consequences of future ATM systems for ATCO selection were also tackled.

On the second day, attendees actively participated in an Open Forum. The Open Forum gave the opportunity for presentations from national experts on

[1] See also EATMP, Human Resources Team, (1999). *EATMP Human Resources Strategy Document*. Brussels: EUROCONTROL.

planned and current implementation activities and problems from the practitioner's point of view.

The Open Forum led into a Panel of Experts by presenting findings, addressing problems and asking questions which then were discussed and answered by the Panel. The Panel discussion summarised the seminar.

In the following chapters the slides used in the presentations are included. This will help those who wish to obtain a quick overview before reading the papers.

2. KEYNOTE PRESENTATIONS

2.1 The MRU Experience, by Prof. Dr. Berndt Brehmer, Swedish National Defence College and Bättre Beslut, Sweden.

In translation, the Swedish acronym Projekt Marknadsföring Rekrytering Urval och Utbildning (MRU) stands for Marketing, Recruitment Selection and training. It refers to a project initiated by the Air Navigation Services (ANS) department of the Swedish Civil Aviation Administration (CAA). The project is aimed at improving the selection and training of ATCO candidates in Sweden. The acronym emphasises the unique possibilities in the Swedish system of having an integrated approach to the recruitment, selection and training of ATCO candidates. This is a result of the fact that in Sweden, the whole chain from marketing to training, is handled by the same agency, the CAA. In the present paper, however, we will be concerned mainly with the selection aspect of the MRU project.

2.1.1 The Problem

The Swedish CAA has had the same problems as corresponding agencies in other countries that are in charge of the selection and training of ATCOs: high failure rates and, what is even worse, highly variable failure rates. The latter feature makes planning difficult, if not impossible.

The failure rate in the Swedish system has been decreasing from 46% in the 1970's to 34% in the 1980's to 27% in 1990's (up to 1993 when the MRU project started) (Haglund, Andersson, Backman and Sundin, 1993a). The variability has also decreased. In the 1970s, the failure rate varied between 73% and 29%, in the 1980s from 47% to 14%, and in the 1990s, it varied from 37% to 10% (Haglund, et al., 1993a). The cost of a failure was estimated at about 2.0m Swedish Krona per failed applicant, so it is clear that the failures were costing the Swedish CAA a considerable amount of money each year.

MRU project was aimed at both of the problems described above. Specifically, the goals for the project were

- that the failure rate should not exceed 10% and
- that the outcome should not vary more then 10%.

In short, the goal was set at a 90% success rate, +/- 10%. This goal should be reached in the year 2002.

2.1.2 MRU Phase 1: A Project Designed to Improve Selection

The first step was to look into the selection procedures used. This seemed reasonable in view of the fact that these procedures had remained unchanged since they were first adopted more than 30 years ago. As a consequence, the MRU project started as a project aimed at improving selection (Haglund, Andersson, Backman and Sundin, 1992).

Selection was then a two step process. The first consisted of testing and interviewing by a consulting company (which shall remain unnamed here). The second step was a decision by a selection board consisting of ATCOs. The decision was based on the data that had been collected in the first stage. Thus, there were no formal methods for the integration of these data, but the integration rules, whatever they were, emerged from the selection board's discussions.

The selection battery was a battery originally developed for the selection of pilots. It had never been validated for the selection of ATCO candidates. It consisted of three tests chosen to measure *flexibility* and the *ability to come up with new ideas*, two tests chosen to measure *logical ability*, three tests chosen to measure *spatial ability*, and four tests chosen to measure *attention to detail* and *short-term memory*. In addition, there was a test on the ability to perform different things simultaneously and two interviews, one conducted by a psychologist, and one conducted by an experienced ATCO. The interviews aimed at evaluating certain personality characteristics assumed to be important for performing the ATCO job successfully, such as *stress tolerance*, *ability to co-operate*, *ability to take initiatives* and *motivation to become an ATCO*. Finally, the candidates were subjected to a so called percept-genetic test, designed to measure *defence mechanisms* that might interfere with good performance as an ATCO. As described above, the final decision was then made by a commission that attempted to form an overall picture of each candidate on the basis of the results from the tests and the interviews as well as references and other material from earlier employment. As noted above, this was an informal assessment, that followed no set rules.

As noted above, the selection procedure had not been validated. As a first step, the MRU project therefore tried to get some idea of its validity by assessing the relations between the results from the tests and interviews on the one hand and training outcome on the other (Brehmer, 1993a). Training outcome, in this case, refers to whether the candidate received his or her ATCO licence. The results were not encouraging. The squared multiple correlation between tests and training outcome (corrected for degrees of freedom) was $R^2 = .03$. This is probably as close to a zero correlation as one is likely to come in an empirical assessment. In short, there was no evidence that the selection procedure had any validity.

This assessment is, of course, problematic in that it was based on candidates who had already been selected using the selection procedure that was being evaluated. This means that there was restriction of range in the selection variables. This is likely to decrease the correlations that can be obtained. A second possibility is that the relations between the selection variables and the training outcome are non-linear, and that the probability of passing training does not increase above the cut-off scores for the tests. The latter hypothesis, is, of course, hard to evaluate on a sample such as the one used in this evaluation. However, the results with respect to the Standard Deviations (SDs) indicated no really serious restriction of range problems, at least not serious enough to explain the near zero multiple correlation. As a consequence, it seemed most reasonable to conclude that the low R^2 value should be interpreted to mean that the selection procedure lacked validity.

A new selection procedure was therefore deemed necessary to achieve the goals set for the MRU project. In this we were greatly helped by the Head of the ANS division of the Swedish CAA. When learning about the results of the evaluation of the selection procedure, he decided to dispense with the services of the consulting company, and directed the MRU project to develop a new selection procedure. This put the project in a not very enviable position, for there was clearly no time to go through the usual steps of selecting and validating new tests. Were we therefore doomed to repeat the performance of the consulting company who had just been fired, deserving a fate no better than it?

Fortunately, a way out of this dilemma was found. In anticipation of work towards a new selection procedure, the MRU project had decided to evaluate a test developed by the Federal Aviation Administration (FAA). As a first step of this evaluation, the MRU project had decided to perform a discriminant validity study. The plan was to compare a group of applicants for ATCO training with a group of qualified ATCOs. The general idea was that if the test did not discriminate between these groups, it probably would not have much predictive validity either. (We later found that the FAA test did not discriminate very well between applicants and qualified ATCOs, see, Brehmer, 1996a. Recent results also suggest that it has limited predictive validity, as we would expect). The FAA test validation study made it possible to evaluate more tests for a possible selection battery. (We had already decided that the FAA test should not be included in this new battery until it had undergone standard validation).

2.1.3 Job Analysis

The first step in the development of a selection procedure is, of course, to perform a job analysis to search for candidate selection variables. Steps towards such an analysis had already been taken when the decision to develop a new selection battery was made. This analysis (Haglund, Andersson, Backman and Sundin, 1993b) relied on a critical incident approach using focused group interviews with 57 qualified ATCOs (17 Aerodrome Control Tower (TWR), 24 Terminal Control Centre (TMC) and 16 Area Control Centre (ACC) controllers). The aim of these interviews was to collect descriptions of good and bad ATCO behaviours relating to Air Traffic Control (ATC). These behaviours were then analysed to yield descriptions of problematic situations in ATC and behaviours that the ATCOs had used to solve the problems facing them (”key behaviours”). Four main problematic situations were found (and one miscellaneous category):

1. flow control,
2. co-ordination,
3. disturbances and irregularities,
4. variation in workload.

The most important key behaviours for handling these problematic situations were:

1. decision making;
2. collection of information;

3. having high levels of aspiration with respect to knowledge of one's work;
4. maintaining good social relations.

These results paint a picture of the ATCO as a person capable of making the correct decisions within his/her domain, who has the ability to collect the information that is required, who is motivated for his/her work, and who is able to uphold good social relations. This certainly seems like a person who could do the ATCO job.

The problem with the description is, of course, that it does not point to any characteristics that are unique for ATCOs: the four kinds of key behaviours would be good in any kind of work, and the analysis does not indicate that the demand for these behaviours would be extreme for ATCOs, i.e., that ATCOs would need to exhibit these behaviours to a greater extent than, say a process controller in a pulp plant. Moreover, the behaviours do not point to any traits of abilities that could be used for selection, with the possible exception of the ability to uphold good social relations. To make good decisions and to collect the right kind of information for these decisions are presumably *learned behaviours* in so far as they relate to behaviours in the ATC environment. The results of this analysis thus agree with those from analyses of ATCO behaviour based on cognitive psychology. They also come up with lists of required processes that are needed in any kind of work (Brehmer, 1996c; see, e.g., Aerospace Sciences Inc. (ASI), 1991, for an example).

This result may indicate that although the ATCO job is unique, it may not require unique abilities, it may only require that normal people are trained well to do the job, as was pointed out by Hopkin (1988) in a review of research on ATCOs.

We did not want to give up that easily. To dig a little deeper, we decided to collect information on the relative importance of different key behaviours by means of questionnaires distributed to qualified ATCOs.

The focused group interviews yielded 199 key behaviours. On the basis of these, three questionnaires were constructed, one for each category of controllers, based on the key behaviours reported in the interview with that category.

The resulting questionnaires were filled in by three groups of 162 qualified ATCOs, one group of 54 TWR controllers, one groups of 54 TMC controllers and one group of 54 ACC controllers. Each respondent was asked to rate the importance of each behaviour, as well as its frequency.

The ratings were subjected to a principal components analysis (Brehmer, 1993b). The results showed, first, that the factor structure was different for the importance judgements and the frequency judgements, and second that the structure for the importance judgements which are our main interest here, did not correspond to the structure that we thought that we had put into the data, i.e., the different kinds of key behaviours listed above.

This might have signalled trouble, but we had done thinking. Specifically, we had tried to characterise the essence of ATC, i.e., to find what characterises ATC compared to other occupations. In this, we took the *control* part of ATC seriously, and this led us to consider the ATCO's job as a matter of exercising control. Specifically, we hypothesised that the essence of the ATCO's job is a matter of controlling air traffic flows.

Elsewhere, I have suggested that process control can be seen as a matter of dynamic decision making (Brehmer, 1992), and that important aspects of dynamic decision making can be characterised in terms of control theory. Specifically, control theory can be used to specify the preconditions for control. These preconditions are the same, regardless of whether we are considering manual or automatic control, and the same regardless of the nature of what is to be controlled. Specifically, there are four preconditions of control:

- there must be a goal;
- it must be possible to ascertain the current state of the system;
- it must be possible to change the state of the system;
- there must be a model of the system.

Applied to ATC, this means, first that the ATCO must know and understand the goals of the system. This goal is often said to be safety, but in fact, it is, perhaps, better to think of the ATCO's goal as that of making sure that the aircraft in the system reach their destinations as quickly as possible. Safety is then a *constraint*: If safety is not upheld, the aircraft will not reach their destinations.

The ATCO receives information about the state of the system either by radio reports from the pilots, or from a radar. In the former case, the ATCO must construct a mental representation of the airspace and the aircraft in it. In the latter case, some of the aspects of the airspace can be found on the radar screen, but this representation is only two-dimensional. Therefore, a radar controller lacks part of the information that he or she needs. Even a radar controller must, at times, actively construct a mental picture of the state of the system. The quality of the information that the ATCO has about the state of the system, therefore, depends not only on the equipment, but also on the skills of the controller.

The ATCO has only one means to change the system, and this is to issue commands and advice to the pilots. This will only work if the ATCO is understood by the pilot, and the likelihood that this will happen depends upon the proper use of phraseology.

Finally, ATCOs must have a model of the system with which they are working. We may distinguish among three kinds of models:

- the overall model of the state of the system;
- the model that the ATCO constructs to solve a problem that he or she faces;
- the models of aircraft and other components that the ATCO has stored in his/her long-term memory and that he/she uses to construct the models used for problem solving.

The first model corresponds to what is now often called ”situation awareness”, and it involves knowing the current state of the system, how it came to be what it is, and how it will develop in the near future. This model will help the ATCO detect possible anomalies. Clearly, this model is what provides the ATCO with his or her understanding of the airspace and the aircraft in it.

This model must rely on *long-term memory structures*. It could not be a short-term memory construction for the simple reason that there is too much communication among ATCOs in a control centre and between the ATCOs and the pilots. Under these conditions, it would be very difficult to construct and maintain mental models in short-term memory. This is because short-term memory is extremely sensitive to auditory interference. Any model that the ATCO constructs in short-term memory must therefore be very short lived, if he or she managed to construct it at all.

We have therefore hypothesised that ATCOs rely on patterns stored in long-term memory for their control of the system, and that they will recognise the current pattern on their screen as an example of well ordered traffic in their sector or as an example of problematic traffic. In this respect the ATCOs would be similar to chess masters, who seem to store and use patterns in exactly this way (Chase and Simon, 1973). To investigate this in more detail, we (Brehmer and Victor, in preparation) repeated the classical Chase and Simon experiment on ATCOs. In the experiment, we compared experienced ATCOs with students and ATCO students for radar screens depicting well ordered traffic and random traffic. The subjects were allowed to study the screens for 20 sec., and they were then asked to reconstruct them with paper and pencil. The results showed that experienced ATCOs were superior to the other groups, but only for well ordered traffic. They did not perform better than the other groups for the random displays. That is, the experienced controllers had patterns in long-term memory that they could use to reconstruct traffic patterns, but they only had such patterns for well ordered (or real) traffic. That is, their better performance was not a question of generally superior memory, but of specific experience. For traffic patterns for which they had no experience, i.e., the random patterns, they could not of course rely on their superior experience. Their performance was therefore no better than that of subjects with no experience at all. This, incidentally, shows that memory capacity is not likely to be a useful selection variable. But it does emphasise the importance of training and experience.

The models that the ATCO actively constructs for problem solving, on the other hand, will probably be constructed in short-term memory. However, we should not completely discard the possibility that the ATCO may have stored useful models for problem solving in long-term memory also, and that these models are used for problem solving. Or, to be more precise, they eliminate the need for a problem by providing the ATCO with recipes for handling air traffic problems.

Armed with this general model, the results of our factor analyses were simple to interpret, for the factors that had been extracted corresponded to elements of the general control model. The most important factors related to the ability to achieve adequate situational awareness and mental models for problem

solving, to use the means for control, to regulate one's workload, to adapt to the situation in a flexible way, and to have the requisite social ability so as to be able to understand the pilot's point of view. Interestingly, there were no factors relating to the ATCO's goals. This is because there were no key behaviours relating to this aspect in the job analysis and consequently no items relating to goals in the questionnaires. Apparently, this aspect does not create any critical incidents for ATCOs.

The results of this analysis were important in that it provided a new start with respect to the training of ATCOs, based on an understanding of the essence of the job. The results of this analysis now forms the basis for the training of ATCOs in Sweden. But it did not directly provide us with information that could be used for developing selection instruments. Indeed, most of the factors found in the analysis point to training as the important factor. Thus, two of the kinds of models that the ATCO relies on seem to reside in long-term memory and be the result of training. So does his or her means of influencing the system. The strategies used to control workload are probably also learned. The only possible exception was the second kind of models, the models that the ATCO constructs in short-term memory to solve problems. These models require the ATCO to construct three dimensional dynamic representations and to use these for solving the problems that he or she faces. This was something that was clearly specific to the ATCO job, and perhaps something for which there might be individual differences, albeit one for a limited, but important part of the job. Here, at last, we had a starting point for developing new methods.

2.1.4 Selection of Tests

In the new provisional MRU battery, we included three kinds of variables:

- school grades (when graduating from high school, the Swedish *Gymnasium*) in Swedish, English and Mathematics;
- the situational interview described below;
- psychometric tests on spatial ability, general reasoning, and attention to detail (proof reading). These tests were chosen because they had the highest correlations with training outcome of all tests in the original selection battery (see Brehmer, 1993a)[2].

The school grades were also included in an attempt to provide an estimate of the applicants' ability to perform scholastic work, which is an important aspect since the selection is also for *training* to become an ATCO, and not only for doing the ATCO job, once one has qualified for it. School grades are also a useful proxy for measures of general intelligence since there is generally a

[2] The test on general reasoning was the well known Ship's destination test, constructed by Guilford and Christensen. The tests on spatial ability came from a Swedish test battery. One is called Hand rotation and requires the testee to imagine how his/her hand will look when rotated, and the other, Figure rotation, requires the testee to consider how figures look when rotated. The test on attention to detail was a test on proof reading from the Minnesota Clerical Abilities Battery from 1933.

substantial, albeit not perfect, correlation between school grades and general intelligence. The situational interview was a new development designed to measure aspects that had not been measured before.

2.1.4.1 The MRU Situational Interview

The results above suggest that an important aspect may be the ability to construct dynamic three dimensional representations and to solve problems using these representations. This is not measured by standard psychometric tests of spatial ability[3]. In the MRU project we decided to develop an interview to measure this ability. Interview questions, we thought, would force the interviewees to construct the representation (in most tests on spatial ability, the testees do not have to do that, the representation is provided in the test questions), and then use it to solve some problem. The situations we constructed to measure this ability were like the problems that ATCOs meet in their profession in that they involved aircraft in the air or on the ground. They did not, however, require specialised ATCO knowledge, e.g., knowledge about rules, characteristics of aircraft and the like, for their solution. That we were reasonably successful in this is shown by the fact that although the ATCO group as a whole perform better than a group consisting of applicants for ATCO training, many applicants nevertheless perform better than many qualified and experienced ATCOs. Thus, ATCO experience helps, but it is not essential for performing well on this set of items (see Brehmer, 1995c).

A second dimension with selection potential was social attitudes. This was also one of the dimensions to come out of our job analysis. This is hardly surprising; the ATCO job requires the ATCO to co-operate with other ATCOs and with pilots in a number of ways, so the ATCO's social attitudes with respect to co-operation should be important.

Finally, we decided to include educational attitudes. There were two reasons for that. First, the ATCO trainees must go through a fairly lengthy training period where they have to acquire a considerable amount of theoretical knowledge. Second, the ATCO job requires continuing education throughout the ATCO's career. A positive attitude to education should be important, therefore, both to become a qualified ATCO and to be able to function successfully in the ATCO profession.

As is well known, interviews have a lot of problems, and they often lack both reliability and validity. However, the recent development of the *situational interview* seemed to offer a way out (Latham, Saari, Pursell and Campion, 1980). In a situational interview, the interviewee faces a number of situations and is asked about what he or she would do in each of them. The interviewee's answers are compared with answers that have been evaluated by Subject Matter Experts (SMEs) (experienced ATCOs in our case) with respect to whether or not the behaviours described in the answers would be desirable from a person in the job for which the selection is to be made. In addition, a number of aspects concerning how the question is answered are

[3] There is considerable doubt whether tests designed to measure spatial ability measure this ability or general reasoning, see, e.g., Lohman, Pellegrino, Alderton and Regian (1987).

noted by the interviewer. In the MRU interview we do not use these data, but rely only on the more objective scoring of the content of the answer.

We constructed 22 situations designed to measure educational attitudes, 18 situations designed to measure social attitudes, and 24 situations designed to measure the ability to form three dimensional representations and to solve problems using these representations (hereafter called ”ATCO problems”).

The psychometric characteristics of this interview have been examined using a sample of 185 applicants and 189 qualified ATCOs (Brehmer, 1995c). Reliability as assessed by Cronbach's α were satisfactory (.86 for attitudes to education, .85 for social attitudes and .93 for ATCO problems). In a discriminant analysis, it made 87.3 % correct classifications of ATCOs and applicants, but only the social attitudes and ATCO problems sub-scales contributed significantly to the discrimination.

The scales are highly intercorrelated. This bothered us until we finally understood that this is a natural consequence of how we scored the interviewees' answers. They are always scored in terms of how a qualified ATCO would answer them. In short, all questions may be said to measure a common dimension of ”ATCO-ness”, and they *should* therefore be highly intercorrelated (Brehmer, 1998).

2.1.4.2 What does the Situational Interview Measure?

The fact that the situational interview was designed to measure attitudes to education, social attitudes and ability to construct three dimensional representations and to use these to solve problems does not mean that this is what the interview measures. One attempt has been made to investigate what the scales measure, by correlating them with other test data that have been available (Brehmer, 1996b). This was made for applicants and ATCOs separately. For ATCOs, there was no significant multiple R between the scores on the social attitude scale and school grades, two tests of spatial ability, one on attention to detail, and one on general reasoning. For applicants the adjusted R^2 was .055 with significant weights for mathematics grad and general reasoning scores. For ATCO-problems, the adjusted R^2 was .03 for ATCO and .14 for applicants with significant weights for mathematics grade, general reasoning and one of the spatial tests (hand rotation) for the applicants. These results suggest that applicants and ATCOs may not solve the ATCO problems in the same way. Specifically, since there is no correlation between the scores on the ATCO problems and general reasoning or spatial ability for the ATCO, it is possible that the ATCO rely on their experience when solving these problems, which the applicants actually have to reason to solve them. On the other hand, the results may simply reflect the fact that SDs for the test scores were lower for the ATCOs and that the chance of finding a significant correlation was therefore lower for that group than for the applicant group.

Before we had understood the reason for the intercorrelations among the scales from the situational interview, we tried to develop a new version of the

interview designed to give cleaner measures of the traits in question. When assessing the psychometric characteristics of this new interview, we found, that although it had acceptable reliability and although it discriminated between applicants and ATCOs as well as the old interview, it did not correlate very highly with the old interview purporting to measure the same traits. A principal components analysis yielded one factor for the old interview and one for the new interview. Obviously, we failed to construct a parallel version of the MRU situational interview. The explanation for this failure is not clear to us.

2.1.5 Discriminant Validation

Discriminant validation is a form of validation for desperate people. And ”desperation” describes the state of mind of the MRU project when faced with the task of developing a new selection battery.

To those who cannot wait for conventional validation results from a standard predictive validation, two forms of validation are possible. The first is *concurrent validation* where a sample of people in the profession for which a selection is to be made, are tested with the battery to be validated and then ranked with respect to proficiency. The correlation between the test scores and the proficiency scores then provides the validity coefficient. The problem with this form of validation is that it likely to be subject to restriction of range problems since only people in the job can be used for the validation. It seems likely that they are a positively biased sample compared to a non-selected one. However, the problem is obviously less than when the battery that was used for the selection is validated in this manner, as was the case in our evaluation of the earlier selection battery.

The logic of a *discriminative* validation (which I have never seen being used for developing a selection battery in the way it was done in the MRU project) is as follows. First, the ability of the selection battery to discriminate between people in the job and a non selected sample, such as a sample of applicants, is established. If it discriminates between these two samples, there is some chance, but no guarantee, that the battery measures something of importance for selection. There is no guarantee because the variables that discriminate between the people already in the job and those applying for it may, of course, be irrelevant to prediction of success in the job.

Once the discriminate power of the new battery has been established, a prediction equation is developed for predicting whether a testee belongs to the group of applicants or the group of people already in the job. Such an equation would predict the extent to which a testee is similar to the people already in the job. If the battery measures similarity with respect to something that is important for doing the job in question well, the equation developed in this way obviously provides a valid selection equation, once a suitable cut-off point has been established. However, it should not be confused with the more appropriate predictive equation.

The logic of discriminate validation, then, is straightforward. The main problem is that there may be differences between the two groups that are irrelevant to success. This is a very real problem when the people in the job have already

been selected in some systematic manner. In the present case, we used two groups, one group consisting of qualified ATCOs and one consisting of applicants for ATCO training. Neither of these groups can be considered non-selected. Those who apply for ATCO training are hardly a random sample of the population, and those who are ATCOs were once selected with the test battery described above. That the applicant group is not a random sample is not so problematic; we are not interested in the ability of the battery to discriminate between ATCOs and people in general. We are interested only in selecting from the sample of people who apply for ATCO training.

The characteristics of ATCO group is problematic, however. We know that the persons in this group have been selected with a quite extensive test battery. That this battery may not be valid is not only beside the point; it is the problem. That is, it is quite possible that this group differs from the applicant group in ways that are irrelevant to performing the ATCO job. Consequently, we have two opposing tendencies here: the fact that the ATCO group is selected so that the SD in the selection variables will probably be lower than in the applicant group. This tends to lower the possible correlation. On the other hand, the groups may be similar in irrelevant ways, which may increase the correlation. Thus, there is some uncertainty surrounding the discriminative selection equation, but it should be better than no validation at all. It is important, therefore, that the tests used in the discriminative validity assessment are based on a sound job analysis. Arguments that the selection instruments measure relevant forms of similarity can only be based on the quality of this analysis. In the present case, we feel that we have performed a valid job analysis, so feel reasonably certain that the MRU selection battery measures relevant forms of similarity.

A total of 374 persons, 185 applicants and 189 qualified ATCOs took part in the study (Brehmer, 1995a). Their results were first subjected to discriminant analyses assessing the extent to which the tests would discriminate between applicants and ATCOs.

There were differences in performance between the two groups. ATCOs performed significantly better than applicants for all three school grades, all three scales of the situational interview, and all psychometric tests except one of the spatial tests, but even for this test, the ATCOs outperformed the applicants, even if the difference here was not significant. The results for the psychometric tests are not surprising; these tests had been part of the battery originally used to select the ATCOs. That the ATCOs had higher scores also on situational interview scales is also to be expected since the responses to the interview questions were scored with respect to what would be good answers for an ATCO. The higher results for the school grades are also reasonable since school grades tend to positively correlate with general reasoning, which had been one of the selection variables. The SDs were lower for the ATCOs for the psychometric tests, as would be expected since these tests had been used in the selection, and for the ATCO problems in the situational interview. The latter result was due to a ceiling effect, the scores of most ATCOs were in the higher end of the scale.

A discriminant analysis showed that 89.78% correct classifications of ATCOs and applicants could be made with the total battery. However, only four variables contributed significantly to the discrimination: Grade in mathematics, General reasoning, ATCO questions and Social attitudes in the situational interview. Using only these four variables, 88.5% correct classifications could be made. This is a very small loss compared to what incurred when using all variables, so the decision was to use a battery with these four variables. This is known as the MRU provisional selection battery.

On the basis of these data, a prediction equation was then developed using multiple regression. Applicants were given the code 1 and ATCOs the code 2. The resulting regression equation gives a number for each person. The closer this number is to 2, the more similar the person is to an ATCO.

The cut-off point was then set so as to have minimum overlap between the two groups, meaning that the applicants who would be selected with this equation would be highly similar to the ATCO group[4].

This battery and its associated selection criteria have now been used in nine selections. Close to 2000 applicants have been tested. The results have been remarkably stable when examined in terms of the regression coefficients for predicting ”ATCO-ness”. In all of these comparisons, the same ATCO sample has been used, so the results are somewhat limited.

Table 1: Regression results for 8 consecutive samples

	Sample							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Math Grade	.089	.004	.035	.023	.037	.053	-.020	-.020
General reasoning	.065	.126	.173	.073	.100	.115	.123	.143
Social attitudes	-.350	-.320	.310	-.310	-.310	-.190	-.115	-.119
ATCO problems	.894	.852	.853	.880	.869	.797	.740	.771
Adjusted R^2	.575	.564	.591	.549	.549	.527	.469	.506
N	319	244	358	350	286	363	241	260

The decrease in the beta weight for the Mathematics grade is due to the stricter adherence to the selection criterion with respect to this variable. As a consequence, the sample of applicants became more homogenous with respect to this variable from sample 2 on, and this has made this variable quite useless as a selection variable. It should presumably be removed from the selection equation.

[4] For obvious reasons, the actual selection criteria are not given here.

Apart from this, the weights for the selection variables stay quite constant, as does the adjusted R^2. This suggests that we are recruiting from the same population, and that the selection equation functions in the same manner as for the first sample, that used to derive the weights for selection.

The fact that Social Attitudes receive a negative weight does not mean that we want to recruit anti-social individuals. It is a purely statistical effect, due to the high intercorrelation between the two scales from the situational interview.

2.1.6 What Has Been Achieved?

So far, about 210 applicants have been accepted into ATCO training on the basis of their test results on the MRU provisional selection battery. Some 50 of these have completed training. Disregarding the first course, which was used to determine the parameters of the selection equation, we have a mean success rate of 85% for the remaining two courses. Not quite the 90% we were aiming for, but nevertheless better than before the MRU project started. For basic training at the academy, we have results for nine courses with a mean success rate of 90%. These results are encouraging, especially when considered together with statements from the teachers at the academy that (to be conservative) their students are no worse than they used to be. In view of the fact that this has been achieved at 35% of the cost when the earlier selection battery was used, this sounds even better.

However, we cannot ascribe these results (and we must remember that they are uncertain) solely to the new selection procedure. At the same time as it developed the new selection methods, a number of changes has been made in the training and education, both at the academy and the subsequent On-the-Job Training (OJT). Perhaps the most important of these changes has been a change of attitudes of the instructors. It would not be unfair to say that training used to be ”selection by other means”. Now, the attitude is that training should not be a matter of finding those who are not suited to the ATCO job. Instead, the attitude is that the students are good enough, and that it is up to the instructor to see to it that their potential is realised by using appropriate training methods. We have been able to ascertain that real attitude changes have occurred (Brehmer, 1995b). These changes in instructor attitudes are probably as important, or perhaps even more important, than the new selection methods.

2.1.7 Conclusion

It is really too early to draw any definite conclusions from the MRU project. So far, all signals are good: the simplified (and cheaper) selection procedure does not seem to have led to more failures in ATCO training. Of course, we have no evidence that it is the new selection procedure that has led to the good results. The improvements in education and training may well be the primary cause of that.

Taken as a whole, it nevertheless seem reasonable to conclude that satisfaction can be obtained with a fairly simple selection battery. The reason for this is found in the results of our job analysis which suggests that most of

the components of ATCO performance are based on learning and experience, rather than special abilities. On the whole then, the MRU experience suggests that Hopkin's second alternative, that ATCOs are unique because of their training rather than because of their innate abilities, is the more correct one. This implies that we ought to out more of our future efforts into better training methods and into more and more esoteric selection methods.

2.1.8 References

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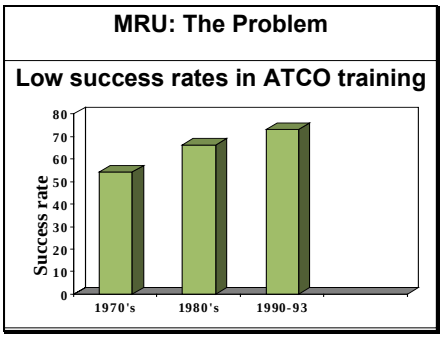
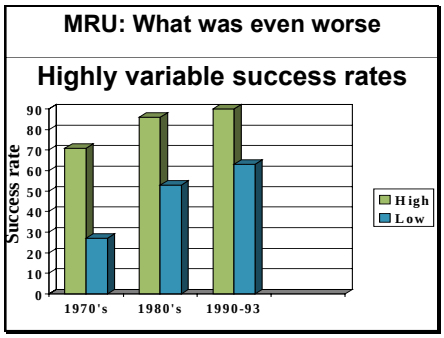
2.1.9 Slides Used During the Presentation





MRU: The Goal

90% success rate +/- 10% in 2002

MRU: The First Step

Analysis of the existing selection battery
- Flexibility and the ability to come up with new ideas (3 tests)
- Logical ability (2 tests)
- Spatial ability (3 tests)
- Attention to detail and short term memory (4 tests)
- Ability to perform different things at the same time (1 test)
- An interview by an ATCO
- An interview by a psychologist
- Selection committee

MRU Selection: First results

•Existing selection battery had never been validated

•Results from existing selection battery did not correlate with training outcome (Adjusted R^2 = .03)

•The Head of the Air Navigation Services of the Swedish CAA decided to dispense with the existing battery and directed the MRU project to develop new selection methods

MRU: First Job Analysis

•Group interviews using a Critical Incidents Approach with a total of 57 qualified ATCOs (17 TWR, 24 TMC and 16 ACC)

•Good and bad ATCO behaviours were collected

•Analysed to yield problematic situations and the behaviours that had caused these situations and what the ATCOs had done to solve the problems

MRU: First Job Analysis Results

•**Problematic situations**
- Flow control
- Co-ordination
- Disturbances and irregularities
- Variation in workload

•**Key behaviours**
- Decision making,
- Collection of information
- Having high levels of aspiration with respect to knowledge of one's work
- Maintaining good social relations

MRU: Interpretation of First Job Analysis Results

•As expressions of general capacities, these behaviours are not specific to ATC but desirable in any job

•Learned behaviours, specific to air traffic control:
- decisions concerning ATC problems
- information to guide these decisions

•No guidance for developing selection methods

MRU: Second Job Analysis

•Three questionnaires were constructed on the basis of the results from the first job analysis, one for each type of controller

•Distributed to 54 TWR, 54 TMC and 54 ACC controllers (about 25% of all Swedish controllers) who were asked to estimate importance and frequency

•Importance judgements were subjected to a principal components analysis

MRU: Second Job Analysis Results

•The analysis did not yield the factors that had been "put in"

•Results were interpreted in terms of a theoretical analysis of air traffic control as dynamic decision making

The MRU Model: Air Traffic Control as Dynamic Decision Making

- Dynamic decision making as control
- Four preconditions for control:
  - There must be goal
  - It must be possible to ascertain the state of the system
  - It must be possible to change the state of the system
  - There must be a model of the system

MRU: Results from the Second Job Analysis: Factors

- Situational awareness, good mental model
- Social ability
- Uses the possibilities to influence the situation
- Collects information to update the mental picture
- Flexibility
- Regulates work load
- Ability to tolerate stress
- Follows prescribed procedures

The MRU Provisional Test Battery

11 potential selection variables were evaluated

- 3 tests on spatial ability
- 1 test on General Reasoning
- 1 test on ability to pay close attention
- School grades in Swedish, Mathematics and English
- Three scales from the MRU situational interview

The MRU Situational Interview (1)

- The situational interview method was developed by Latham, Saari, Pursell and Campion (1980)
- A series of situations are presented, and the interviewee is asked what he or she would do
- To provide objective scoring, the answers are scored by comparing them to alternatives generated by domain experts
- Various behaviours while answering are also registered (not used in the MRU interview)

The MRU Situational Interview (2)

- Three subscales
  - Educational attitudes (22 items)
  - Social attitudes (18 items)
  - Ability to construct dynamic representations in three dimensions and to solve problems using these representations (ATCO problems) (23 items)
- The three subscales have acceptable reliability (Cronbach alpha = 0,89, 0,87 and 0,88 for applicants)

The MRU Situational Interview (3)

- The three scales are highly intercorrelated (> .54)
- This is because all items are scored in the same way, i.e., with respect to the extent to which the behaviour in question would be desirable for an ATCO, i.e., the all measure the same thing: good ATCO behaviours

Discriminant Validation

- A form of validation for desperate people
- The extent to which the potential selection instrument discriminates between applicants and people already in the profession is assessed
- A prediction equation is developed to predict the similarity between a person and people in the profession is developed and used for selection with a suitable cut-off score

Discriminant Validation (2)

- It has to be assumed that the discrimination between the applicants and the people in the profession is based on something that is important for performing the job
- It has to be assumed that being similar to people in the profession in the respect measured by the potential selection instrument is important for doing the job
- This makes the job analysis extremely important
- The cut-off is problematic and arbitrary

Discriminant Validation (3)

•The adjusted R^2 = .57 ($p < .001$) for predicting "ATCO-ness"

•The cut off score is set so that we have to test 6 applicants for every applicant that is accepted

•About 10% of the controllers in the validation sample score below the cut off now used

The MRU Provisional Selection Battery

•4 selection variables proved sufficient

- General Reasoning (Ship's Destination)
- Grade in Mathematics
- Two scales from the MRU Situational interview:
  - •Social attitudes
  - •ATCO problems

•88,5 % correct classifications of ATCOs and applicants

The FAA Test

•A "Job Sample Test" which requires the testee to direct aircraft

•It requires considerable practice (3 days)

•We have assessed its predictive validity with 56 cases

•The adjusted R^2 between the test scores and training outcome was $R^2 = 0{,}068$ ($p < .058$) and it identified 23,5 % of the failures and 92,3 % of the successes (log reg)

The MRU Provisional Selection Battery

•Results have proved highly stable, weights do not vary much from sample to sample

•According to the staff at the Swedish Air Traffic Control Academy, the students that have been selected with the new battery are no worse than the students that were selected with the old selection battery

•The cost is 35% of what it was with the old selection battery

The MRU Provisional Selection Battery (2)

•Two courses selected with the provisional MRU selection battery have completed training with a mean success rate of 85%, not quite the goal of 90% but there are 3 years to go

•This cannot be attributed to the new selection methods alone. There have also been changes in education and training: Training is no longer seen as selection "by other means"

Conclusions

•We will never be able evaluate the relative importance of selection and training for the current success rate
•We are looking at ways to improve training and we are evaluation new tests
•It is going to be hard to improve on the current results
•However, it seems reasonable to conclude that if you have a good education and training system, you may not need very complex selection methods

Hopkin's Alternatives

One contention is that the would-be controller should be young, physically fit, mentally stable, articulate, considerably above average in intelligence, and educated to college entrance standards or thereabouts. These are not stringent criteria – many people could meet such requirements.

Another contention is that, to be selected, a future controller must possess a combination of particular skills and attributes...Quite a long list can be compiled of factors thought to have predictive value….Few people would pass such a stringent selection procedure.

In practice, the evidence tends to favour the first contention...

2.2 The Use of Biographical Data in the Pre-selection of *ab initio* ATC Applicants, by Mr. Hinnerk Eißfeldt, Dipl. psyc., German Aerospace Center, (DLR), Department of Aviation and Space Psychology, Hamburg, Germany.

2.2.1 Abstract

In 1995 the DFS (Deutsche Flugsicherung GmbH) and the DLR started to look for ways to increase selection efficiency. Faced with over 1500 applicants each year and a decreasing selection ratio, high investments in resources were necessary. It was decided to develop a pre-screening process on the basis of biographical data. A review of the reference literature showed this approach to be new in the context of *ab initio* selection. This paper describes the development of the biographical questionnaire, areas of content and also experience with the first application for research purposes. On the basis of over 1200 questionnaires, the Chi Square Automatic Interaction Detection (CHAID) method was used to analyse different success rates for various subgroups. Empirical results showed the potential to reduce the number of examinations by up to 50% whilst identifying about 90% of recommended candidates. In order to steer clear of ethical issues, this approach was not pursued and a screening approach was adopted instead which reduced the sample of applicants by about 20% on the basis of unfavourable answers. The length of the questionnaire was reduced from 144 to 106 questions to make it more acceptable to applicants. Since April 1998, the biographical questionnaire has been sent out to all applicants. Results from the first period of screening (about 36% of applicants in 1998 were screened) show only a small improvement in the success rate of the selection procedure. The main reason for this is the change in style of answer in anticipation of real application of screening. Other reasons are discussed including changes in population and seasonal effects. However, in comparison with the non-filtered sample, it can be shown that applying pre-screening to a total intake of 120 trainees would save about German Marks (DEM) 400,000,-- per year. Ways of improving screening efficiency are discussed.

2.2.2 The Development of a Biographical Questionnaire to be Used to Pre-screen for Suitability for Selection as *ab initio* ATC trainees

The high requirements and low success rates of the ATC ability test procedure create a particular financial burden for the employer. In the past, this had led to repeated deliberations as to whether appropriate measures could influence the flow of applicants (in particular those for pre-selection) in such a way as to increase the proportion who were successful. In recent years, particular filter settings have from time to time been tested on real applicant data. This proved that excluding certain subgroups (e.g. on the basis of school leaving grades or age groups) would increase the efficiency of the procedure. Since, however, the absolute number of suitable candidates would at the same time also be significantly reduced, such approaches were never put into practice. At the most, these analyses played a role in the setting of a new age limit.

Experience with the "paper-sift" procedure practised at EUROCONTROL also suggested that pre-screening could be beneficial. However, this procedure (all applications received are examined by three senior employees and evaluated using a point system) entails considerable manpower effort, which would not be practicable given the numbers of applicants in the case of the DFS.

Back in 1995, the DFS and the DLR agreed to examine the sifting of applications. Following in-depth research of the reference material (Jäger (1978); Schuler and Stehle (1986); Rothstein, Schmidt, Erwin, Owens and Sparks (1990); Hollmann (1991)), a biographical questionnaire was drawn up with initially over 200 questions, subsequently reduced after thorough examination to 144. The questions refer to the areas of work and professional experience, training, parental home and family background, choice of occupation, activities and interests as well as to the questionnaire material itself. The questionnaire was sent out to all applicants before the invitations to the pre-selection tests, informing them of the questionnaire's objective and the fact that it was being used exclusively for research purposes. For the evaluation of the results, importance was attached to obtaining a large enough sample to enable reliable conclusions to be drawn from the contents. The analysis of the data was based in the end on 1207 questionnaires. Of these, 1124 data sets (93.1%) were complete, while the remainder had some gaps (pages not completed), partly owing to misprints, partly owing to superficial completion. In terms of biographical details, the test group fully conformed to the standard parameters, particularly since this was a comprehensive survey.

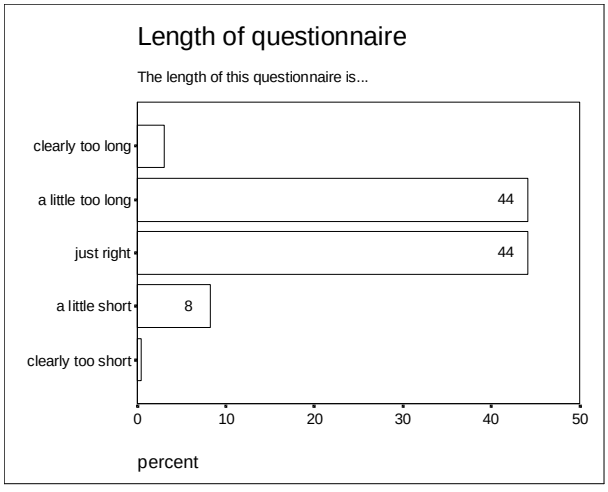


Figure 1: Assessment of the length of the biographical questionnaire

An initial analysis of the questions to assess the questionnaire and the method of processing yielded satisfactory results. Figure 1 shows opinions on the length of the questionnaire (144 questions). Overall, the form was considered to be slightly too long. In response to the question as to the length of the questionnaire, around 44% considered it to be "just right" or as "a little too long". 8% considered the questionnaire "a little short", while only 4% thought it "clearly too long". This result is altogether satisfactory, but prompted a further tightening up of the material for the final version of the questionnaire.

The question on acceptability read: "Do you consider these questions to be suitable for the selection of candidates to be examined from the point of view of content?" This question is crucial with regard to the possible implementation of pre-screening insofar as decisions are to be based on the information applicants supply themselves. Information candidates supply regarding themselves will only tally with their own self-assessment if they consider it to be advantageous. In this context, applicants may perceive an advantage either in being invited to the test, or in not having their application considered further which would save them unnecessary expense and effort. This, however, is dependent upon the procedure being deemed worthwhile. If a majority rejected the procedure its usefulness would be questionable.

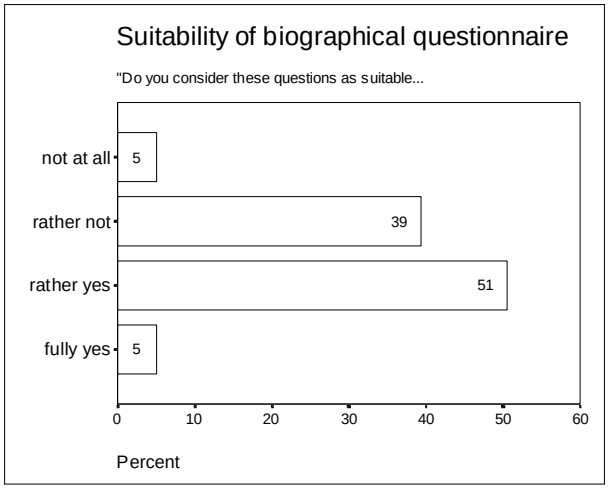


Figure 2: Assessment of the suitability of the biographical questionnaire

As Figure 2 shows, in all 56% of the respondents consider the present questions suited to the purpose. Only 5% of the applicants categorically reject the procedure while on the other hand just as many fully agree with it. Approval of the procedure is thus not overwhelming but is deemed sufficient for the procedure to be considered usable. The biographical data were examined using the CHAID analysis procedure to establish whether certain combinations of data made a positive outcome of the application procedure predictable. Various models were examined in the process, both procedures whose contents were determined as well as procedures derived on purely empirical and statistical bases. Depending on the procedure, a reduction of 17% - 50% in the number of applicants proved possible, with 90% - 100% of all ultimately suitable applicants identified. Use of pre-screening with the lowest reduction in the number of applicants (17%) would mean, for example, on a total of 1207 tested applicants a saving of 234 pre-selection tests and 26 main selection tests, without a single suitable applicant being lost. Information on the DLR test system applied for ATCOs in general can be found in Eißfeldt (1991) or Lorenz (1999, this volume, sub-chapter 2.3).

Another interesting finding appeared when financial figures were inserted into the CHAID – procedure. On the background of evaluating for instance mailing activities for their financial outcome, CHAID allows to express certain events in

terms of financial volume, e.g. money spent for printing, postage and clerical work for advertising on the one hand and newly subscriptions to a magazine (responders) on the other. For ATC selection, cost values of DEM - 2.000,-- for an unsuccessful pre-selection procedure, DEM - 5.000,-- for an unsuccessful main test procedure and an overall saving of DEM + 100.000,-- for every applicant recommended for training were chosen for computation on the empirical basis of N=1207. CHAID analyses then resulted in a model optimised for financial outcome. Although basing on the same selection ratio of still about 7% the root node information (the information in the very basic cell before the sample is split into subgroups) indicated a value of DEM 4.874,90 earned with any applicant sitting the tests. In other words to invite candidates for testing means making money for the organisation, and not to spend resources. This should be considered in all sorts of cost-benefit analyses and might strengthen the position of selection specialists in defending their budgets.

Although, strictly speaking, the results apply only to the sample examined, we can assume that they can be generalised in view of the size of the sample. Given that there were over 2000 pre-selection tests in 1997, the particular financial potential of the pre-screening process developed is clear: including the expenditure for the tests, travel and administrative costs, six-figure savings would have been feasible. Accordingly, the introduction of the pre-screening was agreed upon. It was however specified that the process should be applied using only criteria that were unobjectionable in ethical terms and under no circumstances should entire subgroups be excluded from the selection procedure. In the meantime, the procedure was also described to the DFS general works council, which agreed to the use of pre-screening. Among all parties involved the strict protection of filter criteria against in-house and out-house communication was agreed upon as this was seen being crucial for a successful use of the procedure.

2.2.3 Results of Application of Pre-screening in the Test Year 1998

On the basis of the existing analyses, the biographical questionnaire was again revised and the final version was developed now comprising 106 specific questions.

The procedure was used for the first time in April 1998 once Optical Character Recognition (OCR) readable answer sheets had been prepared and testing of automatic evaluation was completed.

Since then all applicants were selected for participation in ability tests for work as an ATCO using the pre-screening procedure. The screening function agreed upon was based on the principle of excluding from the tests applicants who presented themselves in a markedly unfavourable light in their answers to the questions posed. This criterion was empirically determined following examination of the content in particular also as regards ethical aspects. According to experience with the test sample (N=1207) this criterion should be effective in the case of approximately 20% of all applications, without any ultimately suitable candidates being excluded from the procedure. We address below the question of whether applicants pre-selected through use of the

screening process in 1998 performed differently in the ability tests from candidates who had not been pre-screened. In 1998 a total of 2146 applicants were examined at the pre-selection stage. Of these, 1359 were tested without being sent in advance the biographical questionnaire, thus without application of the pre-screening. The other 787 applicants (36.7% of all participants in the pre-selection procedure), were selected to sit the ability tests for work as ATCOs after application of the pre-screening process.

195 (=24.8%) of the applicants selected on the basis of pre-screening and 323 (=23.7%) of the applicants, who were not pre-screened were successful in the two-day pre-selection procedure or were given a warning about their English. Of the applicants who by the filter had been pre-screened, 29.1% (30%) of the men and 19.8% (16.3%) of the women completed the pre-selection procedure successfully. For the purpose of comparison, the proportion of non-screened applicants is given in parentheses. In the following test stage (main test), 42 of the 101 pre-selected applicants took part in the interview. Out of 340 applicants who were not pre-screened, 155 were interviewed. The success rate for the main test was 31.7% in the pre-screened group of applicants and 31.1% in the group who were not pre-screened. In the main test, the success rate for the men with application of the screening was 37.5% (34%), while for the women, it was 21.6% (24.8%). The success rates for applicants selected without pre-screening are again given in parentheses. Overall, it becomes apparent that use of screening had at the most a somewhat minor impact on the success rates in the pre-selection and main tests in the test year 1998. Irrespective of whether pre-screening was used, applicants achieved similar results.

There may be various reasons for these findings, which are contrary to expectations. On the one hand, the impact of changes in the sample may be one cause such as possibly the increase in the proportion of women in the screened sample or indeed seasonal variations. These could for example explain why initially (on the basis of pre-selection procedures observed up to October), there was an improvement in the success rate at the pre-selection and main test stages, which is not reflected in the results for the entire year. In this instance, more applicants without chances elsewhere may have been tested towards the end of the year, whereas those with a greater achievement potential are more likely to complete their application procedures early in the year. It is also conceivable that increasing strictness in the examining board's decisions made itself felt, since increasingly long waiting periods for candidates recommended for training went hand in hand with application of screening. Such reasons may have obscured actual positive effects of screening, but statistically this cannot be clearly proven.

However, possible changes in the response behaviour of the applicants can be analysed more clearly. The effect of 'real' application of screening can be seen in various ways here. As compared with the test sample, it was clear to the applicants in the test year that their answers would be crucial to the further processing of their applications. Hence, we see an increasing tendency to give "neutral" replies to many of the questions, i.e. replies at either extreme are deliberately avoided. Likewise, self-portrayal appears more goal-oriented, i.e. in case of doubt, anything unfavourable is not correctly reported. A clear

example of this can be seen in the applicants' assessment of their performance in their last school year: altogether approximately 85% rank themselves among the better half of pupils and less than 10% among the weaker half, while the remainder state that they cannot remember. An analysis of the *Abitur (*school-leaving examination) grades available from the selection procedure shows such favourable self-assessments to be often unrealistic. Examination of the subgroup with particularly poor *Abitur* grades (*Numerus clausus*[5] of 3.5-4.0) reveals for example that almost half of these applicants (47.4%) describe themselves as among the best 10% or 25% or the better 50% of pupils, indicating a more than unrealistic self-assessment.

2.2.4 Influence of the Real Situation on Response Behaviour

A further effect of the use of screening can be seen in the processing of the personality questionnaire TSS during pre-selection: most of the scores differ significantly between the "screened" and the "unscreened" subgroups, although the average differences are barely more than 0.4 Standard Nine Score (Stanines). It is always the screened group which presents itself more positively, for example as less timid, less aggressive, more sporty, tidier, more sociable, etc. This could of course be an altogether welcome effect of the use of the screening. However, this trend goes hand in hand with a notable effect with regard to social desirability, i.e. pre-screened candidates taking part in the pre-selection test answer on average less openly than those who did not have to complete a biographical questionnaire at the outset (average difference of 0.6 stanines). This supports the assumption that applicants also present themselves in a favourable light in the biographical questionnaire itself.

Overall, it has to be noted that screening on the basis of "unfavourable answers", which appeared suitable after evaluation of the test sample, cannot satisfy requirements in real use.

Table 1: Summary statistics for application of screening in 1998

	Empirical Results 1998	
Yes	Filter Application	**No**
787	N	1359
	Stage 1 (group tests, paper/pencil)	
24,80%	Positive	23,80%
	Stage 2 (Apparatus tests, AC, Interview)	
31,70%	Positive	31,10%
	Interview	
76,20%	Recommended	68,40%
	Selection ratio	
7,86%	Pos. out of 100	7,16%

In order nevertheless to make a more accurate assessment of the efficiency of using pre-screening, the resulting selection rates are given here (Table 1). They exclude calendar year distortions (candidates from the previous

[5] Restriction on the number of admissions to courses on the basis of *Abitur* grades.

year/candidates waiting for the main test) and show 7.16% for the unscreened subgroup and 7.86% for the screened group.

If we set these values against an annual target figure of 120 course places, then without use of screening, 1676 applicants would have to be examined in order to fill the places on the course (Table 1). If screening were to be used, only 1527 tests would be necessary, amounting to a difference of approximately 3 pre-selection tests and consequently also 3 main tests. Table 2 indicates that on the assumption that the cost of an unsuccessful pre-selection procedure is DEM 2,000 and that of an unsuccessful main test procedure DEM 5,000, an overall saving of about DEM 400,000 could be made by using screening. Since, in 1998, a good third of the applicants were screened, savings representing one pre-selection procedure and one main selection procedure, with all their associated costs, can be assumed to be quite realistic.

Table 2: Assumed savings per annum by using screening

	Target: 120 intakes	
Yes	**Filter application**	**No**
	Selection Ratio	
7,86%		7,16%
1527	Phase 1	1676
34	Dates Phase 1	34
379	Phase 2	399
32	Dates Phase 2	34
	149 x 2.000,-- +20 x 5.000,-- assumed savings: DEM 398.000,--	

Another cost-cutting effect can be seen in connection with the flow diagram for the main selection procedure regarding the number of interviews and hence the duration of this procedure. Here there was a significant reduction in interviews with a negative outcome. Without use of screening, 31.6% of all interviews had a negative outcome (33.8% in the previous year), while where screening was used, the percentage of unsuccessful interviews fell to 23.8%. Since the number of interviews per main selection procedure fell overall to an average of 5.2, members of the DFS examining board were thus often able to leave at the end of the first day of interviews and therefore got back to their units earlier. The associated savings are difficult for outsiders to calculate, but must be considerable. Thus, even with only slightly improved success rates, genuine savings can be demonstrated, savings which have certainly covered the cost of developing the biographical questionnaire and probably also at least offset the operating costs of the screening process (staff and materials).

Nevertheless, the use of this screening procedure has by no means satisfied all the requirements. It will be a question of learning from experience to date, and readjusting the pre-screening in order to achieve the desired increase in efficiency. In real application of the procedure, to base screening solely on unfavourable self-assessment seems not to be possible. Greater thought

should be given to empirically derived screening functions, which must of course also continue to satisfy ethical criteria. Recent findings on the validity of biographical data for selection (Borman, Hanson and Hedge (1997), Schmidt and Hunter (1998)) do underline the potential value of this approach in selecting ATC applicants.

2.2.5 References

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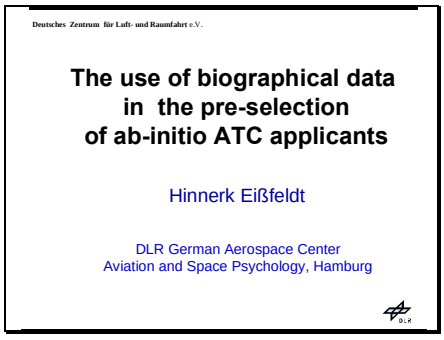
2.2.6 Some of the Slides Used During the Presentation



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Overview

Pre-selection methods
Biographical data
Outline of research
CHAID analysis
Recommendations
Results of application

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Methods of pre-selection

- using application forms - papersift
- adjustment of entry qualifications
- special questionnaire

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Biographical Questionnaire

Requirements

- Self-description of applicants as basis material
- analysis of large sample to identify subgroups with different pass rates
- adjusting the stream of applications by means of empirical results
- validation of the approach

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Biographical Questionnaire

Pro's and Con's

+ relatively high validity reported for biographical data (r = .35)*
+ saving resources in daily operation
+ savings in later selection stages
- costly to develop,
- needs control
- not used with ab-initios so far

** Rothstein et al., 1990*

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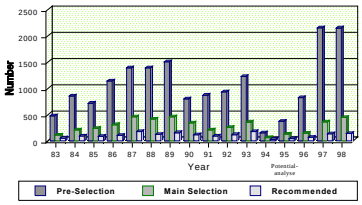
Selection of ATCOs for DFS



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Present situation

- Low selection ratio - tendency to decrease
- Large investment of resources in selection & training
- High costs involved
- Occasionally doubts in the meaning of university entrance level (Abitur)

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Approaches to improve

- Review of research on biographical data, studies on reliability & validity of self-descriptions etc.
- Simulation of filter-settings using data from 1992 -1993
- Empirical Study on the use of biographical data started in 1996

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Questionnaire development

- Sampling relevant questions (> 200) from literature
- Reduction of the item material down to 144 questions
  - geared towards background of applicants
  - avoiding redundancy in questions
  - trying different item formats

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Biographical Questionnaire

Breakdown of Item pool

Experience at work	(8)
Education and training	(26)
Family	(29)
Job-motivation	(14)
Interest and activities	(26)
Experience in school & job relations	(33)
Meta-Questions	(6)

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Results : Data base

- Return: 1223 filled-in questionnaires

  11 without (readable) names
  5 not correctable data entry mistakes
- Sample size for analysis : N = 1207

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Results: Sample Description

- **Gender**:
  57,2 % male, 42,8 % female
- **School Certificate**:
  71,3 % general (grade average 2,7)
  16,3 % technical
  0,9 % international
  10,6 % no certificate yet

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Results: Sample Description cont'd

- **Age:**

< 19	10,4 %
19 - 20	41,7 %
21 - 22	27,8 %
23 - 24	15,1 %
> 25	5,1 %

Mean: 20,7 Std. Dev.: 1,9

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Results: Missing values

39 x omissions (blocks or pages)
21 x sporadic answers (jumpers)
14 x give ups
9 x print (missing pages)
25 x multiple answers

1124 complete data sets = 93,1%

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Data Analysis Method: CHAID

Chi-square-based
Automatic
Interaction
Detection

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Method: CHAID analysis

- Identifies in the pool of predictors those leading to an extreme distribution of the criterion variable
- organizes identified predictors in a hierarchical sequential model (tree)

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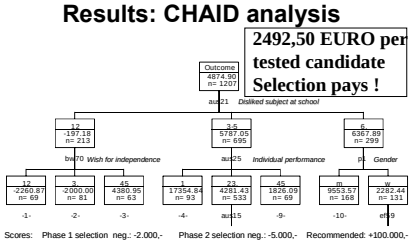
Cost benefit considerations

CHAID allows calculations of return on investment for the different nodes

Chosen financial values:
Phase 1 negative: - 2.000,00 DM
Phase 2 negative: - 5.000,00 DM
Finally recommended: + 100.000,00 DM

Results: CHAID analysis

2492,50 EURO per tested candidate Selection pays !



Scores: Phase 1 selection neg.: -2.000,- Phase 2 selection neg.: -5.000,- Recommended: +100.000,-

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Results: Possible Applications

- A reduction of the applicant pool varying between 17% to 50% is possible
- with identification of 90% - 100% of all recommended applicants
- Reservation:
  This result is only valid for the sample under study (N > 1200)

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First conclusions

- Content-driven filter (disadvantageous answers), reduction ~ 20% ,'soft' action
- Only ethical agreeable criteria
- Protection of criteria from communication (in-house and out-house)
- Regular control of results, unfiltered sub-sample every year

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Implementation

- Revision of biographical questionnaire, (106 questions)
- Development of a machine-readable answer-sheet
- Application by DFS, scientific control by DLR
- Start distributing questionnaires 04/1998

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Application: first results
as of 28.10.1998

About 1100 applicants
have been filtered in 1998

~ 22% of applicants have not been invited for testing due to filter process

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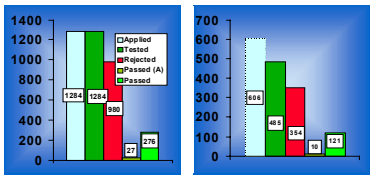
Pre-Selection 1998
N = 1769, as of 28.10.98

unfiltered N = 1284 **filtered N = 485**



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Application 1998 total results

787	N	1359
	Stage 1	
	(group tests, paper/pencil)	
24,80%	positive	23,80%
	Stage 2	
	Apparatus Tests, AC, Interview	
31,70%	positive	31,10%
	Interview	
76,20%	recommended	68,40%
	Selection Ratio	
7,86%	pos. out of 100	7,16%

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Hypothetical savings from filter application per year

	Target: 120 intakes		
Yes	Filter application	No	
	Selection Ratio		
7,86%		7,16%	
1527	Phase 1	1676	151 x 2.000,-
31	Dates Phase 1	34	
379	Phase 2	399	20 x 5.000,-
32	Dates Phase 2	34	402.000,- DM

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Application 1998 total results

Only minor effects of filter application on selection output

Possible explanations (I):

- shifts in population structure, e.g. more female applicants compared to experimental sample

- seasonal effects on sample quality

- changes in selection procedures, e.g. more strict decisions

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Application 1998 total results

Only minor effects of filter application on selection output
Possible explanations (II):

- effect of 'real application' leading to more careful answers
  compared to experimental sample (missing values, avoiding extreme answers)

- tendency of applicants to present themselves in more social desirable way, as proven by personality scores

both indicating clear limitations for the approach to use 'disadvantageous answers' in real application

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Summary

- **To invite applicants for testing can rather be seen as to make money for the organisation - not to spend it**
- **To use a filter based on biographical data saves resources and allows to allocate limited resources more goal-oriented - even if the improvement of selection rates seems small**
- **One has to be aware that answering styles of applicants are influenced by 'real' application of biographical data**
- **To use biographical data for pre-selection requires a continual recruitment process providing a steady surplus of applications and continuous scientific control**

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Conclusions (I)

1) To concentrate selection resources on applicants more likely to pass is beneficial

→ In case of a surplus of applicants: Use filters - any you can think of - and start early

2) Valid criteria for identifying the 'good stuff' by means of self description are:

Subjects and performance at school leisure time activities aspects of social adaptation

→ **Not**: Aspects obviously linked to ATCOs job

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Conclusions (II)

3) To establish a filter needs large samples, stable populations, a lot of scientific effort and quite some time

→ Recommendable only for large organisations

4) To apply a filter established for a different population or a different cultural background will lead to unintended effects

→ Avoid taking over foreign solutions

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Conclusions (III)

5) It should be possible to develop a set of criteria valid for most of the member states serving as checklist for the national paper sift- process

6) Any filter based on biographical data will only work as long as the criteria are protected from communication

2.3 Empirical Validation of the DLR Selection of International *ab initio* ATCOs, by Dr. Bernd Lorenz, German Aerospace Center, (DLR), Department of Aviation and Space Psychology, Hamburg, Germany.

2.3.1 Introduction

Since 1992 the DLR, Department of Aviation and Space Psychology, has been commissioned by EUROCONTROL for the selection of their *ab initio* ATCO trainees. The major aim was to improve training outcome facing an average failure rate of 42% encountered during training in the years before 1992 (Fassbender and Lorenz, 1995). The DLR selection system applied represents a compilation of the system that had already been used to recruit trainees for the DFS (formerly BFS). Eißfeldt and Maschke (1991, see also Eißfeldt, 1991) report an attrition rate (failures plus resignations) of 18% based on 201 *ab initio* students recruited over the period from 1982 through 1985. Another approximately 7% failed during the following period of sector validation (personal communication), so that a 25% overall attrition rate is the realistic figure at DFS. Within Europe attrition rates in the range of 20% to 70% are common at large air navigation authorities (EATCHIP, 1996). In this regard ATCO selection is quite different from pilot selection where attrition rates below 10% are common by applying quite similar selection tools (Stahlberg and Hörmann, 1993).

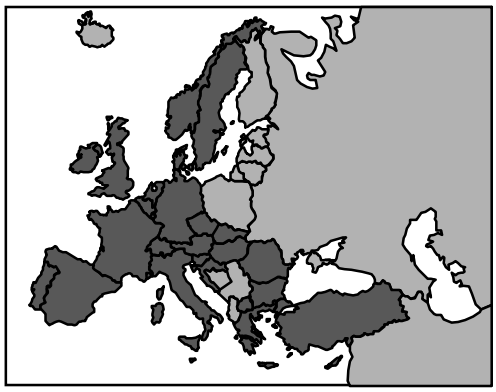
In the past EUROCONTROL generally needed 24 *ab initio* ATCO trainees who were trained in two courses per year. Basic training takes place at the IANS in Luxembourg. Advanced and OJT is provided at the Maastricht Upper Area Control Centre (MAS UAC), which is the ATC unit where the students have to work after licensing. The ATC service supplied at this unit is solely upper area control of the north-west European air space.

The pool of applicants originates from all EUROCONTROL member states. Since in the past a number of new nations has joined EUROCONTROL, the source of applicants has expanded significantly. Figure 1 shows the current status of membership in the Agency and the number of applicants tested at DLR in the period since 1992 until now which comprise 1411 applicants.

By looking at the adhesion dates of the now accumulated number of 28 member states, it becomes evident that since the beginning of the EUROCONTROL-DLR co-operation the national diversity has doubled. Particularly from nations like Spain, Italy, and Bulgaria, who have joined the Agency quite recently, there has now been quite a large proportion of applicants.

Therefore, increasingly, the selection methods must consider the international, multicultural aspect. This requires the proof that the selection does not contain impacts on the national heritage of the applicants and that all applicants have equal opportunities to be successful in the selection. These are obvious differences to the national DFS selection of ATCO trainees and causes a

much greater heterogeneity in the composition of the applicant population. Referring back to various international selection activities (Manzey, Hörmann, Osnabrügge and Goeters, 1990; Goeters and Fassbender, 1991; Stahlberg and Hörmann, 1993), DLR could implement selection methods administered completely through a simple and international standard of the English language ensuring that an impact of English language skills on the understanding of test instructions was negligible. The tests themselves were proven to be culture-fair to the highest possible degree in the European context, in the sense that only minor test score differences between European nations were found (Fassbender, 1991). The psychological selection for EUROCONTROL takes place at the DLR test centre in Hamburg.



Nation	Adhesion Date	N 1992-1998	Nation	Adhesion Date	N 1992-1998
Germany	13.12.60	196	Austria	01.05.93	7
Belgium	13.12.60	173	Norway	01.03.94	27
France	13.12.60	82	Denmark	01.08.94	14
Luxembourg	13.12.60	5	Slovenia	01.10.95	19
Netherlands	13.12.60	111	Sweden	01.12.95	15
UK	13.12.60	232	Czech Rep.	01.01.96	6
Ireland	01.01.65	71	Italy	01.04.96	103
Portugal	01.01.86	43	Romania	01.09.96	18
Greece	01.09.89	42	Spain	01.01.97	104
Turkey	01.03.89	29	Slovak Rep.	01.01.97	5
Malta	01.07.89	21	Croatia	01.03.97	10
Cyprus	01.01.91	2	Bulgaria	01.06.97	43
Hungary	01.07.92	28	Monaco	01.12.97	0
Switzerland	01.07.92	5	F. Yugoslav Rep. Of Macedonia	01.11.98	0

Figure 1 : EUROCONTROL membership, adhesion dates and number of applicants tested at DLR testing centre in the period of 1992 through 1998

2.3.2 The *Ab Initio* ATCO Selection Procedure

Ab initio ATCO selection is performed in a sequential procedure (see Figure 2). In a first classroom-like selection phase, paper-and-pencil tests are administered in groups of up to 50 applicants. The second selection phase

involves individually presented computer-based apparatus tests. The third and final phase is an interview performed by a five-member selection board represented by two DLR-psychologists, two ATCO training officers from MAS UAC and/or IANS and a representative from Brussels headquarters chairing the board. Between all phases decisions on passing to the next phase are made. During the first two years of the DLR service supply for EUROCONTROL phase-1 and phase-2 were separated in time involving gaps between 1 to 4 months. To reduce travel costs, both phases were later organised into a one-week procedure.

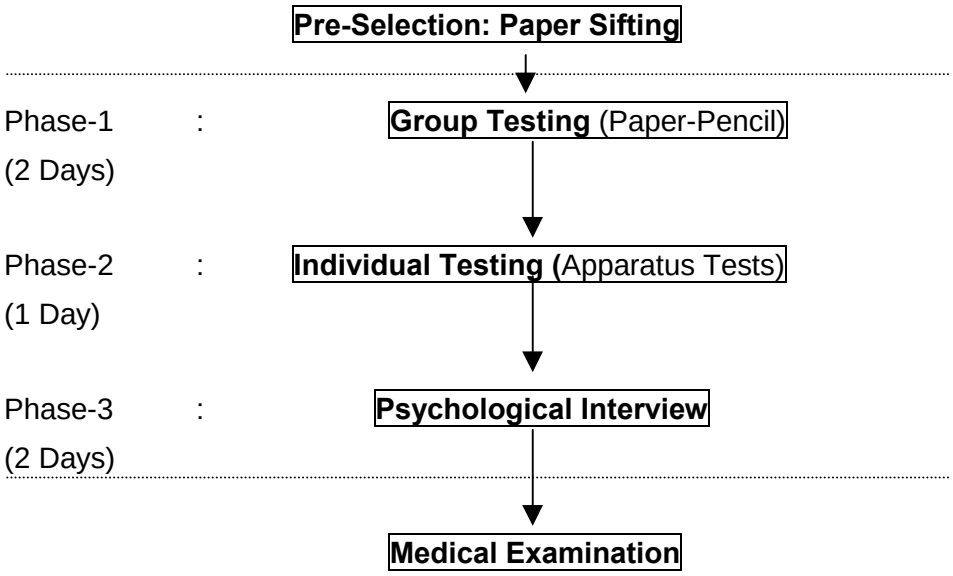


Figure 2: Stages of the *ab initio* selection programme

Phase-1 and phase-2 tests cover the full range of abilities, skills, and personality traits as being recognised as essential prerequisites for the development of efficient ATCO skills (EATCHIP, 1996). Nearly all tests were developed by DLR and hence especially tailored for use in the selection of aviation personnel. The relevance of the selection measures for all three ATCO working positions, i.e. tower, approach and en route centre, could recently be confirmed by a comprehensive ability requirement analysis following the Fleishman approach (Eißfeldt, 1998; Heintz, 1998). Apart from objective performance scores, behavioural observations on carefully designed coding categories (Sus, 1993) and ratings given on standardised rating scales by the test instructors of the apparatus tests are collected. The composition of the whole battery follows the principle of redundancy, i.e. each ability domain (memory, mental arithmetic, etc.) is covered by at least two tests in order to enhance the reliability of the assessments of that particular domain. A further principle is bimodality, i.e. that within each domain, tests using visually and tests using acoustically presented stimuli, are administered. A computer-assisted test management tool enhanced the level of standardisation in the administration of the paper-and-pencil tests. Standard sound-file based instructions and timed item presentations (e.g. slides or auditory items) can be initiated by the test instructor and are controlled by the test management computer.

Table 1 contains the list of tests used in phase-1 selection and a short description of the task demand (see Lorenz et al., 1999 for a more detailed description of the tests).

Table 1: Aptitudes knowledge tested in phase-1 selection

Test	Ability/Content	Task
ENS	Written English	Multiple-choice questions on English vocabulary and grammar
ENA	English Listening Comprehension	Comprehension of spoken English via headphone (numbers, vocabulary, meaning of complex matters presented in short-stories)
BOU	Perceptual Speed	Marking quickly and accurately target letters in random series of letters
KBT	Mental Concentration/ Working Memory	A complex multi-step attention task, involving the search for symbols, symbol-number substitution, arithmetic, and continuous memory
KRN	Mental Arithmetic	Calculation problems presented via headphone
WSB	Mental Arithmetic/ Concentration	Simple calculations on spots of a dice according to a set of specified rules to be kept in mind
FPT	Spatial Orientation	Matching the headings of probe and target aircraft following a series of rotations to be performed mentally on the probe aircraft
ARA	Spatial Orientation	Drawing a figure in a grid according to fast left-, right-, and straight-instructions via headphone
ACT	Planning / Decision Making / Visual Scanning	Guidance of several aircraft through a control zone according to a set of rules
VFF	Flexibility of Closure	Detecting figures hidden in a noise visual pattern
MEK	Visual Associative Memory	Learning and recalling picture-number associations
CLE	Auditory short-term memory	Memorizing and recognition of code messages presented via headphone
TVT	Mechanical Comprehension	Multiple-choice test on comprehension of mechanical, technical and physical principles
VIG	Vigilance	Detection of rare target events during simultaneous monitoring of visual and auditory stimuli

During phase-1 selection, the applicants further complete a personality questionnaire addressing 10 personality traits: Achievement Motivation, Emotional Instability, Rigidity, Extraversion-Introversion, Aggressiveness, Vitality, Dominance, Empathy, Spoiltness and Mobility. A further scale ‘Openness’ provides some indication as to the applicant‘s tendency to present himself/herself in a socially desirable way. Phase-2 selection involves the assessment of the applicants‘ choice reaction time, its stability over a period of approximately eight minutes and the response accuracy.

The major part of the phase-2 selection, however, is taken by a complex simulation-like work-sample test, the Dynamic Air Traffic Control test (DAC), which assesses the applicants‘ efficiency in timesharing and to cope with a complex dynamic task demand. The test involves the guidance of aircraft through a defined airspace, keeping track on proper headings and altitudes to avoid conflicts and to hit the departure gates of the airspace. At the same time an acoustically presented task has to be solved continuously on the applicant‘s own request. The overall procedure includes a structured instructor briefing between two identical test runs to judge the learning potential of the candidate (see Eißfeldt, 1995, for a more detailed test description).

2.3.3 Empirical Validation

By the end of 1998 a total of 1411 applicants had been tested since the start of the DLR-EUROCONTROL co-operation. Table 2 contains the outcome of

the selection dependent on the different stages. A total of 958 applicants (67.9%) were rejected after phase-1. 202 (14.3%) applicants were rejected in phase-2. Relative to the total number of applicants entering phase-2 (n = 453) this gives a proportion of 44.6% (see % row-wise). Finally, after the interview 88 (6.2%) applicants were rejected, which is a proportion of 35.1% relative to the total number of 251 applicants that were interviewed. 163 applicants were recommended giving a selection ratio of 11.6%. This figure remained fairly stable across years although there was some variation between individual selection weeks. This stability reflects to some degree the level of standardisation in the decision process based on a solid normative database.

Table 2: Outcome of Selection Dependent on Selection Phase

Selection Phase	Total N Entering	N Rejected	% column-wise (rel. to total N entering)	% row-wise
PHASE - 1	1411	958	67.9	67.9
PHASE - 2	453	202	14.3	44.6
PHASE - 3	251	88	6.2	35.1
Recommended:	163	**Selection Ratio:** 11.6		

2.3.4 The EUROCONTROL *Ab Initio* Training Programme

The EUROCONTROL *ab initio* training programme is divided into three major phases. The programme takes place at the IANS (phase-1 and phase-2) and at the MAS UAC (phase-3 and OJT). At IANS, theoretical subjects (meteorology, navigation, Air Traffic Services (ATS), telecommunications, aerodynamics and aircraft performance) are taught as well as practical course units on area procedural and area radar control. This involves classroom lectures and simulator-based exercises. At MAS UAC sector specific planning control and radar is trained followed by OJT. At all stages of training the progress of students is assessed. At the earlier course phases completed at IANS, the appraisal of training progress takes the form of written, oral and practical examinations, as well as instructor assessments at the end of course units. At MAS UAC instructor ratings and check-outs are performed.

2.3.5 Predicting Pass/Fail

Up to now 10 *ab initio* training courses of EUROCONTROL containing 11 to 13 students each (intake-course 16, through to intake-course 25) have been supplied by applicants selected by the DLR selection system. Six courses have meanwhile reached the full licence stage. Table 3 depicts the number of students recruited, failed, resigned, and licensed since intake-course 16. The resulting failure rate of 42.2% up to course 21 indicates no improvement in training outcome. Taking the resignations into account an overall success rate of 53.5% was obtained. This figure challenges the expectation that the comprehensive DLR-selection system could fix the problem of a poor training success with the existing selection system. Further in-depth analyses of the training data were performed to reveal where and how to improve the selection service.

Table 3: Training results of *ab initio* students at EUROCONTROL from 1992-1998 (N=117)

	Intake Course											
	16	17	18	19	20	21	**Sub-Tot.**	22	23	24	25	**Tot.**
Start	8/92	2/93	8/93	4/94	10/94	6/95		2/96	10/96	5/97	2/98	
	Training completed							**Training not completed**				
Recruited	11	13	12	11	12	12	**71**	12	10	12	12	**117**
Failed	4	6	2	5	7	6	**30**	3	3	3	0	**39**
Licensed	7	7	9	5	5	5	**38**	0	0	0	0	**38**
Resigned	0	0	1	1	0	1	**3**	0	0	0	0	**3**
Pending							**0**	9	7	9	12	**37**
Failure Rate (%)	36.4	46.2	16.7	45.5	58.3	50.0	**42.2**	(resignations not included)				

For the purpose of computing multiple regression analysis, three composite scores of phase-1 selection were computed: (1) Spatial Comprehension, (2) Quantitative Reasoning/Working Memory, and (3) Perceptual Speed). Next, the three scores of the Choice Reaction Time (mean response time, response variability and accuracy) and four composite scores of the DAC (lateral control first run, lateral control second run, overall vertical control and overall performance in the secondary auditory task) were used as predictors. The derivation of the composite scores were based on a principal component analysis of the DAC-scores (see Lorenz et al., 1999, for details). An analysis on the whole group of 68 cases using the pass/fail criterion failed to identify any significant predictor among the composite scores of the selection. In a second approach, the group of failed students were split into a subgroup of students who failed during the early institutional training phases in Luxembourg (N = 17) or later during practical field training at MAS UAC (N = 13). Whereas again no prediction of pass/fail during institutional training could be achieved, pass/fail during field training could be predicted by a model combining the DAC-Acoustic score and the response variability of Choice Reaction Time (CRT). The multiple correlation (corrected for restriction in range) was .49.

2.3.6 Predicting Training Proficiency

For an analysis on the predictive validity of the DLR-selection system against proficiency assessments (exams, instructor assessments), the data from intakes that have terminated training were taken and resignations were not included. The validation study, therefore, consists of 68 cases (30 failed, 38 passed students from intake 16 to intake 21). Exams and instructor assessments performed at IANS and MAS UAC yielded a set of 22 variables (for failed students this may be less depending on when training had to be terminated).

An inspection of the intercorrelations among these variables and a principal component analysis guided the derivation of composite scores to reduce the number of criterion variables. A first criterion composite, subsequently referred to as ‘Field Training’, is a sum of the instructor assessment after phase 2D (planning control) and all instructor assessments obtained in phase 3, thus the four proficiency variables which were obtained latest into training before OJT

at MAS. A second composite was built by summing all instructor assessments and scores of practical exams obtained during phase-1 and phase-2 training at IANS. This composite was labeled 'Institutional Training'. Further, a third and fourth composite was obtained by averaging all scores of written and oral exams, respectively. The internal consistency of the four composites were then evaluated by computing the Cronbach's alpha index which can be regarded as a reliability estimate of the score. This index and the intercorrelations of the criterion composite scores are given in Table 4:

Table 4: Reliability (Cronbach's alpha) and intercorrelations[a] of the criterion composite scores

	α	1	2	3	4
1) Field Training (N = 47):	.86	-			
(2) Institutional Training (N = 67):	.77	.36*	-		
(3) Written Exams (N = 68):	.69	.23	.19	-	
(4) Oral Exams (N = 68):	.61	.09	.48**	.36**	-

[a]Significance of intercorrelations: *p < .05; **p < .01

A series of multiple regression analyses were performed separately for two different sets of predictor variables, first, performance data, and second, personality data and interview ratings on motivation and stress resistance (see Lorenz et al., 1999 for more details). This was done for each of the four criterion composite, separately. All regression models were inspected for the existence of differential prediction with regard to native mother tongue (English versus non-English) and gender. Overall the performance set of predictors were found better related to training proficiency than the personality set of predictors. For this latter set only the stress resistance rated by members of the selection board correlated significantly with the 'Institutional Training' composite, meaning that candidates rated lower on their stress resistance performed poorer on this criterion. Figure 3 summarises the results obtained by multiple regression analyses. It presents on the top level the four composite domains of the training criterion, on the second level the pass/fail criterion separated for the failing stage, IANS or UAC, and on the bottom level the predictor models of the selection composites. Significant relationships are indicated by connecting lines or arrows. If the measures obtained were separated in time dotted lines or arrows were printed indicating **predictive** validity , if not, the lines were solid indicating **concurrent** validity.

By this, the intercorrelation between the criterion composites can also be judged on their criterion related concurrent as well as predictive validity. This is an important issue since from a cost-benefit point of view an early detection of students who fail later into training is desirable. Only statistically significant relationships are indicated by connecting lines and the value of the respective correlation. All predictive correlations (dotted lines) were corrected for restriction in range. The best prediction was achieved for the 'Field Training' criterion by model 5 in Figure 3 which was established by four statistically

significant predictor variables: DAC-Acoustic, the Paper-Pencil Speed composite, the Paper-Pencil Spatial Comprehension composite and response variability in the Choice Reaction Time. This model achieved a multiple R = .64. The predicted scores of model 4 (prediction of pass/fail at MAS UAC) and model 5 turned out to be redundant (r = .99 derived from the unselected sample of N = 412) since these scores rely on almost the same selection variables. In other words, model 4 and model 5 both predict the common variance of pass/fail at MAS UAC and the 'Simulator-Supported-Field-Training' - criterion composite.

The prediction of the 'Institutional Training' composite was achieved by a linear combination of three selection scores: the DAC instructor performance assessment, the DAC instructor rating on the applicant's motivation, and mean response time in the CRT test. However, the latter two variables have a somewhat surprising meaning: Fast CRT performer and applicants with high ratings on motivation achieved lower criterion scores. Moreover, no correlation exist between predicted scores of model 5 and model 3 suggesting that these two criterion scores reflect different characteristics of the student. This notion gets some confirmation by the fact that there was only a comparatively low correlation between both criterion scores of .36. Comparing the selection predictors, it seems that assessments derived from institutional training in IANS were closer related to **subjective** assessments (DAC instructor, and, as noted above, interview board) of the selection, whereas field training at MAS UAC was closer related to **objective** performance data.

Surprisingly the outcome of written exams could not be predicted. For oral exams no common regression was found for English native speakers and non-English native speakers. It turned out that the prediction of oral exams was further complicated by the fact that both groups differ at the criterion level. In oral exams, English native speakers scored 77.41 on average, whereas the non-English native speakers scored 79.93 on average ($F(1,66) = 4.69$; $p < .05$). Thus, surprisingly, non-English native speakers scored better despite of their language disadvantage. This seems difficult to explain. One reason could be that English native speakers were treated harder in oral exams. Although this would indicate a 'bias' at the criterion rather than on the predictor level, two separate regression models were fitted for both subgroups of mother tongue. For the group of non-English native-speakers only CRT-MRT was predictive with the above described meaning, i.e. slow response time predicts better criterion performance. In the model of the English native speakers the paper-pencil speed composite and the paper-pencil Spatial Comprehension composite entered the equation having an overall corrected multiple correlation of .56. However, since the reason of the differences in the oral exams between both groups were unclear this finding should not be regarded as evidence for the existence of differential prediction.

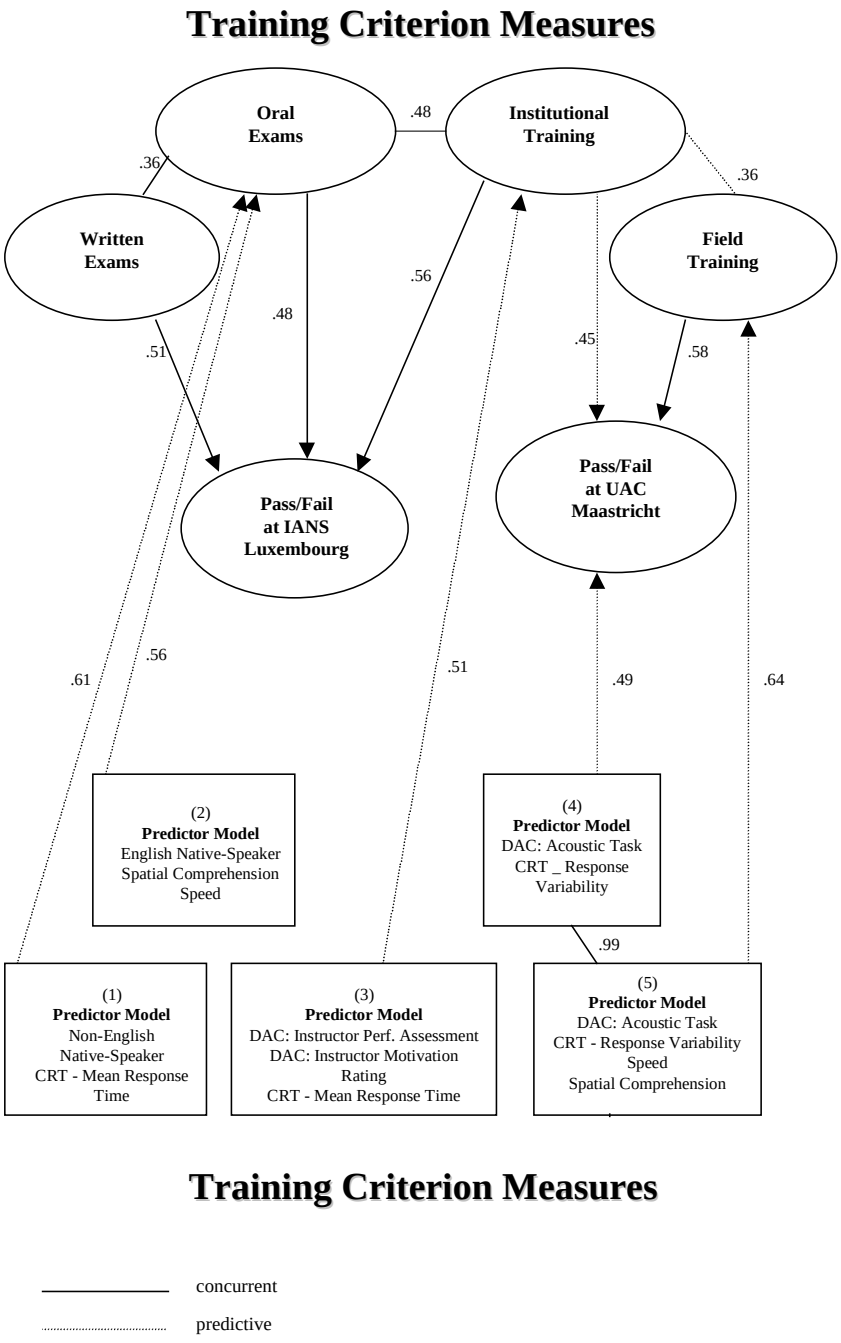


Figure 3: Interrelationships between predictor models of selection measures and training criteria as well as within training criteria. Only significant relationships are indicated by connecting lines.

What further can be derived from Figure 3 is that e.g. 'Field Training' could not be predicted by both the oral and the written exam composites collected at IANS. This applies also for the Pass/Fail-criterion at the MAS UAC site. In both cases the selection predictor models performed equally good, e.g. pass/fail at the site, or even better as in case of the 'Field Training' composite score. What seems most alarming is the fact that at the stage where most of the students failed, i.e. during Institutional Training, no prediction at all could be achieved. And it is this problem which needs to be addressed in future efforts to improve the training outcome.

2.3.7 Conclusions

Validation of the selection procedures against ATCO training effectiveness and on-the-job performance is an essential part of an optimal human resource plan aiming at higher effectiveness and efficiency in the closely connected recruitment–selection-training processes. On both sides of the equation, the predictor and the criterion, initiatives need to be taken to achieve this aim. Although the selection test battery appears comprehensive enough by covering the full range of abilities that are currently considered as relevant for ATCO effectiveness, some changes in the selection decision rules should be made. First, at phase-1 this regards a higher weight to be put on the spatial comprehension domain. Second, regarding phase-2 the importance of the CRT has to be reconsidered. The main criterion up to now has been the mean response time favouring the fast performer. It turned out that the stable but slow performer was more effective in practical ATCO training . This aspect has to be evaluated with more emphasis in the future. Third, the study underlines the importance of job-related work sample tests. In the present selection battery this is given by the DAC test. The component with the best predictive quality was DAC-Acoustic, i.e. the number of correct answers to self-paced acoustically presented problems. Further evidence from the ongoing validity study for the DFS should be awaited. If this finding can be cross-validated some efforts should be made to refine the scoring rational as well as the decision criteria of the DAC. The finding that the test battery did best in the prediction of the latest criterion data of training seems promising since there is good reason to argue that this criterion is most closely linked to the ultimate criterion to be predicted which is effectiveness at the ATCO job. Moreover, this evidence is of particular importance since other constraints inherent in any scientific efforts to demonstrate predictive validity render it more difficult for later stages in comparison to earlier stages of criterion assessment. The constraints are: (1) further limits due to restriction in range in both predictor and criterion performance, (2) loss of statistical power as a result of further sample shrinking, and (3) the larger gap in time making intervening effects on criterion performance more likely.

On the criterion side detailed job performance criteria with proven reliability are necessary to enable appropriate prediction. In particular at the second phase at IANS efforts to increase the reliability of performance assessments should be considered. The lack of failure prediction raises the question as to what criteria cause a student to fail at this stage. Further, the large differences in attrition rates between intakes are an important issue to be addressed in the future. It may be that the composition of courses has an impact and could

explain these differences. Especially in multicultural working environments teams may differ markedly with regard to the development of team cohesion or teamwork . In this regard it is interesting to note that the intakes 16 - 18 had an average mixture of 4.5 nationalities in comparison to an average of 6 different nationalities in the intakes 19 - 21. The most successful intake #18 had a mixture of only 3 nationalities (5 plus 2 re-coursed students from UK, 6 from Belgium, and 1 from The Netherlands). These observations are currently more of an anecdotal rather than of a statistical nature. However, they point to an issue that deserves attention in the future with regard to the increasing multicultural character of the working environment at the MAS UAC and could become an issue also in other areas.

A look at the literature reveals that the selection of controllers is a difficult task. The STF of EATCHIP has published a survey on the situation of ATCO candidate selection in ECAC states (EATCHIP, 1996). An average failure rate of 24% with a range between 2% and 70% was calculated based on the reports obtained by the different authorities. The authors cautioned that this data has to be considered with extreme care because of different evaluation criteria applied in training, different training schemes (e.g. length of training), different procedures concerning the number of re-sits allowed after examination failures and expectations concerning the level of proficiency to be achieved in training etc. (p. 71). In a very recently published survey (EATCHIP, 1998a) an average pass rate of 70% among 27 ECAC states was reported covering a training period that has not been addressed in the 1996 survey. Large differences between states were also prominent in this survey. In recent years, changes in the training philosophy have been discussed following more the idea of ‘training for success’ rather than of training for screen (Wickens, Mavor and McGee, 1997). Consequences on the reduction of training attrition remains to be verified. Also our data provide some indication that the outcome of practical exams at the institutional training stages was affected by ‘exam stress’. Efforts to reduce this source of failure should be considered at IANS. This could be achieved by introduction of continuous assessment stressing the feedback rather than the check-out character of assessment to help students to overcome the stress of a “last chance“ exam situation.

Since ATC tasks are continuously changing with the advance of technology, there is a regular need to accommodate selection and training criteria accordingly (Wickens, Mavor and McGee, 1997; CAST, 1998; EATCHIP, 1996, EATCHIP 1998b). Therefore there is a continuous demand on the development of training and selection procedures which also stresses the importance of a close co-operation between both fields of expertise.

2.3.8 References

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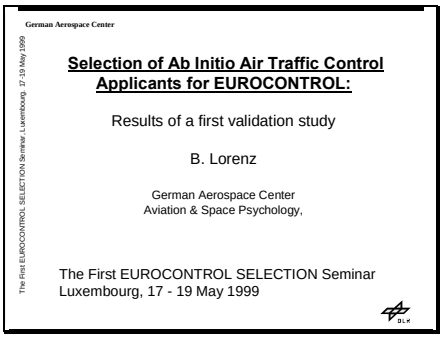
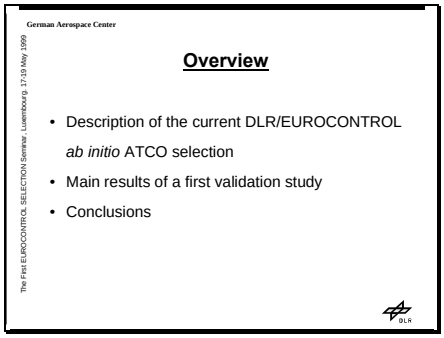
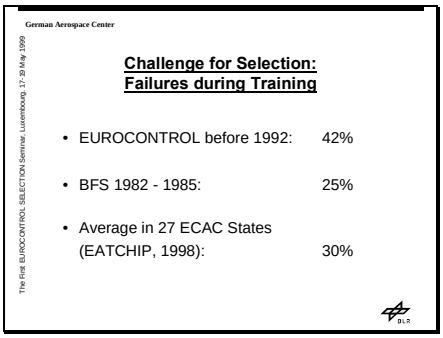
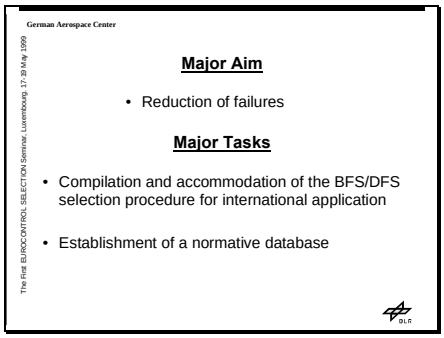
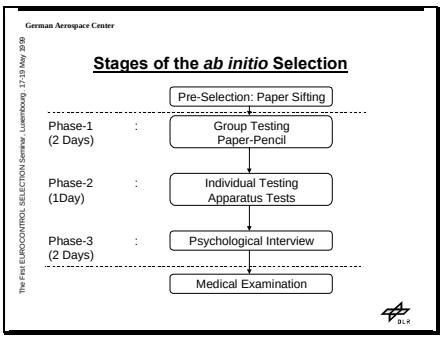
2.3.9 Some of the Slides Used During the Presentation

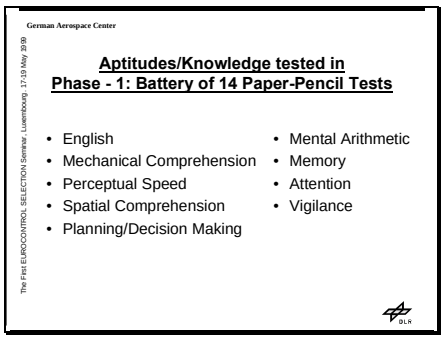












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The First EUROCONTROL SELECTION Seminar, Luxembourg, 17-19 May 1999

Personality Questionnaire

- Achievement Motivation
- Emotional Instability
- Rigidity
- Aggressiveness
- Vitality
- Dominance
- Extraversion
- Empathy
- Spoiltness
- Mobility

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The First EUROCONTROL SELECTION Seminar, Luxembourg, 17-19 May 1999

Aptitudes tested in Phase - 2: Two Computerized Tests

- Psychomotor Speed and Accuracy
- Dynamic Decision Making/ Multiple Task Performance

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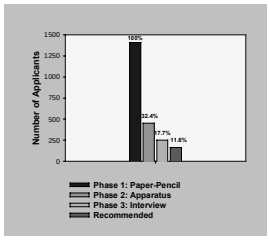
The First EUROCONTROL SELECTION Seminar, Luxembourg, 17-19 May 1999

Selection Ratios



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Aims of the Validation Study

- Prediction of pass/fail during training
- Prediction of student proficiency data obtained during *Institutional* training at IANS and *Field* training at UAC

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Data Evaluation

- Study sample: 68 students from intakes 16 - 21
- Construction of composite scores to reduce the number of variables
- Multiple regression analyses
- Checking for ‚differential prediction' as a function of
  - mother tongue (English vs. non-English native speakers)
  - gender

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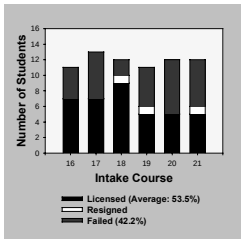
Training Success



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Derivation of Selection Composite Scores Generated by Factor Analysis

- **Phase-1 Performance**
  - Spatial Comprehension
  - Arithmetic Reasoning/Memory
  - Perceptual Speed

  Predictor Set 1
- **Phase-2 Performance**
  - 4 DAC-composites
  - 3 CRT-variables
  - Behavioural ratings of test instructors
- **Personality**
  - 4 TSS composites
  - 2 interview rating scores

  Predictor Set 2

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The First EUROCONTROL SELECTION Seminar, Luxembourg, 17-19 May 1999

Derivation of Training Composite Scores Guided by Factor Analysis of 22 Training Scores

- *Field* training: Phase-3 Assessments
- *Institutional* training: Phase-1 and 2 Practical Exams and Assessments
- Written exams: Phase-1 and 2
- Oral exams: Phase-1 and 2

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Reliability (Cronbach's α) of the Training Composite Scores

	# of Scores	α
• **Field Training (N=47)**	4	.86
• **Institutional Training (N=67)**	6	.77
• **Written Exams (N=68)**	4	.69
• **Oral Exams (N=68)**	4	.61
• **neglected** (written exams)	4	
Total # of Scores	22	

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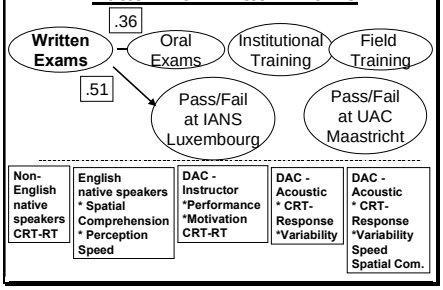
Pattern for Written Exams



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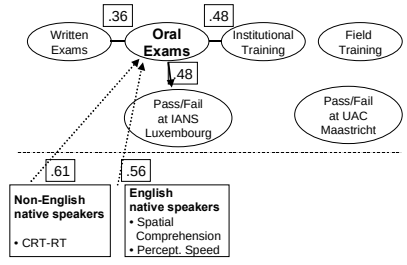
Pattern for Oral Exams



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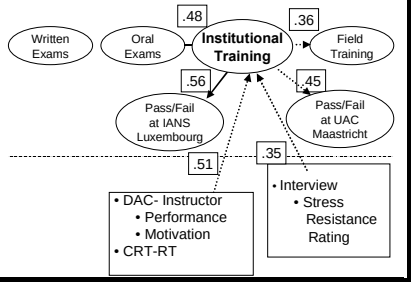
Pattern for Institutional Training



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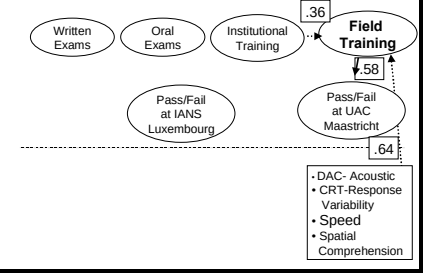
Pattern for Field Training



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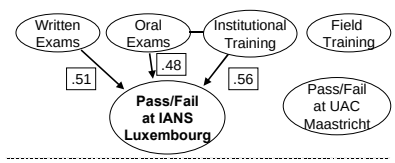
Pattern for Pass/Fail at IANS



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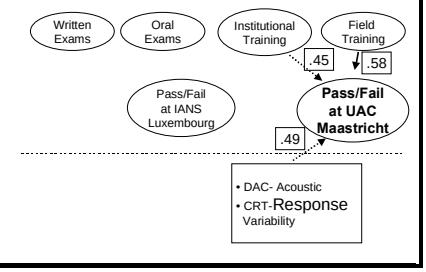
Pattern for Pass/Fail at UAC



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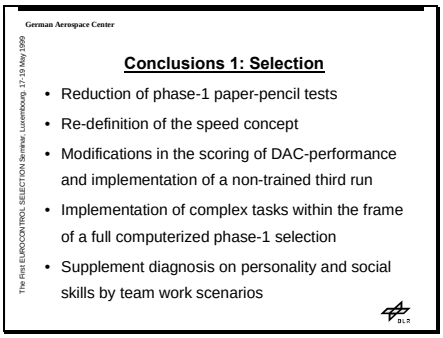
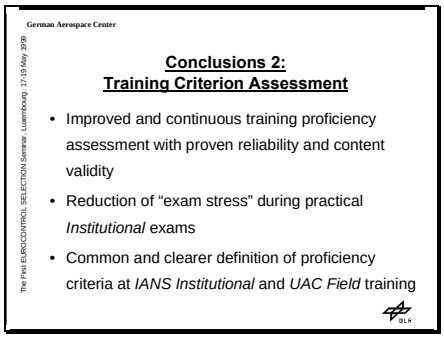
Principal Findings

- The major aim to reduce the failure rate is not achieved.
- The selection battery achieved a better prediction of training proficiency during *Field* than during *Institutional* training.
- Predictor Pattern differed between *Institutional* and *Field* training criteria

The First EUROCONTROL SELECTION Seminar, Luxembourg, 17-19 May 1999


German Aerospace Center
The First EUROCONTROL SELECTION Seminar, Luxembourg, 17-19 May 1999
Conclusions 1: Selection
• Reduction of phase-1 paper-pencil tests
• Re-definition of the speed concept
• Modifications in the scoring of DAC-performance and implementation of a non-trained third run
• Implementation of complex tasks within the frame of a full computerized phase-1 selection
• Supplement diagnosis on personality and social skills by team work scenarios
DLR


German Aerospace Center
The First EUROCONTROL SELECTION Seminar, Luxembourg, 17-19 May 1999
Conclusions 2:
Training Criterion Assessment
• Improved and continuous training proficiency assessment with proven reliability and content validity
• Reduction of “exam stress” during practical *Institutional* exams
• Common and clearer definition of proficiency criteria at *IANS Institutional* and *UAC Field* training
DLR

2.4 Abilities and Aptitudes Required of ATCO Candidates and Active ATCOs: Cross Nations and Cultures Findings, by Shlomo Dover, Ph.D., Human Resources International, (HRI), Israel.

This presentation is dedicated, with great appreciation, to our clients.

2.4.1 Abstract

The distribution of HRI's ATC selection system, ATScreen, and of the group's other selection systems have given us a unique opportunity to study the psychometric and validity aspects of ATC selection across nations and cultures.

This report will summarise some of the data-analysis findings we have obtained in the process of testing active ATCOs and ATC candidates and future selection directions implied by these findings.

Findings refer to 5 countries, from Europe to the Middle and on to the Far East, representing a variety of cultures, social and educational systems. Findings will also be compared to 2 populations: pilot candidates and US students in a graduate flight-studies faculty.

The results that will be presented imply the following findings and conclusions.

2.4.1.1 The Psychometric Perspective: Aptitude and Low-Fidelity-Simulation (LFS) Tests

The differences between the averages of most of the tests included in ATScreen's test battery are within half of a SD. The SDs of the tests' distributions are similar as well.

Of great interest are the following findings:

- Abstract and Numerical Reasoning tests – There are almost no differences in the statistics obtained for these tests.
- ATC students and graduate ATCOs scored higher than the candidates did.
- ATC candidates' tests' statistics are similar to the statistics obtained on these tests by comparison groups such as pilot candidates and US flight studies graduate students.

Findings refer to Table 1.

2.4.1.2 Team Resource Management (TRM) Measures Aspects

We are using a questionnaire that is profiling the subjects on 5 interpersonal conflict-resolution styles: Competitiveness, Co-operation, Compromise, Withdrawal, and Concession. A comparison between ATC candidates, active ATCOs and comparison population of pilot candidates shows:

- The ATC selection process favors less Competitive and more Withdrawing and Concessing profiles of candidates.

- Whereas ATC candidates are similar to Pilot candidates, active ATCOs are lower on Competition and higher on Withdrawal and Concession.

Findings refer to Table 2.

2.4.1.3 The Validity Perspective

Content, concurrent and predictive validity bases were established for ATScreen in various validity follow-ups and proved quite consistent. Results shed interesting light on many methodological issues. The extent to which there is a need for a differential test battery per the various ATC jobs and ATC construct validity are two of the more interesting issues highlighted in our work.

Job analysis of the various ATC jobs show that whereas the aptitudes and skills required of Tower, Ground and Sector ATCOs are similar, their intensity varies from one ATC job to another. (See Table 3).

Construct validity data show interesting differences between the patterns of the intercorrelations between ATScreen's tests in some of the countries monitored. The conceptual structure emerging from the results implies a clear profile of the good ATCO.

A number of perspectives that seem to account for- and provide further insight to the results and findings will be discussed. Among them will be:

1. The similarity of the requirements of such a well-defined job as the ATC job is.

2. The culture-free and functional nature of the state-of-the-art LFS type of tests. These tests are embedded in ATScreen's test battery.

3. The implications of the ATC construct represented by the ATC applicant population and the issue of the criterion as a moderator of validity will be discussed as well.

More findings will be presented as part of the discussion.

2.4.2 Introduction

The distribution of HRI's ATC selection system, ATScreen, and of the group's other selection systems has given HRI a unique opportunity to study the psychometric and validity aspects of ATCO selection across nations and cultures.

The present report will summarise some of the data-analysis findings we have obtained in the process of testing active ATCOs and ATCO candidates. In the

report I will also address some future selection directions implied by these findings.

Two issues are in the focus of this report:

1. Can ATCO selection tests' psychometric results be generalised across nations and cultures?

2. Can ATCO selection systems' validity results be generalised across nations and cultures?

Whereas the definition of these issues appears functional, their resolution has very basic implications with regards to selection methodology.

In order to study these issues an extensive database has been analysed. Data referred to ATCO applicants and active ATCOs from 5 countries, from Europe to the Middle and on to the Far East, representing a variety of cultures, social and educational systems.

Findings have also been compared to 2 non-ATCO populations: pilot candidates and US students in a graduate flight-studies faculty.

2.4.3 The Psychometric Perspective

2.4.3.1 Measuring Abilities: g, s, l or i?

Two contradictory approaches, each lead by some of the founding fathers of psychometric methodology, guided psychometric thinking in its beginning stages.

Spearman (1904) emphasised the relationship between psychometric tests. In this line he has imprinted the term g with regard to his belief that all the psychometric tests have a very basic common element included in every test measurement. It is not surprising, then, that Spearman has developed some of the most basic statistical measures of relationship: the Spearman correlation and Factor Analysis.

Contrary to Spearman, Thorndike (1909) and Thurstone (1935) have suggested the multiple-ability view according to which abilities – s - are diverse and specific.

These two basic approaches to the measurement of abilities had been further developed later into two approaches: one pointing at a link between general and specific abilities, and the other suggesting that integrated rather than specific abilities are the ones that count and should be measured.

Recent findings (Vernon, 1969) suggested that there is a link – 'l' - between g (general) and s (specific) abilities. Accordingly, ability test's factors are arranged in a pyramidal hierarchy with g at the apex. Lower-order group factors are at the next level down. Overall, the lower the ability group is in the hierarchy, the less its saturation with g is.

Another approach claims that tests should elicit responses that will enable us to assess whether the candidates' aptitudes, skills and abilities suit the requirements of the job. Hence, integrated - say 'i' abilities - rather than distinct abilities, should be measured (Asher and Sciarrino, 1974; Motowidlo, Dunnette, and Carter, 1990).

Just to confuse things, recent researchers claim that information-processing measures, e.g., speed of mental processes, provide a much better measure of human ability than any specific, general, linked or integrated ability measures (Sternberg, 1977; Dillon, 1989; Bennett, 1993; Bejar et al., 1991).

The answer to the question whether selection-tests' psychometric results can be generalised across nations and cultures is closely related to the question 'what are we measuring?' and has important consequences to it.

2.4.3.2 Cross-cultural Approaches

Unfortunately, cross-cultural studies of psychometric tests have been carried out in relation to the debate whether intelligence is innate or acquired and in a context of comparing racial groups.

Jensen's conclusions (1982) represent one extreme in this regard presenting data showing a growing gap between test results of native-African and whites in the US, where the whites score increasingly higher on these tests.

Contrary to these results, a growing body of evidence (Neisser, 1998) is quoted as showing that if existing, such a gap between native-Africans and whites is rapidly narrowing. Not only that, but research findings show that the average obtained on intelligence scores increases rapidly (in the Netherlands, for example, tests scores increased in 21 points between 1952 and 1982).

Clearly, the answer to the question whether the psychometric results of the ATCO selection tests' can be generalized across nations and cultures may have critical implications to the approaches described in this regard.

2.4.4 The Validity Perspective

2.4.4.1 ATCO Job Specification and ATCO Selection System Validity

A major element representing the validity perspective is the criterion. Often do selection tests obtain relatively low validities with the criterion they have been designed to predict. Many factors may account for this limited validity (e.g., predictor's and/or criteria variance, restriction of the range, contamination, etc.).

However, the detailed specification of the criterion plays a major role in accounting for these low validities. Many jobs are not very well defined and specified, hence it is difficult to assess or measure whether the person who is assigned to the job performs well or less good.

Contrary to this reality of vague job specifications, an ATCO job is very well defined. Even more so, and with regards to our subject – the generalisability of validity results across nations and cultures – ATCO jobs have highly similar job-specs almost everywhere.

It is logical to assume, then, that similar job requirements in various nations and cultures would result in similar validities of the selection tests that measure the aptitudes, abilities and skills required of the job would obtain across these various populations.

In view of the distribution of HRI's ATCO selection systems worldwide, it would be interesting to find out whether validities are similar for these various populations.

2.4.4.2 Providing Meaning to Validity: Construct Validity Revival

Construct validity gains growing importance in contemporary selection methodology. In Messik's words "… validity researchers have questioned whether all validity evidence might not be conceptualised more fruitfully as construct validity evidence" (Messick, 1995).

Consequently, obtaining a meaningful profile and consistent relationships between the aptitudes, abilities and skills measured by the tests included in a selection composite becomes as- and even more important than the empirical incremental variance-based validity. As such, construct validity results may provide a meaningful construct structure and characterization of ATCOs' aptitudes, abilities and skills.

In view of these considerations it is highly important to establish ATCO selection systems' construct validity and to study its implications on ATCO selection and training.

The construct structure of ATCOs' aptitudes, abilities and skills and their characterization involves identification of the configuration of the interrelationships between the tests measuring them and of the most parsimonious representation of these tests.

The Smallest Space Analysis (SSA) method will be used to study the selection system's construct validity. The SSA method coincides with measurement principles for the new generation of tests (Embretson, 1997). However, while Factor and Multivariate Analysis (Spearman, 1904; Mulaik, 1972) are widely known and widely applied, the Guttman conceptualization and procedures (Guttman, 1968; Lingoes, 1973) is less known.

2.4.5 The Psychometric Tests Studied in this Project vis-à-vis their Relatedness to ATCO Job Requirements

The psychometric properties and validity of the tests included in ATScreen, the ATCO test battery, were studied in this project.

These tests were designed to measure aptitudes, abilities and tests required of an ATCO job. The ATCO job requirements will be thoroughly reviewed in order to relate the results regarding the psychometric and validity properties of the tests included in the ATCO selection test battery to the careful and standard specification of the ATCO job. Table 1 presents the integrated global tasks required of an ATCO job. The integration is based on literature results.

Table 1: The integrated global tasks required of an ATCO

• Vectoring of aircraft to both dynamic and static points.
• Detection and identification of radar targets.
• Management of ATC.
• Communication with aircraft.
• Operation of computerised command and control systems.

Job analysis results obtained by HRI show that not only are ATCO requirements similar across locations, but they are also similar at the intra-job level. Table 2 presents evidence regarding the ATCO's tasks' generalisability based on analysis results for the typical 3 ATCO jobs: Tower Runway, Tower-Ground Movements, and Approach/Area.

Table 2: Job analysis results for Tower Runway, Tower- Ground Movements, and Approach/Area.

ATC JOB ATC MAJOR ACTIVITIES	Tower Runway	Tower Ground Movements	Approach/ Area
1. Information gathering	80 – 90%	80 – 90%	90%
2. Decision making	30 – 40%	20 – 30%	60 – 70%
3. Communications handling	50%	50 – 60%	70%
4. Interact with the computer	5%	5%	60 – 70%
5. Update strips	5%	5%	10%
6. Interact with team members	5 –10%	5 – 10%	5 – 10%

Table 3 presents the last reference information in this regard: the abilities, aptitudes and skills required of an ATCO job as defined based on job analysis results.

Table 3: The abilities, aptitudes and skills required of an ATCO job as defined based on job analysis results.

Spatial orientation.	Understanding and following instructions as specified.
Capability to discern changes (alertness and vigilance).	Integration and interpretation of data on the basis of various info. sources.
Attention to details.	Short and medium-term memory.
Alertness.	Clear diction.
Accurate estimation of range and velocity.	Mathematical ability.
Proper decision making Under pressure (e.g. information, time).	Reaction Time.
Multitasking.	

The tests included in ATScreen, HRI's ATCO selection system, provide measures of all the abilities, aptitudes and skills listed in Table 3 in the form of regular, LFS tests and personality questionnaires. ATScreen's test list is presented in Appendix A1.

Of special interest is the personality aspect measured in ATScreen. Job analysis results indicated that this aspect is especially important because of the functional requirements required of ATCOs (e.g., co-operation in covering sectors on different screens) and with regards to some of the hardships presented by the job (e.g., shifts work).

Consequently, the personality questionnaire that has been included in the system provides a profile of the applicant's style when encountering interpersonal conflict situations. In a way, this questionnaire provides information related to TRM aspects of the ATCO's performance. The profile refers to 5 dimensions: competitiveness, co-operation, compromise, withdrawal, and concession. Every applicant gets a score on each dimension.

2.4.6 Population

Psychometric findings refer to 5 countries, from Europe to the Middle and on to the Far East, representing a variety of cultures, social and educational systems. Construct validity findings will refer to an example consisting of a group of active ATCOs and a group of ATCO applicants from one European country.

Psychometric findings will also be compared to 2 populations: pilot candidates and US students in a graduate flight-studies faculty. The groups are not identified by country name, however as results have been produced by the CAAs selection teams of the countries involved, data and findings are available for replication.

2.4.7 Findings

2.4.7.1 The Psychometric Perspective: Aptitude and LFS Tests

Table 4 presents the statistics of the aptitude and LFS tests for 3 groups: ATCO applicants, active ATCOs and 2 comparison populations (US students and commercial pilots). Groups come from 5 countries of 3 continents and cultures: Europe, the Middle East and the Far East.

Results show that the differences between the averages of most of the tests included in ATScreen's test battery are within half of a SD. Tests' SDs are similar as well. Hence, the results provide important evidence supporting the hypothesis that tests can be used and tests' statistics can be generalised across nations and cultures.

Of great interest are the following findings:

a) The Abstract and Numerical Reasoning tests – There are almost no differences in the statistics obtained for these tests.

b) ATCO students and graduate ATCOs scored higher than the applicants did.

c) ATCO candidates' test statistics are similar to the statistics obtained on these tests by comparison groups such as pilot candidates and US flight studies graduate students.

2.4.7.2 The Psychometric Perspective: TRM Measures Aspects

Results in Table 5 compare the profiles of the ATCO candidates, the active ATCOs and the comparison population of pilot candidates. Results show as follows:

a) The ATCO selection process favours less Competitive and more Withdrawal and Concession like profiles of candidates.

b) Whereas ATCO candidates are similar to Pilot candidates, active ATCOs are lower on Competition and higher on Withdrawal and Concession.

2.4.7.3 Validity Generalisability Aspects

Content, concurrent and predictive validity bases were established for ATScreen in various validity follow-ups and proved quite consistent. Validity studies established ATScreen's concurrent and predictive validity. (Validities in the range of R=.53 were obtained in the original validity study). Subsequently, upper- and lower cut-off points were specified.

Even more so, the same tests proved highest predictors of ATC performance in various countries. (These were the LFS tests Planning and Heading-and-Range, quantitative Reasoning, Memory and Concentration, and the Co-operation scale).

Results shed interesting light regarding the extent to which there is a need for a differential test battery per the various ATCO jobs. Job analysis results presented in Table 2 show that whereas the aptitudes and skills required of Tower, Ground and Sector ATCs are similar, their intensity varies from one ATC job to another.

Table 4: ATCO aptitude and LFS[6] selection tests' statistics: ATCO candidates (for ATScreen's tests see Appendix A1)

Europe 1 (N=1088)

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	16.8	19.8	21.1	22.3	10.2	15.1	6.9	4.6	70.6	279	403
SD	(3.4)	(4.8)	(5.6)	(4.7)	(4.8)	(3.3)	(1.9)	(2.6)	(47)	(123)	(157)

Europe 2 (N=339)

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	16.5	20.2	27.9	19.2	8.3	14	7.9	3.1	92	403	473
SD	(3.3)	(4.4)	(4.3)	(4.1)	(3.4)	(3.2)	(1.7)	(2.1)	(58)	(172)	(131)

Middle East 1 + Middle East 1a (N=40)[7]

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	16	21	24	22	11	16	8	4	65	265	348
SD	(3)	(4.9)	(5.7)	(5)	(4.7)	(2)	(1.7)	(2.8)	(31)	(130)	(97)

Middle East 2 (N=117)

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	16	19.2	23	15	8.9	13	7.8	2.9	86	388	471
SD	(3.5)	(4.7)	(4.6)	(6.1)	(3.9)	(3.9)	(1.6)	(2.1)	(50)	(191)	(152)

Far East 1 (N=660)

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	14.7	19.3	25.4	22.6	9.1	13.6	8.7	2.2	96.5	345	486
SD	(3)	(4.9)	(5.7)	(5.1)	(4.3)	(3.6)	(1.8)	(2)	(61.3)	(171)	(154)

ATCO aptitude and LFS selection tests' statistics: Active ATCOs

Europe 1a (N=72)

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	16.4	22.4	21.3	25.1	11.3	17.1	7.6	3.2	75.2	283.6	384
SD	(4.5)	(3.6)	(6.4)	(2.3)	(5.3)	(2)	(2)	(2.2)	(50.7)	(114)	(118)

[6] Low Fidelity Simulation tests.
[7] The ATCOs hired are the ex-air force ATCOs.

Middle East 1 + Middle East 1a (N=40)[7]

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	16	21	24	22	11	16	8	4	65	265	348
SD	(3)	(4.9)	(5.7)	(5)	(4.7)	(2)	(1.7)	(2.8)	(31)	(130)	(97)

Far East 1 (N=165)

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red[8]	Dy3	Dy4
Ave.	16	18.1	25.4	18.6	8.7	15.8	7.4	3.2	173	215	385
SD	(3.4)	(4.6)	(5.5)	(4)	(4.2)	(2.6)	(1.7)	(1.5)	(152)	(105)	(94)

Comparison populations: Aptitude and LFS selection tests' statistics

Pilot candidates (N=845)

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	17	19		18		16	9	5	79	301	453
SD	(3.5)	(4.9)		(4.4)		(3)	(1.6)	(2.5)	(50.5)	(182)	(154)

US Students – Flight Studies (N=145)

	Fir	Qre	Va3	Dib	Ori	Hri	Me2	Plb	Red	Dy3	Dy4
Ave.	21.3	19.6	25.6	17.2	9.8		7.8			333	354
SD	(3.1)	(5.5)	(6.2)	(5.8)	(4.4)		(1.8)			(163)	(120)

[8] A different version of the test has been used.

Table 5: ATCO TRM[9] measure statistics

	CO1 Competitiveness	CO2 Co-operation	CO3 Compromise	CO4 Withdrawal	CO5 Concession
ATCO CANDIDATES					
Europe1					
Av. SD	6.5 (2.5)	6.2 (2.1)	6.4 (2.2)	4.5 (2)	6.2 (1.9)
Europe2					
Av. SD	6 (2.1)	6.9 (1.9)	7.3 (2)	4.5 (2)	5.2 (1.8)
Middle East 2					
Av. SD	6.5 (2.9)	6.2 (1.8)	6.4 (2)	5.5 (1.7)	5.3 (2.4)
Far East 1					
Av. SD	5.8 (2.5)	6.8 (1.8)	6.6 (2.1)	5.3 (1.7)	5 (2.1)
Average	**6.4**	**6.5**	**6.6**	**4.6**	**5.4**
ACTIVE ATCOs					
Europe1a					
Av. SD	5.1 (2.4)	6 (2.1)	6.9 (2.1)	5.9 (2)	5.9 (2)
Middle East 1 + 1a					
Av. SD	4.7 (2.6)	7 (1.8)	7.2 (1.6)	4.1 (1.5)	6.7 (1.7)
Far East 1					
Av. SD	4.1 (2.7)	6.1 (1.9)	5.9 (1.9)	7.4 (1.8)	6.2 (2.1)
Average	**4.6**	**6.3**	**6.6**	**5.8**	**6.2**
Comparison Population					
Pilot Candidates (845)					
Av. SD	**6** (2.7)	**7** (1.8)	**6.5** (2.2)	**5.3** (1.7)	**5.1** (2.1)

2.4.7.4 Adding Meaning to Validity: Construct Validity Results

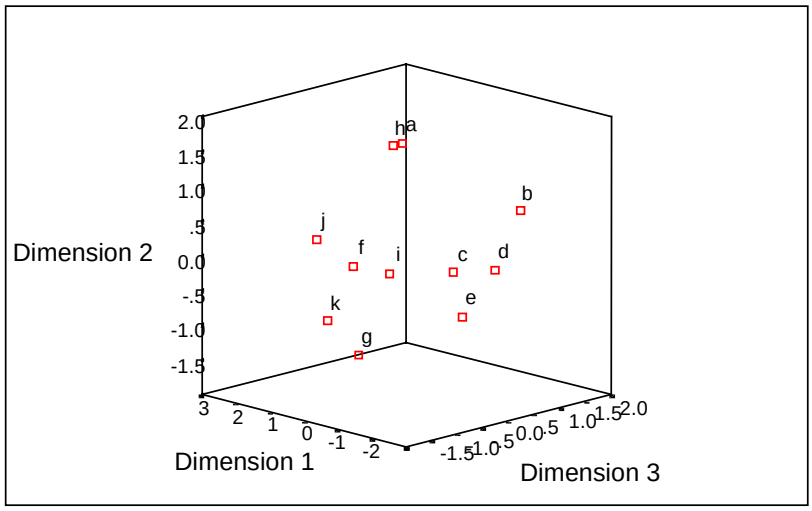
Charts 1 and 2 below present SSA results for active ATCOs and ATCO candidates respectively of a European country studied in this research. Results refer to the intercorrelations between the selection test battery's tests presented in Appendix A3.

As can be seen from Charts 1 and 2, construct validity data show interesting patterns of relationships between the ATScreen's tests as demonstrated by their intercorrelations. The conceptual structure emerging from the results implies a clear profile of the good ATCO. The resulting conceptual structure is presented in Chart 1 hereinafter.

[9] Team Resource Management.

Derived Stimulus Configuration

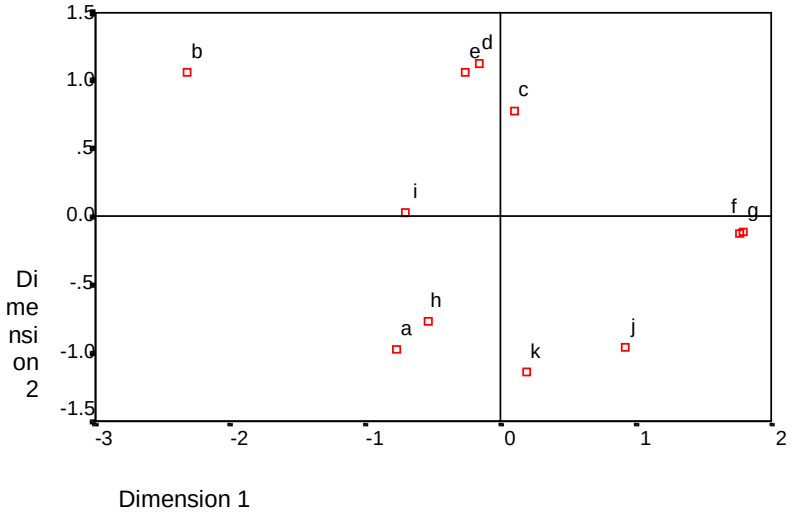
Euclidean distance model: 3 dimensions



Dib A Dy3 b Dy4 c Fir d Hri e Me2 f Ori g Plb h Qre i Red j Va3 k

Derived Stimulus Configuration

Euclidean distance model: 2 dimensions

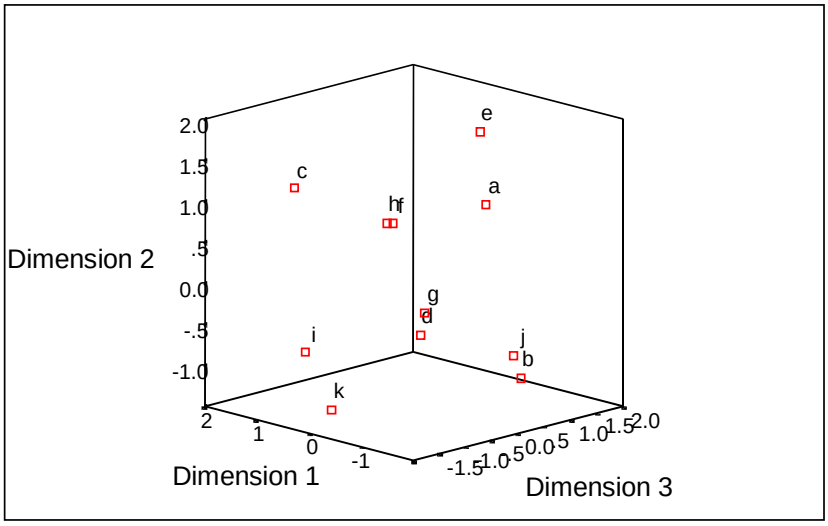


Dib A Dy3 b Dy4 c Fir d Hri e Me2 f Ori g Plb h Qre i Red j Va3 k

Chart 1: SSA results for Europe 1a ATCOs

Derived Stimulus Configuration

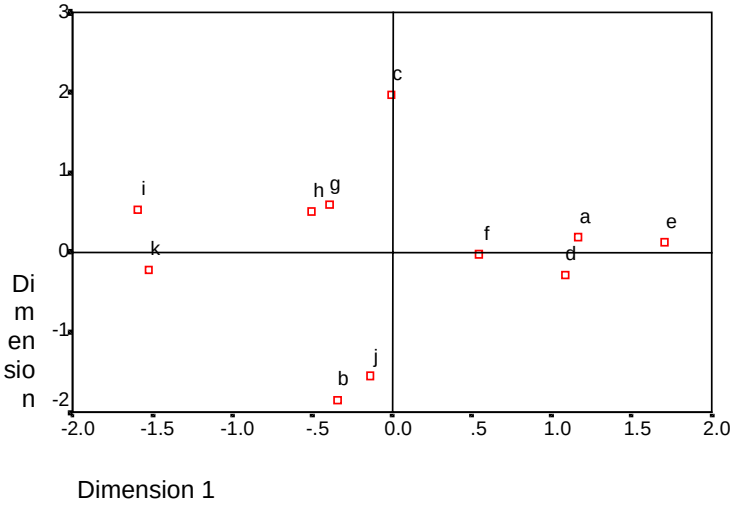
Euclidean distance model: 3 dimensions



Dib A Dy3 b Dy4 c Fir d Hri e Me2 f Ori g Plb h Qre i Red j Va3 k

Derived Stimulus Configuration

Euclidean distance model: 2 dimensions



Dib A Dy3 b Dy4 c Fir d Hri e Me2 f Ori g Plb h Qre i Red j Va3 k

Chart 2: SSA results for Europe 1 ATCO candidates

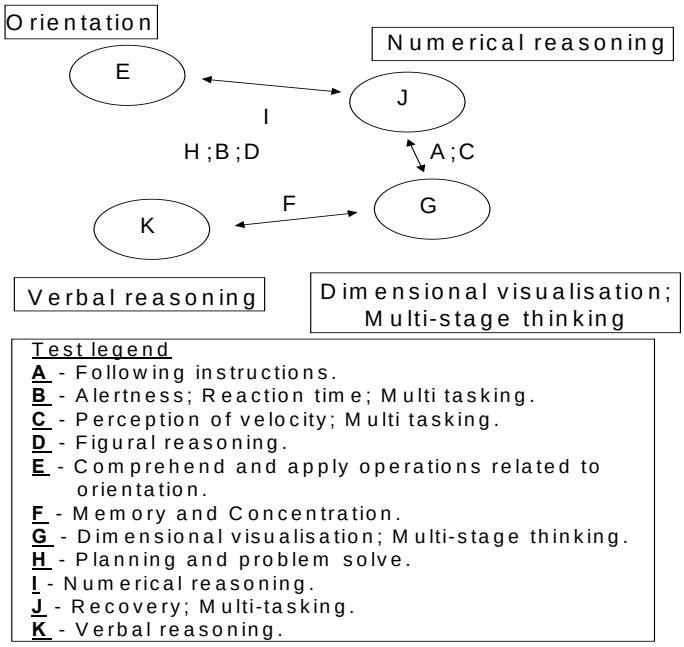


Chart 3: A schematic integrated SSA picture of active ATCO's across countries

2.4.8 Discussion and Summary

The results presented in this report provide interesting inputs to some of the more important issues in contemporary psychometrics.

For most of the tests, psychometric tests' statistics are similar across the nations and countries studied in this project. Validity results proved replicable as well.

Whereas the practical consequences of these results are quite straightforward, the methodological implications of the results provide important inputs to psychometric thinking.

We were not able to relate the results to the 'g' issue. However, it appears that in as much as the aptitudes, abilities and skills measured by the tests represent specific or integrated skills (Vernon, 1969; Asher and Sciarrino, 1974), human performance on these abilities is similar across countries and nations.

Similar ATCO selection tests' content- and concurrent validity results were obtained by ATScreen's customers. The results provide evidence to the system effectiveness in predicting who will make a good ATCO across the countries and cultures.

The sample construct validity results presented in this report provide a basis for defining a construct structure representing the profile of a good ATCO in terms of the aptitudes, abilities and skills accounting for ATCO performance.

Different elements account for the construct structures of ATCOs and ATCO applicants. The ATCO construct structure consists of the following elements:

1. Reaction Time, Alertness and Multitasking; 2. Following instructions and Planning; 3. Memory, Numerical operations, and Recovery; 4. Speed and Velocity, Reasoning and Spatial orientation; 5. Verbal reasoning and multi-stage thinking.

The construct structure emerging of the ATCO applicants' data consists of the following elements:

1. Recovery; 2. Memory, concentration and Planning; 3. Orientation and Following instructions; 4. Reasoning and Spatial Orientation; 5. Alertness, reaction time, multitasking and Recovery; Numerical and Verbal Reasoning.

Clearly, as we are selecting ATCOs, then the ATCO construct structure is the one that should lead us in interpreting applicants' results. Consequently, the closer a profile of a candidate to the profile of an ATCO construct structure, the more suitable for the job he/she is.

Construct validity results, even though limited in sample (only one country), provide a fine example to the importance of this long and not-rightly neglected validity perspective.

The construct validity results that are presented in this study emphasise yet an additional important role that validity results in general, and construct validity in particular, have in supporting the training process.

It quite often happens to us that we get to face rising or high drop-out rates. Basically, we do not have any tools that would tell us whether this drop-out rate is justified and how to cope with it.

Systematic validity data can provide us with valuable information that, when presented and discussed with instructors' managers, can shed important light on attrition reasons. Even more important, such selection data can support the instructors themselves and suggest courses of action for treating individual trainees and groups.

Concurrent validity data show that the LFS-based tests contribute to the prediction of ATCO performance most. Results yield substantial support to the findings and approaches emphasising LFS as a highly predictive selection method (Motowidlo, Dunnette, and Carter, 1990).

LFS tests' objective and advantage are to elicit responses that will enable us to assess whether the candidates' aptitudes, skills and abilities suit the requirements of the job they are applying for.

However, in as much as LFS uses job try-outs, realistic work samples or high-fidelity simulations, they are most expensive. The LFS tests included in HRI's test battery for ATCO selection have a special contribution in this regard.

Following the Construct-Based approach suggested by Baughman et. al., (1997) for measuring complex skills, the HRI LFS tests managed to provide a concrete representation of generic work sample tests through the Personal Computer (PC). As such, they represent a highly predictive, cost effective and inexpensive solution between the expensive high fidelity simulations and job try-outs and the very low and ineffective uses of responding to descriptions of job elements.

2.4.9 References

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2.4.10 Appendix A1: ATScreen’s Tests

Regular Tests	
Figural Reasoning	Fir
Quantitative reasoning	Qre
Verbal Analogies	Va.
Following Instructions	Dir
Orientation (Mental Rotation)	Ori
Low-Fidelity simulation	
Heading and Range Identification (LFS)	HRI
Memory and concentration in face of distracters (LFS)	Me2
Planning and decision making under time pressure (LFS)	Plb
Recovery test	Red
Dynamic Test -1: Reaction time; Multitasking (LFS)	Dy3
Dynamic Test -2: Alertness; Multitasking	Dy4
ATC audio situation test (LFS; experimental)	Aud
Personality questionnaire	
Thomas-Killman test for coping with conflict situations	Prs

2.4.11 Appendix A2: Correlation matrix of Europe 1 ATCOs (N=72)

	Dib	**Dy3**	**Dy4**	**Fir**	**Hri**	**Me2**	**Ori**	**Plb**	**Qre**	**Red**	**Va3**
Ave.	25.1	284	384	16.4	17.1	7.6	11.3	3.2	22.4	75.2	21.3
Dib	-	-.16	-.10	.11	.37	.12	.22	-.04	.11	-.13	.06
Dy3		-	.39	-.39	-.42	-.20	-.22	-.37	-.36	.62	-.09
Dy4			-	-.19	-.16	-.09	-.19	-.22	-.07	.44	-.24
Fir				-	.35	.20	.35	.34	.39	-.25	.14
Hri					-	.32	.22	.37	.38	-.27	.25
Me2						-	.17	.18	.29	-.17	-.17
Ori							-	.21	.11	-.10	.18
Plb								-	.24	-.39	.29
Qre									-	-.26	-.04
Red										-	-.24
Va3											-

2.4.12 Appendix A3: Correlation matrix of Europe 1a ATCO applicants (N=1088)

	Dib	Dy3	Dy4	Fir	Hri	Me2	Ori	Plb	Qre	Red	Va3
	A	b	c	d	e	f	g	h	I	j	k
Ave.	22.3	279	403	16.8	15.1	6.9	10.2	4.6	19.8	70.6	21.1
Dib	-	-.22	-.21	.13	.38	.19	.31	.27	.36	-.14	.42
Dy3		-	.49	-.20	-.28	-.11	-.22	-.24	-.27	.38	-.25
Dy4			-	-.21	-.33	-.14	-.21	-.25	-.31	.50	-.28
Fir				-	.34	.06	.24	.24	.41	-.18	.24
Hri					-	.21	.37	.38	.50	-.28	.46
Me2						-	.15	.19	.24	-.15	.13
Ori							-	.27	.35	-.12	.38
Plb								-	.37	-.17	.40
Qre									-	-.26	.40
Red										-	-.18
Va3											-

2.4.13 Slides Used During the Presentation

Abilities and Aptitudes Required Of ATCO Candidates and Active ATCOs: Cross Nations and Cultures Selection Findings

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The Issues

- *To what degree can ATCO selection tools' psychometric results be generalized across countries and cultures?*
- *To what degree can ATCO selection validity results be generalized and used across countries and cultures?*

The standard specification of the ATCO job gives both issues a special perspective.

Presentation elements

- Review of the relevant methodological issues.
- The objective: ATCO job requirements and subsequent selection tests.
- The data.
- Findings.
- Practical and methodological implications.

Tests' Psychometrics: What Are We Up To Measure?

From
Spearman (1904)
To
Thorndike (1909); Thurstone (1935)
To
Vernon (1963); Gardner (1983)
To
Asher (1974); Motowidlo (1990); and Baughman (1997)

Cross-cultural Psychometric Test results: Approaches and Contemporary Findings

Jensen (1982)
Vs.
Neisser (1998)

Job analysis:

1. The integrated global tasks required of an ATCO -

- Vectoring of aircraft to both dynamic and static points.
- Detection and identification of Radar targets.
- Management of air traffic control.
- Communication with aircraft.
- Operation of computerized command and control systems.

Job analysis:

2. ATCO's Tasks Generalizability

The major activities per time spent in every ATCO job

ATC job major activities	Tower runway	Tower ground movements	Approach / Sector
1. Information gathering	80%-90%	80%-90%	90%
2. Decision making	30%-40%	20%-30%	60%-70%
3. Communications handling	50%	50%-60%	70%
4. Interface with the computer	5%	5%	60%-70%
5. Update strips	5%	5%	10%
6. Interacts with team members	5%-10%	5%-10%	5%-10%

Job analysis:

3. The resulting global aptitudes and skills required of an ATCO

1. Spatial orientation.
2. Capability to discern changes (alertness and vigilance).
3. Attention to details.
4. Alertness.
5. Accurate estimation of range and velocity.
6. Reaction Time.
7. Multi-tasking.
8. Understanding and following instructions as specified.
9. Integration & interpretation of data on the basis of various information sources
10. Short and medium term memory.
11. Clear diction.
12. Mathematical ability.
13. Proper decision making Under pressure (e.g. information, time).

The Test Battery: Covering All ATCO's Job Requirements

(Regular; *Low Fidelity Simulation;* Personality)

- Figural Reasoning - Fir.
- Quantitative reasoning - Qre.
- Verbal Analogies - Va.
- Following Instructions - Dir.
- Orientation (Mental Rotation) - Ori.
- ***Heading and Range Identification (LFS) - HRI.***
- ***Memory and concentration in face of distracters (LFS) - Me2.***
- ***Planning & decision making under time pressure (LFS) - Plb.***
- ***Recovery test - Red.***
- ***Dynamic Test -1: Reaction time; Multi-tasking (LFS) - Dy3.***
- ***Dynamic Test -2: Alertness; Multi-tasking - Dy4.***
- ***ATC audio situation test (LFS; experimental) - Aud.***
- Thomas-Killman test for coping with conflict situations- Prs

Tower Resource Management Aspects: Interpersonal Conflict Situations

Profiling candidate's style of coping with interpersonal conflict situations is referring to 5 dimensions:

Competitiveness *Cooperation*
Compromise
Withdrawal *Concession*

ATScreen's tests' data availability across nations and cultures.

Findings

1. *Test statistics: Aptitude and ability tests across countries and cultures -* ***ATCO candidates***.

2. *Test statistics: Low Fidelity Simulation tests across countries and cultures -* ***ATCO candidates***.

Findings

3. Test statistics: Coping with interpersonal conflict situations across countries and cultures - ***ATCO candidates.***

4. Test statistics: Aptitude and ability tests across countries and cultures - ***Active ATCOs****.*

Findings

5. Test statistics: Low Fidelity Simulation tests across countries and cultures - ***Active ATCOs****.*

6. Test statistics: Coping with interpersonal conflict situations across countries and cultures - ***Active ATCOs****.*

Findings

7. Test statistics: Aptitude and ability tests across countries and cultures - ***Comparison populations****.*

8. Test statistics: Low Fidelity Simulation tests across countries and cultures - ***Comparison populations****.*

Findings

9. Test statistics: Coping with interpersonal conflict situations across countries and cultures - ***Comparison Populations****.*

10. Test statistics: Aptitude and ability tests across countries and cultures
BY
ATCO candidates, active ATCOs and comparison populations.

Findings

11. Test statistics: Low Fidelity Simulation tests across countries and cultures
BY ATCO candidates, active ATCOs and comparison populations.

12. Test statistics: Coping with interpersonal conflict situations across countries & cultures
BY ATCO candidates, active ATCOs and comparison populations.

Psychometric Statistics' Results

- Abstract and Numerical Reasoning tests – There are almost no differences in the statistics obtained for these tests.
- ATC students and graduate ATCs scored higher than the candidates did.
- ATC candidates' tests' statistics are similar to the statistics obtained on these tests by comparison groups such as pilot candidates and U.S. flight studies graduate students.

Psychometric Tests' Statistics' Results

Tower Resource Management Measures aspects

- The ATC selection process favors less Competitive and more Withdrawing and Concessing profiles of candidates.
- Whereas ATC candidates are similar to Pilot candidates, active ATCs are lower on Competition and higher on Withdrawal and Concession.

Concurrent and Predictive Validity aspects.

System validity:
The composites obtained

When regressed on the criterion a multiple correlation of up to R= .53 was obtained between the tests and the criterion.

Subsequently 2 cut-off points were identified:

1. An upper cut-off point identifying candidates whose prospects to prove good controllers are 84% and higher, and
2. A lower cut-off point identifying candidates whose prospects to prove good controllers are 15% and lower.

System validity:
The tests contributing most to the multiple correlation

- Planning.
- Heading & Range.
- Quantitative reasoning.
- Memory.

- SCALE 2 -- cooperation -- from the Thomas-Killman Coping- with-conflict test.

ATCO construct structure as reflected by tests' inter-correlations.

The elements accounting for active and applicant ATCOS

Active ATCO elements

1. Reaction Time, Alertness & Multitasking;
2. Following instructions and Planning;
3. Memory, Numerical operations, and Recovery;
4. Speed & Velocity, Reasoning and Spatial orientation;
5. Verbal reasoning and multi-stage thinking.

Applicant ATCOs

1. Estimate of speed & velocity.
2. Applying orientation skills
3. Memory, concentration and Planning
4. Applying instructions.
5. Reasoning and multi-stage thinking.
6. Verbal and numerical Reasoning.
7. Alertness, multitasking and recovery

Practical Implications

- *Generalizability of valid ATCO selection tests: A standard-job specification effect.*
- *LFS tests' validity: Updating Motowidlo's classification - A room for concrete representations of generic tasks.*
- *The chicken-egg dilemma of Criteria-Predictor relationship.*

Theoretical Implications

- *Construct validity contribution.*
- *The universal specification of the ATCO and its consequences to predictor specification.*
- *Measurement of abilities: A case for integration rather than classification and diversification of skills.*

2.5 A Non-European (US) Experience in Air Traffic Controller Selection, by Dr. Michael C. Heil, Personnel Research Psychologist, FAA, Civil Aeromedical Institute (CAMI), Oklahoma City, OK, USA.

The United States Department of Transportation FAA has developed a new computerized Air Traffic Control Specialist (ATCS) selection test that can be administered to applicants in their home community. This one-day test replaces the Office of Personnel Management (OPM) test and 9-week Academy screen that had been used by the FAA throughout most of the 80s and early 90s. During this presentation, I will briefly discuss previous FAA ATCS selection procedures before providing details about the development and validation of the new computerized selection test. I will also provide an overview of recently completed research associated with this new battery and discuss the FAA's future ATCS selection research plans.

2.5.1 Background

The FAA employs close to 20,000 ATCSs. This number includes first-line supervisors as well as Certified Professional Controllers (CPCs). These ATCSs make up more than half of FAA personnel employed in safety-related occupations. FAA ATCSs are assigned to either en route (n=7373), terminal (n=9461), or flight service (n=2675) facilities.

In 1981, approximately 11,000 of the 17,000 striking ATCSs were fired by then President Reagan. Most of these controllers were replaced by individuals hired between 1981 and 1984. A two-stage selection process consisting of a 4-hour written OPM test and a 9-week Academy screen was introduced during the 1980s. Candidates with the highest OPM test scores were required to undergo medical and security screening before entering a 9-week screening program at the FAA Academy in Oklahoma City. Less than 60% of ATCS trainees successfully completed the screen; those who passed moved on to OJT, where some took as long as 3 years to reach full performance level.

The Academy Screen was discontinued in 1992 due, in part, to issues related to its cost to the government and fairness to students (e.g. people left their jobs and homes for 9 weeks with no assurance that they would pass the screen and be hired by the FAA). Consequently, research and development efforts were geared toward the creation of a new selection procedure. One of these efforts, the Separation and Control Hiring Assessment (SACHA) project first focused on performing a job analysis of the ATCS position. The SACHA project also resulted in the development of new ways to measure ATCS job performance and new tests for selecting ATCSs.

The Pre-Training Screen (PTS), which was developed during the same time period as SACHA, was an attempt to replace the 9-week screen with a 1-week selection test. The life span of both SACHA and the PTS was short, as the SACHA contract expired in 1996 before producing a viable selection instrument, and use of the PTS was discontinued by the FAA in 1996.

During this period, the FAA's initial qualification training program had been redesigned to focus on training, rather than screening. In essence, the FAA's new Multi-Path Hiring and Training Model is based on the assumption that candidates have the basic skills needed to perform ATCS duties. The result was that the FAA had a training program but no pre-hire selection system other than the OPM written test. Because the FAA had little need to hire new ATCSs since 1992, this set of circumstances created few problems. The FAA was able to meet its ATCS staffing needs by hiring Collegiate Training Initiative (CTI) graduates, former military ATCSs and former Professional Air Traffic Controllers Association (PATCO); the former ATCS union (whose members were fired by President Reagan) ATCSs. However, the ATC workforce is aging, and an increasing number of ATCSs are expected to retire within the next decade. Consequently, the FAA's current hiring strategy is deemed to be insufficient in meeting staffing needs.

2.5.2 The Air Traffic-Selection and Training (AT-SAT) Project

The AT-SAT project was initiated in October 1996 to address the FAA's need for a new selection instrument. The purpose of the project was to develop a valid, legally defensible, job-related, computerized ATCS selection battery. The new selection test battery is intended to screen ATCS applicants who are then hired by the FAA and sent to the Air Traffic (AT) Academy for a 15-week training program. At the completion of Academy training, students must successfully pass the Performance Verification (PV) process before being sent into the field for OJT.

The development of a 1-day computerized selection means that ATCS candidates no longer need to inconvenience themselves by leaving their homes and jobs to travel to Oklahoma City for screening. Instead, applicants can now take the test in a testing center in their home community. Their scores are sent electronically to FAA Headquarters in Washington, D.C., for hiring decisions. All item-level data are transmitted to the CAMI in Oklahoma City for validation research.

The AT-SAT project represents an integrated validation study that resulted in the creation of new job-performance criterion measures and new computerized predictor tests. The concurrent validation of the AT-SAT battery will be described in more detail later in this presentation.

2.5.3 Multi-Path Hiring and Training Model

The AT-SAT battery plays a pivotal role in the AT Academy's new Multi-Path Hiring and Training Model. Since the Academy now emphasises training, rather than screening, it is important to have a selection test that identifies candidates with the abilities necessary to be a successful controller. The AT-SAT battery was designed to act as this "filter" into Academy training. With the exception of former civilian ATCSs who are being reinstated, all ATCS candidates must pass AT-SAT. All veterans are eligible for Veterans Readjustment Act (VRA) appointments. Points are added to veterans' selection test score in the following manner: 10 points for veterans who have service-connected disabilities of at least 10% for which the Veterans

Administration is compensating them; 5 points for veterans who served during a time of conflict in a location for which a campaign badge or expeditionary medal was authorized; and 0 points for people who served in the military during peacetime. After adding veteran's preference points, candidates with the highest scores are selected first. These candidates must pass medical and security screening before going to the Academy in Oklahoma City for 15 weeks of training.

2.5.4 Applicant Screening

One of the FAA's largest applicant pools comes from competitive, or "off the street", hiring. Since the proportion of applicants vs. job openings is very large, the FAA cannot afford to administer AT-SAT to every applicant. To address this issue, the FAA human resources department has recommended that people who meet the basic qualifications for the ATCS job be placed into a pool for random referral. Based on hiring needs, a certain number of people will be randomly selected from this applicant pool. Those randomly selected will then take AT-SAT, and those passing are hired from the top-down (i.e., people with the highest scores will be selected first). Since this process is likely to result in a situation where qualified people are not given the opportunity to take the selection test, CAMI has advocated the development and use of a "pre AT-SAT" applicant screening test. This test may be in the form of a biographical data questionnaire or a scaled-down version of an existing selection test. CAMI will begin research associated with this approach before the end of the current fiscal year.

2.5.5 AT-SAT Development and Validation

The AT-SAT battery is based on the SACHA job analysis described earlier. Working co-operatively with contracting organizations, the FAA developed tests to measure the worker requirements identified by the job analysis. After undergoing pilot testing with military personnel, twelve tests were selected to remain in the beta version of the battery, which was then used during the concurrent validation study. When using a concurrent validation approach, the selection test is administered to people who are already employed in the job. Scores on the test are then correlated with indicators of job performance that are collected either concurrently or shortly after the selection test was administered. Consequently, the concurrent validation of AT-SAT necessitated the development of job performance measures that could be compared to AT-SAT scores to determine the extent to which the battery predicts ATCS performance.

Participants. A total of 1200 Full-Performance Level (FPL) en route ATCSs, supervisors, and staff participated in the AT-SAT concurrent validation study. ATCSs from each of 19 en route ATC centers volunteered to participate.

Procedure. Data collection teams were assembled and trained to conduct testing at each of the en route centers included in the study. Each team was comprised of a test site manager and two to four team members who were responsible for administration of the predictor battery and criterion measures. Volunteers in the AT-SAT concurrent validation study were tested over a 2-

day period in a room provided by their facility. One day of computer-based testing was devoted to the predictor test and one day was devoted to administration of a computer-based performance measure.

Each volunteer also identified two peers and two supervisors to complete job performance assessment ratings. The supervisor and peer raters participated in an orientation and training program to ensure valid and accurate scaling. These raters were then asked to complete the performance assessment rating forms and submit them to the researchers.

One hundred en route ATCSs were flown to Oklahoma City to undergo 2 ½ days of testing on high-fidelity AT simulations. Data generated from this study were compared with Computer-Based Performance Measure (CBPM) performance in an effort to support the validity of the computer measure of job performance.

AT-SAT Beta Tests. The beta version of the AT-SAT battery contained the following tests: Sound, Scan, Dial Reading, Angles, Planes, Applied Math, Experience Questionnaire, Analogies, Letter Factory, AT Scenario, Time Wall/ Pattern Recognition, and Memory. Each test contained extensive instruction and practice sessions.

Criterion Measures. The CBPM served as a measure of the technical skills necessary to effectively and efficiently separate traffic on the job. It is a 38-item, 2-hour test where controllers are presented a series of realistic AT scenarios and two to five multiple choice questions pertaining to each scenario. Each question has three to five response options representing different ways the AT problems might be addressed. During administration of the CBPM, controllers were presented with scenarios and given up to 60 seconds to review each one before it began. Each scenario lasted no more than 5 minutes. Respondents were then given 25 seconds to answer each question. Once a response was chosen, controllers were unable to return to previous items or scenarios to review information or change answers.

The peer and supervisor ratings are behavior-based scales with 10 dimensions and 1 overall effectiveness scale. Rating standards, which describe ATCS proficiency at different effectiveness levels in an effort to make ratings more objective, are provided below each of the 10 dimensions. These rating standards were developed as part of the AT-SAT concurrent validation study. Raters were asked to read each category definition and rating standard, then compare the current effectiveness of the controller being rated with that standard. Ratings were made on a 7-point scale and were later combined to produce an overall criterion rating score. These ratings were completed independently of CBPM administration.

Summary of Concurrent Validation Results. A composite criterion was created by combining CBPM and job performance rating scores. AT-SAT tests that either contributed little to the prediction of current job performance or failed to adequately measure worker requirements were removed from the battery. When corrected for restriction in range, a validity coefficient of .67 was found.

The eight tests that remained in the operational version of the AT-SAT battery are described in Appendix A.

2.5.5.1 AT-SAT Practice and Coaching Effects Study

Upon completion of the concurrent validation study, CAMI conducted research to determine if the validity of the battery might be compromised by practice and coaching. Since the AT-SAT battery currently has no parallel forms, applicants who retake the test will be given the same items each time. Additionally, in the US, there are private businesses that attempt to learn all that they can about national tests and then train or "coach" people to pass the test. In an effort to understand the potential effects of practice and coaching on AT-SAT scores, an experiment was conducted using participants representative of the ATCS applicant pool. Another important issue explored by the study was the extent to which practice or coaching may affect decisions about the hiring of personnel by altering the ranking of job candidates. An example of this is a person who would not have been selected based on an earlier test score. Practice or coaching may increase this person's score, so that he or she receives a higher ranking and is then selected for the job.

It was hypothesized that participants' overall score on the AT-SAT battery would improve with repeated trials and that there would be a greater increase in overall score for subjects who were taught specific strategies for enhancing performance. Tests that were based on computer simulation performance - the Air Traffic Scenarios, Scan, and Letter Factory tests - were hypothesized to be more vulnerable to practice effects than other tests contained in the battery.

Participants. The participants in the study were 150 men and women who met the basic criteria for selection as an ATCS: They were US Citizens between the ages of 18 and 30 with normal color vision and a high school diploma. Additionally, they had no prior ATC or direct aviation experience.

Procedure. Participants were randomly assigned to one of three conditions: (1) a group that received coaching prior to taking the test; (2) a group that received coaching after taking the test once; and (3) a control group that did not receive coaching. ATCSs and researchers familiar with the AT-SAT battery developed a 1-day coaching class, which provided participants with an overview of each test, sample test items, and specific test-taking strategies. Coaching always took place on the day prior to test administration. Each group of subjects took the AT-SAT battery a total of 3 times, with 4 weeks between each session.

Results. Test scores were compared for each group using Analysis of Variance (ANOVA) with repeated measures. The results revealed that the composite test score, as well as scores on several of the tests that comprise the battery, were influenced by both coaching and practice. The average change in composite AT-SAT score for people who received coaching on the test was .72 SD ($p<.05$). The mean AT-SAT composite score increased by nearly a half SD (.44) due to practice. In general, performance-based tests

were affected more by both practice and coaching than were tests that required knowledge or abilities not measured by computer simulations.

As demonstrated by these results, coaching may have a large impact on the selection decisions made by an organization (e.g., FAA) that selects candidates "top down" based on rankings. In terms of implications for personnel selection decisions, 7 of the people ranked among the top 10 candidates had received coaching. Of those ranked in the top 5, only one (#5) had not received coaching. Further review of rankings revealed that the average increase in ranking for people who had been coached was 6.23, whereas the ranking for uncoached participants decreased by an average of .64. The results of this study also show that test scores improved due to repeated test administrations. The FAA will attempt to minimize these effects by maintaining test security, limiting re-take opportunities, developing parallel forms, and developing new tests as the ATCS job functions change.

2.5.5.2 AT-SAT Current Status

The AT-SAT final report was delivered to the FAA in February 1999. The final version of the battery contains 8 tests and takes approximately 6 ½ hours to complete. The FAA has contracted with a company that has testing centers in cities across the US (Sylvan Learning Centers) to administer the test to applicants. Although there is currently only one form of the AT-SAT battery, research is underway to develop parallel forms. The battery has currently been validated on en route controllers only. The longitudinal validation of the AT-SAT battery will include applicants for the terminal ATC option. The criterion measure (CBPM) was designed for en route ATCSs only, which means that a version for the terminal option must be created as part of the longitudinal validation.

2.5.6 ATCS Selection Research Tasks

Once AT-SAT becomes operational, data from testing centers, the FAA Human Resources Department, the AT Academy, PV, OJT and ATC facilities will be transmitted to CAMI as part of the selection battery's longitudinal validation. Applicant performance will be tracked throughout training and placement so that the predictive validity of AT-SAT can be assessed. CAMI is currently developing parallel forms of the battery, as well as an applicant screen that can be used prior to AT-SAT administration.

As the FAA prepares for implementation of the AT-SAT battery, CAMI is working to identify the ATCS of the future. As part of this process, CAMI will host an International Air Traffic Controller Selection Conference in June 1999. International researchers with an interest in ATCS selection have been invited to participate and share their ideas.

The AT-SAT battery will continue to play a role in the selection of ATCSs, even as the job functions change over time. The battery has been designed as a dynamic and modular test that will evolve with the ATCS job. As the job evolves and the Knowledge, Skills, Abilities, And Other characteristics

(KSAOs) of the future controller are identified, new tests that measure these KSAOs will be developed and added to the AT-SAT battery.

The research approach undertaken by CAMI to identify the ATCS of the future is based in large part on the conduct of a Strategic Job Analysis (SJA). The SJA approach is based on identification of job tasks and KSAOs required for effective performance of a job not as it is now, but as it is predicted to be in the future. CAMI researchers will attempt to identify ATC and ATM system changes and the impact these changes have on operator KSAO requirements. The SJA will also address continuous workflow aspects of the job and will incorporate teamwork dimensions. As part of this research, new tests will be designed or adapted to meet the new KSAO requirements and alternative validation approaches will be investigated.

2.5.7 Conclusion

The FAA has developed a new computerized ATCS selection test that can be administered to applicants in their home community. This 1-day test replaces the written OPM test and the 9-week Academy screen that had been used by the FAA throughout most of the 80s and early 90s. The concurrent validation of the AT-SAT battery has recently concluded, yet implementation has been postponed due to insufficient hiring needs. This situation should change as a large number of ATCSs are expected to retire in the next few years. The AT-SAT battery is a dynamic and modular test battery that can evolve as the ATCS job changes. CAMI is preparing for these changes by working co-operatively with our international colleagues and utilizing SJA methods.

2.5.8 APPENDIX A: AT-SAT V1.05 Tests

2.5.8.1 Angles

The Angles test measures the subject's ability to recognize angles. This test contains 30 multiple-choice questions and allows subjects up to eight minutes to complete them. There are two types of questions on the test. The first presents a picture of an angle and the subject chooses the correct answer of the angle (in degrees) from among four response options. The second presents a measure in degrees and the subject chooses the angle (among four response options) that represents that measure*. Total Time: 10 minutes.*

2.5.8.2 Dial Reading Test

The Dial test is designed to test the subject's ability to quickly identify and accurately read certain dials on an instrument panel. Subjects are asked to choose from one of five response items for each question about a given display. The test consists of 20 items completed over a total time of nine minutes. Individual items are self-paced against the display of time left in the test as a whole. Subjects are advised to skip difficult items and come back to them at the end of the test. The test consists of seven dials in two rows, a layout that remains constant throughout the test. Each of the seven dials contains unique flight information. *Total Time: 12 minutes.*

2.5.8.3 Analogies

The Analogies test measures the subject's ability to apply the correct rules to solve a given problem as well as their efficiency in using the available information to solve that problem. Analogies are based on words, pictures, or figures and appear in three "windows" on the same screen for a given item. Subjects use a mouse to move freely between the three windows, view the different parts of the analogy item, and select their answer. However, they can view only one window at a time. Window A presents the first part of the analogy that requires subjects to infer the underlying rule. Window B contains that second part of the analogy that requires subjects to apply the inferred rule. Finally, Window C provides subjects the opportunity to confirm their choice by selecting their answer from the available response options. The test has 57 items: 30 word analogies and 27 visual (i.e., either pictorial or figural) analogies. *Total Time: 45 minutes.*

2.5.8.4 Applied Math

This test contains 30 multiple-choice questions and allows subjects up to 21 minutes to complete them. The test presents five practice questions before the test begins. Questions such as the following are contained on the test:

A plane has flown for 3 hours with a ground speed of 210 knots. How far did the plane travel?

These questions require the subject to be able to factor in such things as time and distance in order to identify the correct answer from among the four answer choices. *Total Time: 30 minutes.*

2.5.8.5 Scan

In the scan test, subjects monitor a field that contains discrete objects (called data blocks) which are moving in different directions. Data blocks appear in the field at random, travel in a straight line for a short amount of time, then disappear. During the test, the subject sees a blue field that fills the screen, with the exception of a one-inch white bar at the bottom. In this field, up to 12 green data blocks may be present. The data blocks each contain two lines of letters and numbers separated by a horizontal line. The upper line is the identifier and begins with a letter followed by a two-digit number. The lower line contains a three-digit number. Subjects are scored on the speed with which they notice and respond to the data blocks that have a number on the lower line outside a specified range. Throughout the test, this range is displayed at the bottom of the screen (e.g., 360-710). To "respond" to a data block, the subject types the two-digit number from the upper line of the block (ignoring the letter that precedes it), then presses "enter." *Total Time: 18 minutes.*

2.5.8.6 Air Traffic Scenarios Test

This is a LFS of an ATC radar screen that is updated every seven seconds. The goal is to maintain separation and control of a varying number of simulated aircraft (represented as data blocks) within your designated airspace as efficiently as possible. Aircraft in flight can pass through the airspace or land at one of two airports within the airspace. Each aircraft indicates its present heading, speed, and altitude via its data block. There are eight different headings representing 45 degree increments, three different speed levels (slow, moderate, fast), and four different altitude levels (1=lowest and 4=highest). Separation and control is achieved by communicating and co-ordinating with each aircraft by using the computer mouse to click on the data block representing each aircraft and providing instructions such as heading, speed, or altitude. *Total Time: 95 minutes.*

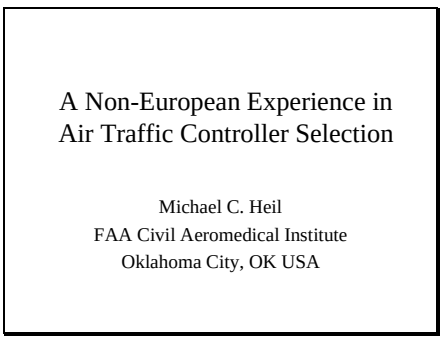
2.5.8.7 Letter Factory Test

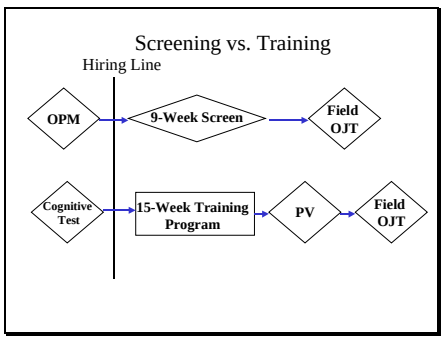
This test simulates a factory assembly line that manufactures only four letters of the alphabet (A, B, C, and D) in one of three colors. The test has 18 sections and requires that subjects use a mouse to perform multiple and often concurrent tasks. Each test section begins with letters appearing at the tops of the conveyor belts moving down toward the loading area. Based on those letters, subjects immediately begin selecting and moving boxes to the loading area to provide just the right number and color of boxes to correctly place all letters. Other tasks subjects perform during the simulated factory settings include: (1) picking up letters of various colors, (2) ordering new boxes when supplies become low, and (3) calling Quality Control when defective letters appear. Each section lasts between 30 seconds and 2 ½ minutes. *Total Time: 91 minutes.*

2.5.8.8 Experiences Questionnaire (EQ)

This is a personality test measuring such things as decisiveness, concentration, and flexibility. Subjects are presented with statements about experiences they may have encountered and asked to record the degree to which this statement is true. *Total Time: 36 minutes.*

2.5.9 Some of the Slides Used During the Presentation

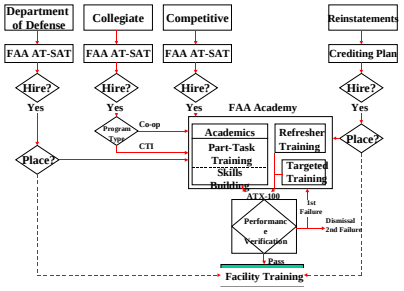




AT-SAT

- **Air Traffic Selection and Training program**
- **Computer-administered ATCS aptitude test battery**
  - Pre-hire selection test battery
  - Assesses job-relevant aptitudes/abilities
- **Developed through**
  - Job analysis (January, 1995)
  - Predictor & criterion development (1996-97)
  - Concurrent, criterion-related validation study (1997-98)

Multi-Path Hiring and Training Model



AT-SAT KSAOs

Sample KSAOs	AT-SAT Beta	AT-SAT v1.0
• Prioritization		
• Tolerance for high intensity		
• Composure		
• Planning	Sound	Scan
• Execution	Scan	Dial reading
• Thinking ahead	Dial reading	Angles
• Taking charge	Angles	Applied
• Reasoning	Planes	math
• Decisiveness	Applied math	EQ
• Problem solving	EQ	Analogies
• Short-term memory	Analogies	Letter factory
• Visualization	Letter factory	AT scenario
• Working cooperatively	AT scenario	
• Numeric ability	Time wall/ Pattern recognition	
• Angles	Memory	
• Movement detection		

AT-SAT Concurrent Criterion-Related Validation

• Administer AT-SAT beta to FPL en route ATCSs

• Collect criterion data for participants
  a) Peer and Supervisor ratings
  b) Computer Based Performance Measure (CBPM)

• Fly 100 participants to OKC for hi-fidelity simulations

Summary of Concurrent Validation

• 1200 participants

• Identified 8 tests to remain in the battery

• Validity coefficient: 0.76

• Results of High-Fidelity support validity of CBPM

AT-SAT Version 1.05

• Computer Administered Selection Battery

• Eight Tests

• Approximately 6 hours in length

Scan
Dial Reading
Angles
Applied Math
EQ
Analogies
Letter Factory
AT Scenario

Coaching & practice overview

Objectives

• Determine if repeated test taking improves test scores

• Determine if coaching improves test scores

• Identify specific tests within the AT-SAT battery that are most susceptible to practice and coaching effects

• Determine extent to which practice and coaching effects might impact hiring decisions

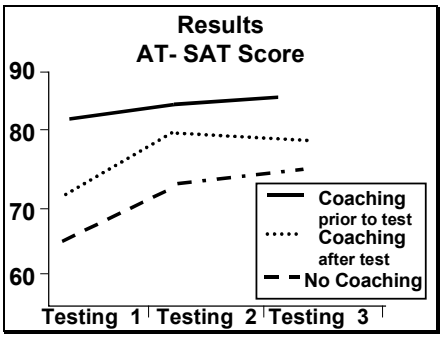
Coaching Protocol

- Developed by Air Traffic Control Instructors and CAMI Researchers familiar with the AT-SAT battery
- One-day (6 hr.) training presented to research participants via Microsoft PowerPoint
- Facilitated by CAMI Researchers
- Provided: Overview of each test
  Sample items
  Strategies

Testing Schedule:

Group	Treatment
Coaching Prior to testing	Coach→Test1→Test2→Test3
Coaching After Testing	Test1→Coach→Test2→Test3
Control	Test1→Test2→Test3

* Coaching always occurred the day before the next testing session
* All test sessions were 3 weeks apart



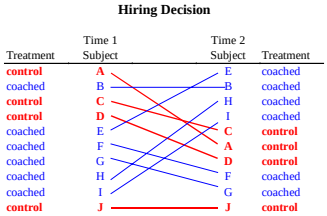
Impact on Hiring Decisions:

- Time 1 AT-SAT scores were rank-ordered for all participants who had not received coaching
- Half of these people then received coaching prior to Time 2 testing
- Time 2 AT-SAT scores were then rank-ordered and compared to Time 1 rankings
- Of the top 5 people ranked in the Time 2, only one had not been coached
- Average increase in ranking for people who had been coached=6.23; Average for uncoached=.64

Scores of Top 10 Subjects at Time 1:

Subject	Score 1	Treatment	Score 2	Score Diff
A	95.50	control	95.71	0.21
B	93.42	coached	99.91	6.49
C	92.77	control	96.85	4.08
D	89.84	control	95.47	5.63
E	89.59	coached	100.00	10.41
F	89.50	coached	94.51	5.01
G	89.34	coached	94.44	5.10
H	86.85	coached	97.10	10.25
I	85.79	coached	96.86	11.07
J	85.59	control	87.53	1.94

Change in Rank Order of Top 10



Practice and Coaching Conclusions

- AT-SAT scores are susceptible to the effects of both practice and coaching
- Coaching has the greatest effect on Experience Questionnaire scores
- Coaching also impacts the ranking of job candidates
- Scenario-based skill tests show the largest practice effect

FAA Steps to Minimize Effects of Practice and Coaching on AT-SAT Score

- Maintain test security
- Limit opportunities to re-take the test
- Develop parallel forms
- Monitor applicant performance on susceptible tests
- Develop and insert new tests as the job evolves

AT-SAT current status

- **Final report delivered February 1999 for FAA review**
  - 8 tests
  - About 6.5 hours
- **Single form for each test**
- **Criterion for en route only**
- **Pending implementation in FY2000**
- **Issues**
  - Parallel forms
  - Longitudinal validation

AT-SAT follow-up

- **Evaluate technical operating & psychometric characteristics of battery based on applicant data**
  - Pass rates, differential prediction, DIF
  - Predictive validity
  - Generalizability
  - Utility
- **Enhance and improve test battery**
  - Parallel forms for test security
  - Effects of coaching and practice
  - Revise existing and develop new tests for FFP1, future CONOPS, modernized NAS

ATCS selection research tasks

- Longitudinal validation
- Parallel form development
- Applicant biodata screen
- International Air Traffic Controller Selection Conference (June 1999)
- New tests

ATCS selection research tasks

- Develop training performance measures
- Develop longitudinal database to support validation
- Extend CBPM to terminal radar and cab
- Implement field performance measures for research purposes only
- Evaluate AT-SAT technical operating characteristics with applicant data

Future ATCS Selection: Research Approach

- Develop strategic job analysis (SJA) methods
- Apply to ATC/M systems as they are developed
- Identify new or changed ATCS KSAO requirements

Desired Characteristics of SJA

- Identify ATC/M system changes
- And their impacts on operator KSAO requirements
- Address continuous process/ workflow aspects of job
- Incorporate “team-work” dimensions
- Flexible “tool kit” for practitioners

SJA Integration

- Identify new, changed, deleted KSAO requirements with strategic job analysis methods
- Design or adapt tests and criteria for those requirements
- Investigate alternative validation approaches

2.6 The Consequences of Future ATM Systems for Air Traffic Controller Selection and Training (CAST), by Mr. Martin Cox, EASAMS Defence Consultancy, Marconi Electronic Systems Ltd., Frimley, Camberley, Surrey, UK.

2.6.1 Abstract

This paper describes research carried out as part of the CAST project. CAST is a Forth Framework project addressing the impact of technological advances in future systems on selection and training of ATCOs. A vital precursor to the development of potential future selection and training programmes was a clear understanding of the tasks ATCOs are likely to carry out in the future. A description of the future controller was generated within CAST to achieve this. This description was based on an understanding of the tasks performed today, and the probable impact of future systems on these tasks. A set of future tasks was identified, together with the skills, abilities, and information requirements required to support their performance.

2.6.2 Introduction

Increasing automation in ATM is already beginning to impinge on the tasks of the ATCO throughout the ECAC area. For example, Short Term Conflict Alert (STCA) is now used widely to support controllers as a “safety net”. For the foreseeable future, ATM will see further use of automation, typically to support the role of the controller, rather than replace him/her. Good system design, incorporating principles such as Human-Centred Automation (HCA) will help to optimise the use of future systems for controllers. However, there will undoubtedly be changes to both the overall roles of the controllers, and at a lower level, to the tasks they will be required to carry out as part of their duties. If tasks change, it is clear that the skills, abilities and knowledge needed to perform these tasks will also change. Thus, the selection of controllers in the future must reflect these changes.

The CAST Project was carried out under the European Commission’s Forth Framework programme to address the impact of technological advances in future systems on selection and training of ATCOs. The overall objective of the CAST project was the identification of consequences for controller selection and training in the future ATC environment (up to 2015). This was based on the move to new working practices due to the new functions and system automation strategies. CAST aimed to provide a set of requirements for selection of future ATCOs and guidelines for *ab initio* training for future ATCOs and transition training for current ATCOs.

As a vital precursor to fulfilling the overall objectives of CAST, it was necessary to carry out an inventory of current and future ATM systems, current controller tasks, and current selection and training processes. On the basis of this inventory, significant transition issues were highlighted which formed the basis of the remainder of the project. Subsequently, future controller tasks and the skills, abilities and knowledge associated with these

tasks were identified. The premise made was that it is impossible to identify future selection requirements without understanding the roles of the future controller and the demands made of him.

2.6.3 Approach Taken

Figure 1 depicts the information related to the transition process, which was needed to identify the consequences on future selection and training. The content of both current and future ATCO selection and training is determined by the ATM system and concept itself, the ATCO tasks that need to be performed, and the ATCO skills, knowledge and abilities that are needed to perform the tasks. It should be noted that the controllers' tasks, skills, knowledge and abilities must be seen as a part of the overall ATM system. Information that was already available is coloured white in the diagram. Thus all information regarding current ATM is available from literature and other projects. Further, information is available on future ATM systems and concepts. From this, transition issues from current to future systems can be identified.

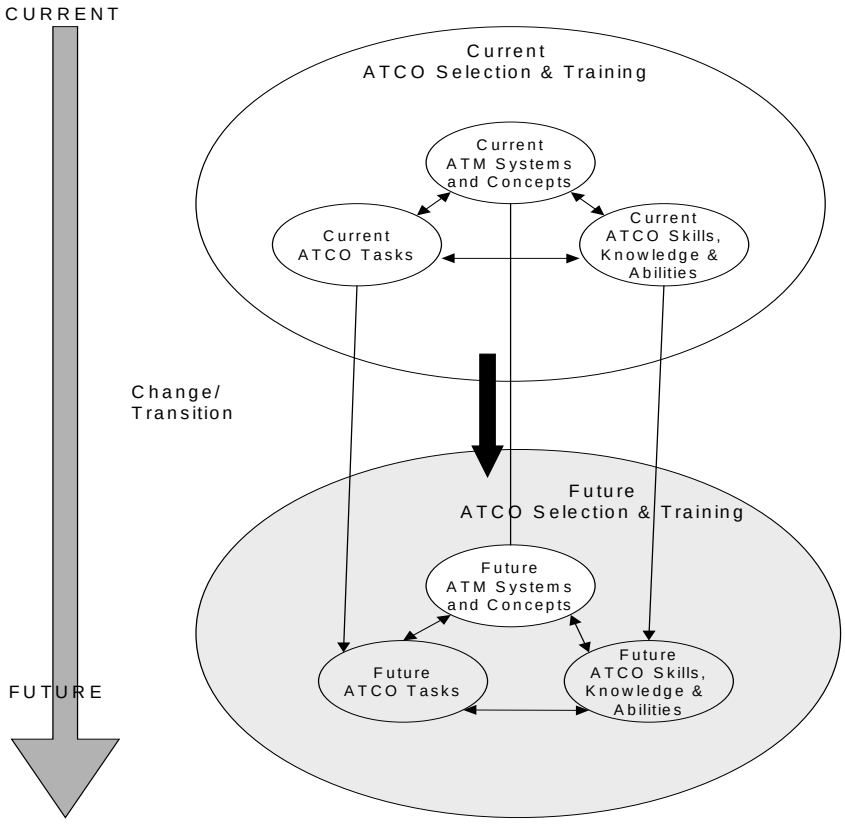


Figure 1: Information needed for identification of future ATCO selection and training consequences.

Information that had to be derived through analysis is coloured grey in the diagram. The description of the future controller tasks was based on an analysis of the future ATM systems to highlight the changes these will bring about for the controller. Typical examples included:

- improved safety nets and additional support tools;
- route structure optimisation (including reduced vertical separation minima);
- initial use of free-routing in upper airspace;
- enhanced conflict prediction and trajectory planning;
- integrated arrivals and departures management;
- use of computer tools for sequencing;
- delegation of some functions to aircraft.

Human factors expertise was combined with input from operational ATCOs to pinpoint the likely impact of these changes on controllers tasks in the future. In order to elicit information relating to probable future tasks from controllers, a series of cognitive walkthroughs was carried out. Seamster (1997) defines cognitive walkthroughs as:

"A means of analysing a task or user interface through exploratory learning. The user learns how to use the interface by exploring various features and functions, and measures of the efficiency of the human-system interaction (e.g. ease of use, number of errors made) are obtained. Verbal reports from users as they use the system or perform the task may also be obtained."

Thus cognitive walkthroughs are a relatively simple, yet effective method for eliciting information from SMEs, and are especially effective for systems that are still under development where the SME is exploring and testing its features. The analyst can rely on simple paper and pencil representations of the proposed system (e.g. descriptions or storyboards), or any computer-based prototypes that are available, taking each controller through the steps that are involved in its use. The cognitive activities of the controller can also be probed as he explores the system. In this study, the Programme for Harmonised ATM Research in EUROCONTROL (PHARE) was used as the basis for the majority of the walkthroughs. The advantages of PHARE were that there are good prototypes available to exemplify system use to controllers, and a number of controllers have participated in early trials of the system concept and tools. It is considered that the cognitive walkthroughs that were accomplished produced a rich source of data. The resulting data were subjected to a cognitive task analysis in order to distil the overall impact of future automation in ATM. This process allowed a logical structuring of the data into the following areas:

- the objective of the new or revised future task;
- details of the potential level of automation associated with the task;
- the anticipated method of support tool usage;
- possible effect on manual procedures;
- key differences between present situation and future scenario;
- significant, specific knowledge required to carry out task;
- focus – centre of interest (aircraft/aircraft pairs, part/whole sector, etc.);
- interaction – contact with other ATCOs, pilots (reason, media, frequency).

Each new or revised task highlighted has associated skill and knowledge requirements. These in turn impact on the abilities and personal attributes that a controller might need in the future. To capture these, the cognitive task analysis data was assessed within a model designed to highlight abilities, personal attributes and requisite knowledge - the “Cognitive Competencies Model (COROM). This model uses various processes to extract from data the competencies possessed by “experts”. This helps to show how experts organise mentally the knowledge needed to perform tasks and what skills they use to employ this knowledge. This permits ultimately a “profile” of an expert to be generated, indicating likely abilities and personal attributes.

2.6.4 Findings – General Observations

It was noted in the introduction to this paper that for the foreseeable future, ATM will see further use of automation, typically to support the role of the controller as demands on airspace capacity potentially increase his/her workload. Generally speaking, with knowledge of previous changes in ATM, it is possible to predict that some tasks carried out by controllers may:

- remain essentially the same;
- change subtly;
- change significantly;
- be replaced by one or more new tasks;
- vanish.

In view of the predicted increase in technology in the ATM system, it is clear that some tasks carried out by controllers may:

I. continue to be carried out by the ATCO but with the support of computer assistance;

II. cease to be carried out by the ATCO, and carried out by an automated agent instead.

It is possible that the strengths of computerised systems may be used beneficially in ATM in many ways, such as:

- relieving the controller of nuisance housekeeping activities;
- increasing flexibility of operations and permit control of more complex systems;
- permitting certain tasks to be carried out more rapidly, and with increased accuracy.

Potentially automation may require the controller to carry out a number of new tasks such as monitoring the automation, integrating multiple information sources, diagnosing faults, and processing system-generated advice (from expert systems and artificial intelligence).

Automation may change the way controllers think and behave. This means that controllers may potentially not need to use many of the skills they use routinely today, as the automated support relieves them of certain tasks. Potentially, basic skills may atrophy or be lost. However, the controller must

retain the ability to recover safely should his/her automated tools not be capable of handling a certain situation, or if they fail. Other critical issues associated with increased automation in ATM that must be considered are:

- the requirement to relinquish control of tasks may leave the controller without a meaningful role to play;
- the controller may regard the automation as threatening to his authority or control;
- the controller may feel that the automation is in control, rather than a tool to be used.

2.6.4.1 Findings – Tasks and Skills

The emphasis on cognitive tasks in ATM lead to the generation of a framework within which future tasks could be couched. This was based on task and skill categories, namely:

- Anticipation or Planning;
- Situation Awareness;
- Monitoring;
- Detection;
- Evaluation;
- Resolution;
- Communication;
- Verification;
- Decision Making.

Within this framework, more than 20 future tasks that controllers are likely to perform were identified. Table 1 gives a brief indication of these tasks, and the considerations associated with the controllers' future performance of them.

Table 1: Indication of potential future tasks in ATM and considerations for task performance

Task / Task Aspect	Future Considerations
Anticipation / Planning	
Differentiate between actual ATC situation and predicted state.	System will show both present and projected ATC situations.
Gauge confidence in computer-generated plan.	A plan may be computer-generated, controller needs information on how planned was conceived and its reliability.
Commit planned route for aircraft to memory.	As controllers may not directly formulate plan, they will have to ensure that they are able to commit the plan to memory.
Situation Awareness	
Build up and maintain situation awareness using computer assistance.	New tasks necessary to ensure ATCOs can maintain situation awareness with the aid of the facilities available to them.
Ensure situational awareness does not fall below a critical level.	Tools may make it harder to maintain an acceptable level of situation awareness. New tasks must address this.
Seek possible alternatives to computer-generated projections or solutions.	System may generate a number of alternatives for controller to select from.
Maintain awareness of what system is doing.	The controller must recognise and understand the activities of the various computer tools and other facilities.
Maintain awareness of system mode.	Two or more modes of system operation may be possible - the controller must select and adapt to the mode.
Monitoring	
Maintain “global” perspective of the sector.	The controller may need to take a wider perspective, which includes monitoring the system tools.
Monitor for system faults.	It will be very important for the controller to monitor the system to ascertain its integrity.
Ensure visual channel does not become overloaded.	The controllers must manage their activities to make sure that they can take in all visual information.
Detection	
Detection of conflicts in the medium-term.	The system will give the controller greater appreciation of projected medium-term conflicts.
Manage track deviations detected by system.	The system is likely to draw the controllers’ attention to deviations - they must then be able to act appropriately.
Evaluation	
Evaluate ATC situation based on system-processed information.	The system will provide processed information.
Resolution	
Select conflict resolution alternatives with the assistance of system tools.	System tools will aid the controller in this important task.
Communication	
Seek source of information presented automatically by system.	A new task will be required to understand the basis for system-generated information.
Manage electronic message exchange (between controllers and between controllers and pilots).	Reliance on interaction with interface using mouse and keyboard.
Ensure rapid, unambiguous communication in emergency situations.	Controller may have to switch from electronic to verbal communication.
Ensure data-linked message has been received accurately by pilot.	Controller must obtain satisfactory acknowledgement from the aircraft.
Verification	
Obtain information on acceptability of plan and actions from computer tools.	Verification can be obtained to a large degree by inspection of computer tools.
Decision Making	
Ensure that controller decision making ability is not prejudiced by manual reversion.	If the automation is involved in the control process, the controller must be able to revert to manual operations if required.
Take account of system-generated information when making decisions.	Controller must integrate all information that the system generates.
Decide when and how to use computer assistance.	Management tasks associated with use of computer tools.
Consider mode of operation.	The controller must decide the optimum mode of operation.

2.6.4.2 Findings – Controller Profile

The results of the analysis using the COROM model was grouped into four areas:

I. Intellectual Processes;
II. Reference Knowledge;
III. Relational Interaction;
IV. Relation to Time and Space.

Table 2 summarises the findings of the analysis, describing the way controllers are likely to work, the information they will use, and the associated abilities.

Table 2: Future controller profile in terms of the findings of the COROM analysis

Profile Aspect	Comments
Intellectual Processes	
Use of complex procedures diminishes	System internalises much information that controller uses currently.
Less "direct" involvement	Both in use of procedures and practice of tasks.
Controllers still require expertise	For example, ability to select between system-generated plans or proposals.
Reference Knowledge	
Maintain basic ATC knowledge	However, depth of knowledge may not be as great.
Understand tools	What computer support tools are available, what they are for, what they can do and what they cannot do.
Relational Interaction	
Less frequent interaction	Direct interaction between controllers replaced by electronic communication. Datalink changes way controllers interact with pilots.
Relation to Time and Space	
Controller works within a longer time and space scale	Planning horizon shifted: fewer short-term decisions, except when problems with automation or in emergencies.
Ability to manage system is key	Gradual transition from controlling to managing aircraft.

Thus in summary, cognitive abilities remain the most important of the ability requirements for controllers. This may result in subtle differences to the desired personality attributes sought for future controllers. As noted in Table 2, in future ATM, there may be less concrete "involvement" for the controller in assessing the ongoing situation. However, there seems little contention that the controller will retain the overall decision-making task. Thus, it is speculated that there ought to be sufficient concrete involvement for this personality attribute to still be sought in potential future controllers.

Several SMEs interviewed during this study considered that the following traits would still be required by controllers in the future:

- conscientiousness (perseverance, thoroughness, etc.);
- neuroticism (steadiness, emotional stability, etc.);
- extraversion (sociability, energy).

It is possible that in the future, aspects of temperament such as openness to new ideas and desire to learn new skills by using new technology may be important. However, it can be argued that controllers have always had to be adaptable, so that this is in fact nothing new. Giving these aspects greater prominence during selection may be desirable.

2.6.5 Summary

The results highlighted in excess of twenty areas where future tasks of controllers are likely to change. The majority of these changes appear to arise because of the use of increased automation in operational ATM. In the discussions of task changes, this was shown to be due to:

- a change in the allocation of function between person and machine (i.e. a computer now performs some or all of a task currently carried out by a controller);
- the use of computer-assistance to extend the abilities of the controller (i.e. the controller is still responsible for the task, but will routinely use computer-assistance in the future);
- a shift in responsibilities for various functions (i.e. the move to free flight in which the controllers' current functions are transferred to the pilot and aircraft).

Some predicted future tasks are likely to be of critical importance to the overall success of future ATM. For instance, tasks associated with the controllers' ability to maintain situation awareness (despite more sparse information due to computer intervention) will impinge on his/her ability to cope with abnormal or emergencies that are beyond the capabilities of the automation. It is these tasks (and the associated skills that are likely to be the focus of future selection and training issues).

Predicted future skills of controllers were analysed. The information that formed the basis of the skills analysis was derived from the cognitive task analyses carried out. The key findings of the skills analysis indicates that the controller:

- is likely to become more passive - having less direct input to the control activities;
- will get less practice in the use of various skills, or must practice these in other ways;
- may not be so aware of the global context of his/her sector - focusing instead on small areas;
- must be able to intervene appropriately when this becomes necessary;
- must be able to understand the behaviour and workings of the facilities that are in place to support him/her.

By 2015, there may be relatively few changes to the controllers' tasks, and computer-support may be far from all-encompassing. However, it became clear from discussions with controllers during this study that the impact upon controllers skills are likely to be great.

2.6.6 Reference:

Seamster, T. L. (1997) *Applied cognitive task analysis in aviation*. Aldershot, England; Brookfield, Vt.: Avebury Aviation.

2.6.7 Some of the Slides Used During the Presentation

The Consequences of Future ATM Systems for Air Traffic Controller Selection and Training

Presentation to The First EUROCONTROL Selection Seminar

Martin Cox
- Marconi Electronic Systems Ltd.

MARCONI ELECTRONIC SYSTEMS

Objectives

- To highlight in as much detail as possible, the consequences of **future ATM systems** for the **air traffic controller**
- To indicate areas where those responsible for **selection and training of controllers** must reassess their **methods**

The Issues

- What are future ATM systems?
- What are the principles behind them?
- How do controllers work at present?
- What will be the impact of working with automation?
- Do we need to select different controllers in the future?
- Do we need to adapt selection and training?

Future ATM Systems

- Improved safety nets
- Enhanced tools: e.g. conflict prediction and trajectory planning
- Route structure optimisation: e.g. RVSM
- Integrated arrivals and departures management
- Free-route airspace and operations
- Autonomous aircraft operations?

Design Principles

- Increased automation
- More flexibility
- Different awareness
- Collaborative decision making

Automation

- Human-centred design
- Tools enhance skills and abilities of controllers
  - Planning, monitoring, conflict detection and resolution
- Datalink
- Larger planning horizon
- BUT - automation unlikely to be uniform

Flexibility

- Use of airspace
- Flexibility regarding work responsibility between:
  - controllers
  - controller and pilot
  - controller and system

Awareness

- System / automation / mode awareness
- Self awareness / workload

Decision Making

- Information sharing
- More co-operation with computer and human in air and on ground
- Team = controllers, pilots, aircraft system and ground systems
- "Cognitive Teamwork"

Present Tasks, Roles, etc.

Understanding present tasks and roles

Identification and description of probable future tasks

Generation of a profile of the future controller

Future Tasks

The Main Issues

- Why will tasks change?
- How might tasks change?
- The effects of automation

Future Tasks - Method

Tools / Operational Concepts

- Selection and training of controllers for *2010 Scenario*
- Focus on *PHARE* and *FREEDOM* concepts
  - computerised tools; electronic strips or stripless environments; datalink; pilot tools; etc.

Future Tasks - Method

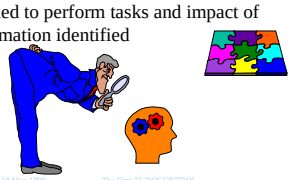
Use of Subject Matter Experts

- Experienced air traffic controllers used to obtain expert opinion
- Cognitive walkthroughs carried out using PHARE demonstration software

Future Tasks - Method

Cognitive Task Analysis

- Key cognitive tasks identified, knowledge needed to perform tasks and impact of automation identified



Impact of Automation

Impact on Tasks, Skills & Knowledge:

- Anticipation / Planning
- Situation Awareness
- Monitoring
- Detection
- Evaluation
- Resolution
- Communication
- Verification
- Decision Making

Future Tasks - Examples

Situation Awareness (SA)

Controllers will have to...

...build up and maintain SA using computer assistance

...ensure SA does not fall below a critical level

...seek possible alternatives to computer-generated projections

...maintain awareness of what system is doing

...maintain awareness of system mode

Further Examples

...gauge confidence in computer-generated plans

...monitor for system faults

...manage track deviations detected by system

...select conflict resolution alternatives with assistance of system tools

...manage electronic message exchange & rapid, unambiguous communication in emergency

Impact of Future Automation

Intellectual Processes

- Use of complex procedures diminishes
- Less "direct" involvement (both in use of procedures and practice of tasks)
- Controller still requires expertise

Reference Knowledge

- Maintain basic ATC knowledge
- Understand tools

Impact of Future Automation

Relational Interaction

- Less frequent interaction between controllers and with pilots

Relation to Time & Space

- ATCO works within a longer time and space scale
- Ability to manage

Future Profile - Findings

Summary

- Cognitive abilities remain most important of the ability requirements
- Subtle changes to desired personality attributes
- Demographic impact likely to be minor

Future Controllers...

..."manage" aircraft

...will be supported by computer assistance, extending their capabilities

...continue to work within a clearly defined role (i.e. TMA, en route, Free Flight?)

...may become more passive

...may get less on-the-job practice in the use of various skills

Future Controllers...

...may not be aware of the global context of their airspace - focus on smaller elements

...must be able to intervene appropriately when this becomes necessary

...must be able to understand the behaviour and characteristics of facilities introduced to support them

Different Controllers?

- Some changes to overall role of controllers
- Changes to allocation of function
- Extend the abilities of the controller
- Shift in responsibilities

Controller does not need to be very different

Selection and Training…

… should recognise increased use of automation (impact on role and use of technology)

… should continue to stress basic skills

… should address limits of automation

… should consider controller motivation

3. OPEN FORUM PRESENTATIONS

3.1 The Datalink Study Conducted by the DFS and their Finding on Future ATC Selection, by Ms. Inez Deuchert, DFS, Germany.

In order to get a first impression on future requirements for *ab initio* controller selection as well as on requirements for transition training issues, a simulation study was conducted. As it is not quite clear yet, what systems will be used in the future and to what extent, the datalink was chosen as a system with high probability of implementation. Basis of the simulation was the Advances Functional Simulator (AFS) of DFS and an EATCHIP III platform provided by EUROCONTROL.

To cover both, the issues relevant for *ab initio* selection and for transition training for validated controllers, the sample comprised of trainee controllers at the OJT phase and instructors from the DFS Academy.

To evaluate the requirements for present and future selection the “Fleishman Job Analysis Survey (FJAS)” was used in a pre and post simulation setting. In addition the “Subjective Workload Assessment Technique (SWAT)” was administered to investigate differences encountered concerning the workload. Via meta plan technique and group discussions, the subjective impressions of the participants were gathered.

Results clearly indicate that a datalink environment, as used for this study, leads to a reduction of speech and voice requirements. On the other hand, there is indication that vision and motoric requirements (e.g. “mouse handling”) will increase.

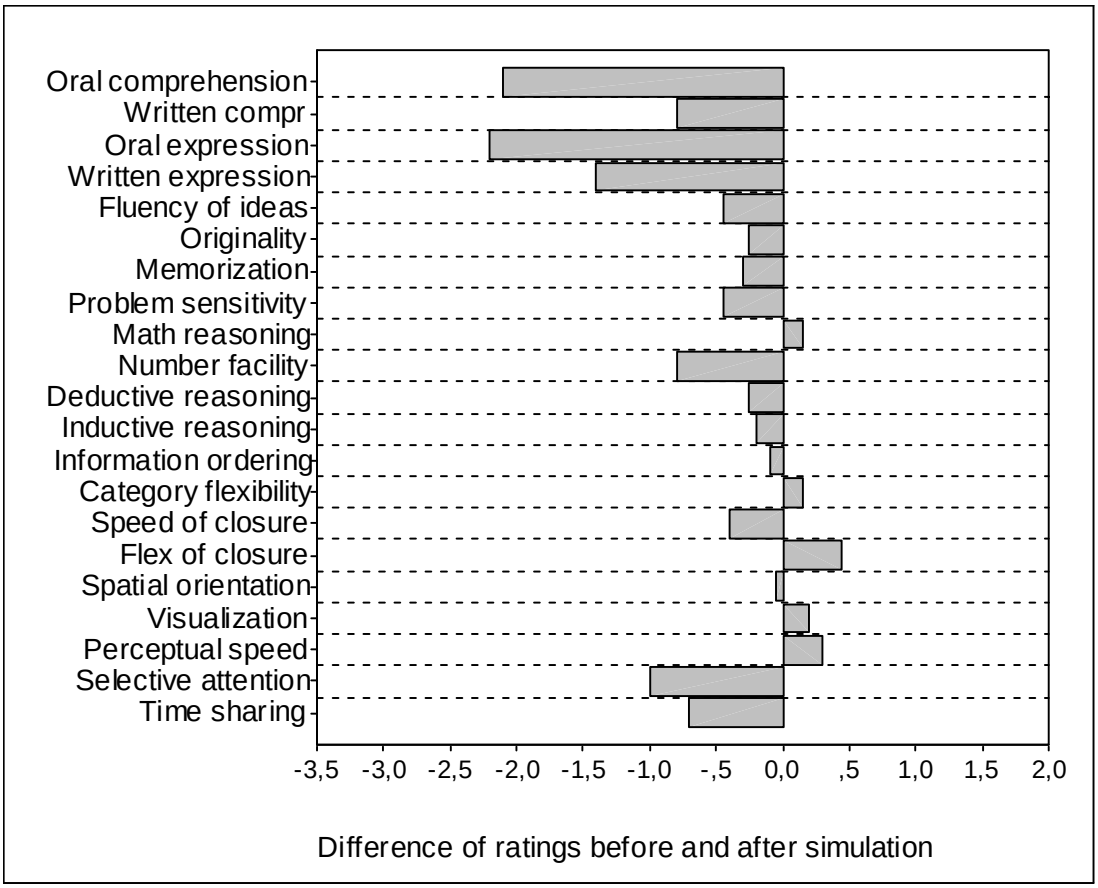
Up to this stage, the results were as expected and easy to interpret. However, it has to be taken into account that no verbal air-ground communication was actually implemented and used during the simulation. This is contrary to recommended practice for almost every datalink system.

A significant increase in psychomotor ability requirements in mouse handling was observed. However, this should not lead to an impression of emerging motoric strain. It has to be considered that prior to the simulation these requirements had been rated extremely low. The “Mouse” input device raises the level of motoric abilities to the extent that they have to be considered essential for the job of an ATCO in a datalink environment.

In contradiction to the expectation, the results concerning social/interactive scales showed significant decrease in many areas. The additional scales reflecting management issues also showed a decrease throughout. Participants in the study perceived reduced requirements concerning aspects of human interaction. However, during the discussion it became obvious that, at times, they felt insecure due to the lack of interpersonal feedback in the datalink environment.

The results concerning main cognitive abilities did not show any significant increase, as has often been quoted in literature.

Under the assumption that the requirement level for cognitive abilities is highly correlated with the cognitive demand, the notion of an increasing cognitive demand through automation is not to be considered as substantial as far as the use of datalink in ATC is concerned. On the contrary, for a variety of abilities in the cognitive domain, requirements were decreasing significantly. This included core aspects like selective attention or time sharing. Well in line with these findings was the fact that the required level of “stress resistance” also showed a significant decrease in the datalink system as used for the study.

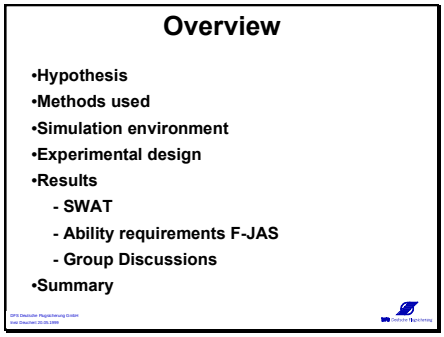


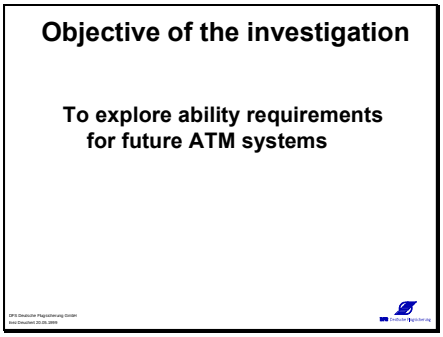
The finding of decreasing requirements concerning core abilities suggests that the application of datalink has the potential to at least smooth the workload patterns of controllers.

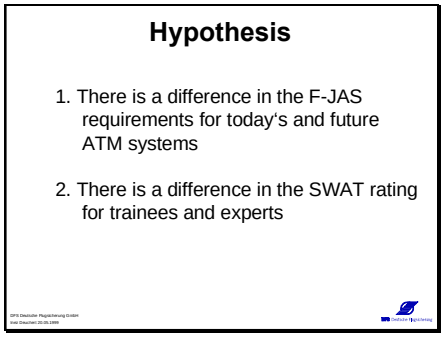
Transferring the results of the study to today’s selection system, and it’s often questioned appropriateness for future ATCO jobs, it looks like that for cognitive abilities, today’s criteria seem to be too high rather than too low. The same applies to interpersonal/social criteria. However, for this domain the implementation of some air-ground voice communication might change the picture again.

As the results are based on one study, and using only one “Future System”, they should not be used to reduce selection criteria before they are replicated by other broader studies. Even if a replication could be achieved, it has to be considered that a lot of the possible decrease in the level of required abilities will be absorbed by the increase of traffic volume which is realistically forecasted for the period of time under consideration.

3.1.1 Slides Used During the Presentation







Hypothesis (cont'd)

3. There is a difference in the individual's ideas on ability requirements between trainees and experts
4. Ability requirements for Air Traffic Controllers working in future ATM systems can be assessed by means of simulation

Methods

- Fleishman Job Analysis Survey (F-JAS)
- Subjective Workload Assessment Technique (SWAT)
- Debriefings
- Meta plan technique (group discussions)

Experimental System

- Simulator for total air navigation systems (STANS)
- EATCHIP III demonstrator HMI
- 4 Controller working positions
- Computer based training system

Simulation Features

Air/Ground
Sector/Sector
Data Link

Stripless System

Planning Tools

Conflict Alert

Traffic samples

- 4 ASIM 2000 scenarios
- Langen FIR
- different levels of traffic density
- warm-up scenario
- 2 sectors, no adjacent sectors (positive co-ordination to adjacent sectors is asumed)

Group of subjects

- 16 trainee controllers (just left academy, now OJT)
- 12 experts, acting as instructors

Design of investigation

- Baseline Measures
- CBT (2h)
- Warm-up (1h)
- Simulation scenarios (4 x 1h)
- Final F-JAS
- Debriefing
- Group discussion

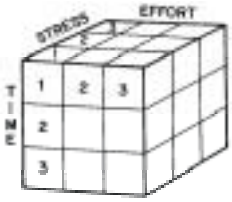
SWAT

- **S**ubjective
- **W**orkload
- **A**ssessment
- **T**echnique

Workload

- Time pressure
- Mental effort
- Emotional strain

Three Dimensional Workload Model



Individual Baseline 1-1-1

•**Time:** Often have spare time. Interruptions or overlap among activities occur infrequently or not at all

•**Mental effort:** Very little conscious mental effort or concentration required. Activity is almost automatic, requiring little or no attention.

•**Stress:** Little confusion, risk, frustration or anxiety exists an can easily accommodated.

Individual Baseline 3-3-3

•**Time:** Almost never has spare time. Interruptions or overlap among activities are very frequent or occur all at the same time

•**Mental effort**: Extensive mental effort and concentration are necessary. Very complex activity requiring total attention

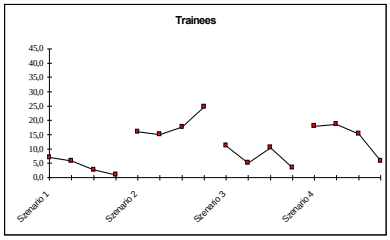
•**Stress**: High to very intense stress due to confusion, frustration or anxiety. High to extreme determination and self-control required

Measurements

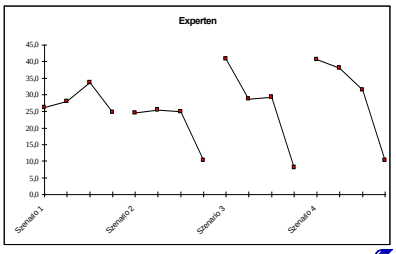
•Every 10 minutes

time pressure	☺	😐	☹
mental effort	☺	😐	☹
emotional strain	☺	😐	☹

Workload Profiles Trainees



Workload Profiles "Experts"



Ability requirements

F-JAS: Fleishman Job Analysis Survey

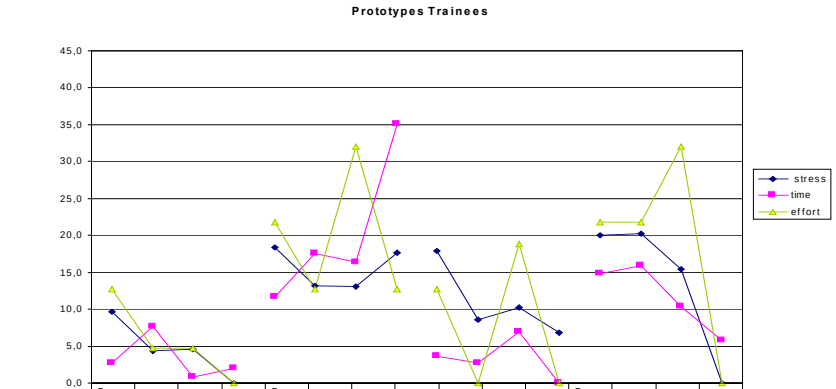
Subject matter experts are asked to:

„rate the task on the level of the ability required" (Fleishman 1992)

using well-developed rating material, providing definitions, anchored scales and examples

covering the domains of cognitive, psychomotor (physical) and sensory abilities as well as interactive/social and knowledge/skills scales

Group Ratings Trainees

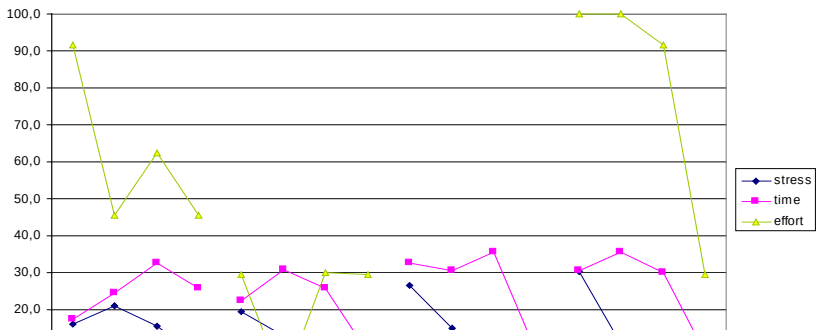


	Szenario 1				Szenario 2							Szenario 4			
stress	9,6	4,4	4,6	0,0	18,4	13,2	13,0	17,7	8,6	10,3	6,9	20,0	20,3	15,4	0,0
time	2,8	7,7	0,8	2,0	11,7	17,5	16,3	35,1	2,7	7,0	0,0	14,8	16,0	10,3	5,8
effort	12,7	4,8	4,8	0,0	21,8	12,7	32,1	12,7	0,0	18,9	0,0	21,8	21,8	32,1	0,0

DFS Deutsche Flugsicherung GmbH
Inez Deuchert 20.05.1999

DFS Deutsche Flugsicherung

Group Ratings "Experts"



	Szenario 1				Szenario 2				Szenario 3				Szenario 4			
stress	16,0	20,9	15,5	7,0	19,6	12,8	12,8	4,3	26,6	14,9	5,0	4,3	30,3	10,7	4,3	4,3
time	17,4	24,5	32,6	25,8	22,4	30,7	25,8	8,5	32,6	30,6	35,5	8,5	30,6	35,5	30,0	8,5
effort	91,5	45,5	62,3	45,5	29,5	0,0	29,9	29,5	100,0				100,0	100,0	91,5	29,5

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Inez Deuchert 20.05.1999

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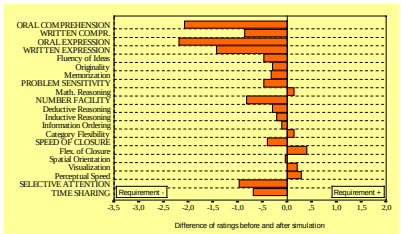
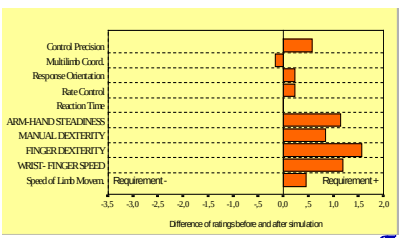
Trend for Cognitive Abilities

N=28



Trend for Psychomotor Abilities

N=28



Trend for Sensory Abilities

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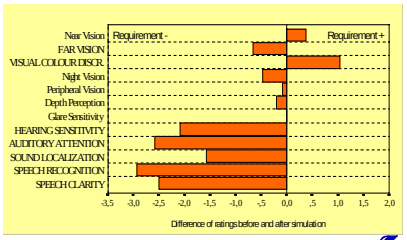
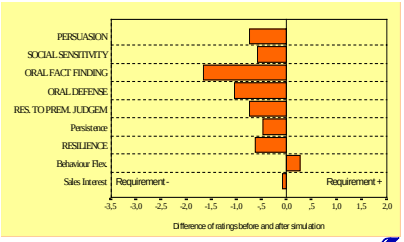


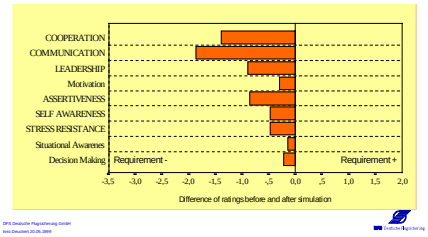
Trend for Interactive/Social Scales

N=28



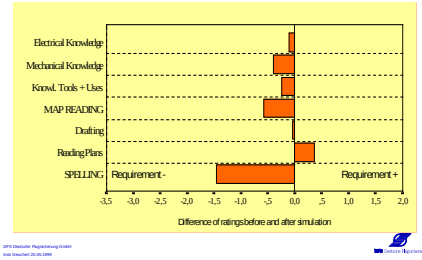
Trend for New Interactive/Social Scales

N=28



Trend for Knowledge/Skill Scales

N=28



Requirement changes

Significant Decrease

- **Oral Comprehension**
- **Written Comprehension**
- **Oral Expression**
- **Written Expression**
- **Problem Sensitivity**
- **Number Facility**
- **Speed of Closure**
- **Selective Attention**
- **Time Sharing**
- **Far Vision**
- **Hearing Sensitivity**
- **Auditory Attention**
- **Sound Localization**
- **Speech Recognition**
- **Speech Clarity**
- **Stress Resistance**

Requirement changes

Significant Increase

- Arm-Hand Steadiness
- Manual Dexterity
- Finger Dexterity
- Wrist Finger Speed
- Near Vision
- Visual Colour Discrimination

Ability requirements

Ability requirements for future ATM systems as used in this study are likely to:

- **increase** for abilities connected with screen view and mouse handling
- **decrease** for most cognitive abilities, interactive/social and skills scales
- **decrease** even for core abilities

Group Discussion

What ability will become more or less relevant with a data link system?

15 out of 42 criteria were named more than once. Only 7 were always pointing in the same direction:

more relevant:	less relevant:
+ memory for visual clues,	- strip marking skills,
+ psychomotor skills,	- phraseology,
+ finger dexterity	- hearing sensitivity,
	- technical knowledge

Hypothesis

1. There is a difference in the F-JAS requirements for today's and future ATM systems ✓
2. There is a difference in the SWAT rating for trainees and experts ✓

Hypothesis

3. There is a difference in the individual's ideas on ability requirements between trainees and experts ✓
4. Ability requirements for Air Traffic Controllers working in future ATM systems can be assessed by means of simulation ✓

Summary

1) It is possible to use simulation to study ability requirements of future ATM systems on empirical basis
2) This study reveals a decrease in required level of core abilities for the simulated ATM system
3) Age and transition will become an issue
4) Applicants meeting today´s DFS selection criteria will be well able to cope with data link systems demand

3.2 New Standards in Psychometric Testing of ATCO Candidates - Developments in Selection Testing for AUSTRO CONTROL, by Dr. Birgit Bukasa, Kuratorium für Verkehrssicherheit, (KfV) Vienna, Austria.

3.2.1 Introduction

The KfV carries out the selection of *ab initio* trainee controllers for Austro Control since 1990. The psychological selection is part of a selection procedure consisting of the following steps (Bukasa, 1995):

1st Step: Having met the general personal requirements, like age between 19 and 25 or secondary school degree qualifying for admission to a university, the candidate has to undergo a knowledge test in geography, English and German at Austro Control followed by a personal interview for those who passed this test. The personal interview is carried out by ATCO instructors and management staff from Austro Control focussing on task specific motivation.

2nd Step: Having passed step 1, the applicant is sent to the KfV for the psychological assessment. It covers performance and personality testing as well as a personal interview and takes about 6 to 7 hours.

3rd Step: Having passed psychological selection, the candidate has to undergo a medical examination as last step of the selection procedure.

Regarding the drop out rates, 2/3 of all applicants fail in step 1, only 1/3 enter the psychological selection. Another 2/3 fail in psychological selection and only 1/3 enter the medical examination. The drop out rate due to medical reasons is nearly zero. These are quite stable qualification quota over the years (Bukasa, 1998). Therefore the current selection ratio is about 11%.

The KfV has a specific test battery for *ab initio* trainee controllers. It consists of 11 ability tests and two personality tests followed by a personal interview. Most of the tests are developed by the KfV. All tests are available in German and English. Except one questionnaire, all other tests are computer-based tests. Instruction, test phase and evaluation are automated. The tests are running on a specific hard- and software, developed also by the KfV.

It has to be noted that the KfV does not only select ATCO candidates, but also pilots and above all drivers, of course using different tests and norms. The KfV does not only have a long tradition in selection and testing but also in the development of appropriate tests and test devices for this clientele. The first generation of computer-assisted test systems was developed in the early 80s. In order to further optimise and modernise psychological testing and assessment from the psychological, technological, and administrational point of view, the KfV started to develop a new generation of computerised psychological test devices in the 90s. In the following, the main aspects of this development will be presented.

3.2.2 The Multimedia Test Device ART 2020

The ART 2020 is a multifunctional test device which allows a comprehensive performance and personality testing.

3.2.2.1 Hardware

The new test system consists of the following components or peripheries:

- two color monitors in the center of the device, the one above is 21 inches, the one below is 15 inches;
- a light pen to work on the screen below;
- a reaction panel with several colored reaction buttons, two squared buttons for multifunctional applications, and two joy sticks;
- two peripheral displays with light-emitting diodes at the left and right side of the device;
- two pedals with analogous and digital function, i.e. to make traditional reactions in the sense of yes/no answers as well as to accelerate or reduce continuously like stepping on the gas and throttle back;
- a headset for acoustical information;
- for pilot selection specific rudder pedals had been developed; for drivers a steering wheel is included.

These features are shown in Figure 1.

Ergonomic and functional aspects played a vital role for the arrangement of these components and the design of the device as a whole.

The core of the hardware concept is a two PC model with a standard network (Ethernet) for the communication and synchronisation of the two computers. Both PCs are equivalent devices (industrial standard PCs with Pentium processors) equipped with at least 16 speed compact disc read-only memory (CD-ROM), a sound board for digital and analogous sound, an analog-digital converter, and a graphic card with a resolution of at least 1024 x 768 pixels and a color depth of at least 16 bit.

Additionally, one PC (the so-called video PC) is equipped with a hardware MPEG accelerator supporting digital films. Moreover, the device is equipped with a universal data input/output board which is used as an interface to the different input sources. Thus, even by using standard computers, it is possible to provide real time measurements which is an indispensable prerequisite for psychological testing.

3.2.2.2 Software

Concerning the software, it was first decided to work with commercial standard software and second to choose Windows NT as operating system. This is in order to profit from the elaborated graphic user interface, good development tools and from further software developments, which will guarantee continuity in future developments. Programming language is C++.

3.2.2.3 Multimedia

The term “multimedia” summarises several technological innovations which are integrated in the new test device allowing the presentation of digital video in true color mode (1024 x 768 pixels) and full screen mode (like a TV). Thus, any kind of films or dynamic sequences of pictures or scenarios can be shown. Moreover, these dynamic scenarios can be combined with computer graphics, supported by any kind of sound from simple acoustic signals up to spoken words and can be linked to different input modes (buttons, pedals, joy sticks, light pen). Computer animation can be applied, too.

3.2.2.4 Improvements

Based on this hard- and software concept combined with multimedia application, a number of innovations have been realised:

3.2.2.5 Optimisation of Administration

Using Windows-NT as operating system which does not require a specific hardware, the new test device can be integrated into any data processing network of the organization. Moreover, several test devices can be linked together (up to 10 devices) and controlled resp. supervised by one remote PC. This led to a significant reduction of time and resources in test administration in daily routine testing.

Moreover, higher data integrity, much better software support, quick and reliable online software service, upgrades, data collection, etc. have been achieved which are important aspects in terms of cost savings and quality assurance, especially for larger organizations like the KfV with 9 test centers, one in each federal Austrian state.

3.2.2.6 Reality-Based Testing

Future trends in psychological assessment and testing information from different sources was put together:

- literature on new test dimensions with promising validity gains (e.g. hazard perception; Hull, 1991; Crick and McKenna, 1991) as well as new concepts of testing (e.g. computer-assisted diagnostics with complex dynamic scenarios, Funke, 1993);

- results from participation in congresses (e.g. the combination of computer and video as measuring instruments as future trends of psychological testing, Schuler, 1994) and

- experiences from the daily routine testing at the KfV resp. feedback from different users (e.g. lack of face validity).

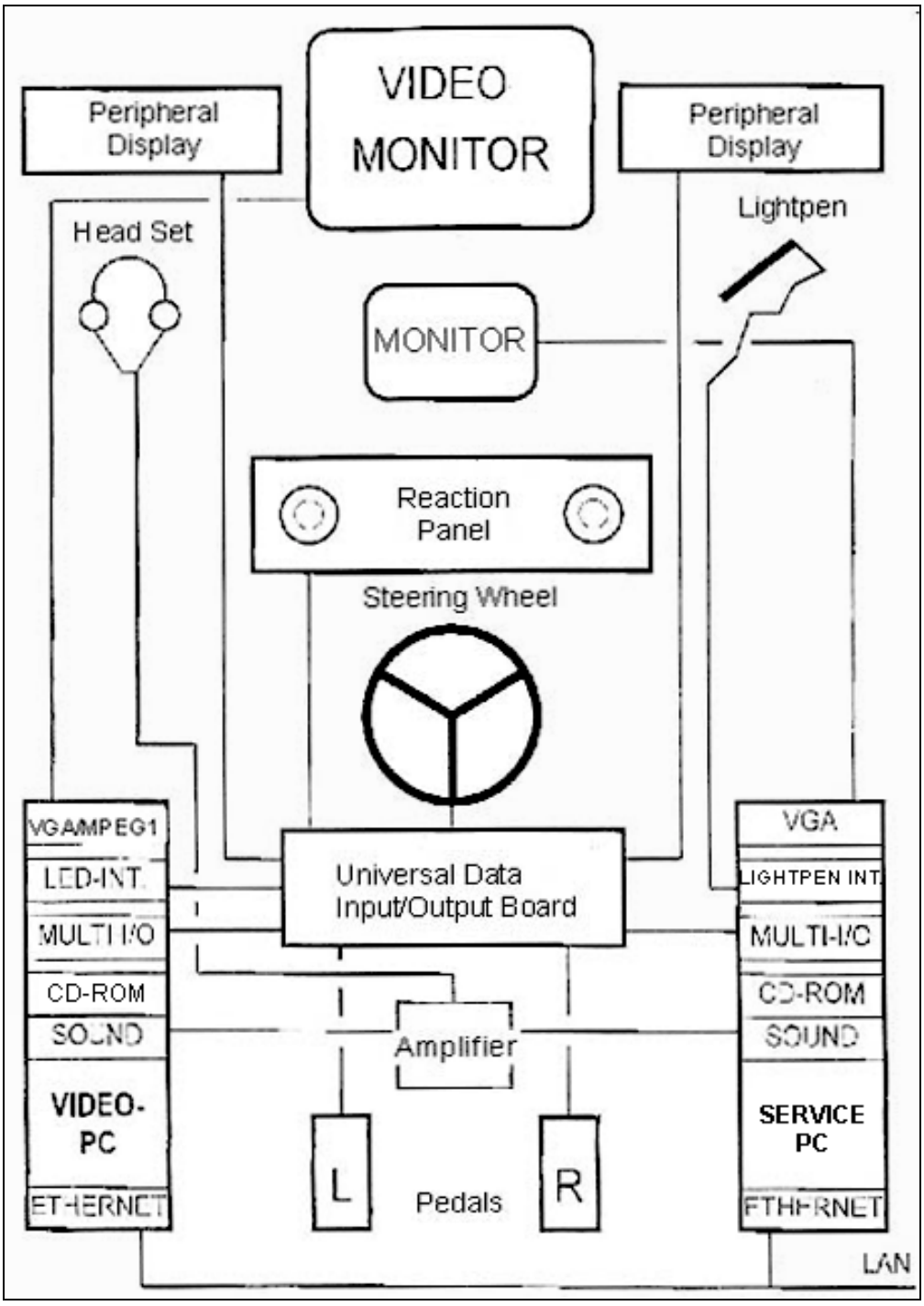


Figure 1: ART 2020 Standard – Hardware Structure

This all together resulted in the concept of reality based testing as developmental goal in the longer run.

Reality-based testing covers several aspects: more complex and/or dynamic tests, more realistic test material as well as more realistic response modes with enhanced user interaction. For example assessing the eye-hand-foot-coordination using joy-sticks and rudder pedals, or in a decision and reaction test, computer generated figures appear on the monitor during a dynamic visual environment. The reactions are to be accomplished either by using buttons, pedals, a light pen and/or joy sticks. Moreover, we are planning tests which will integrate performance and personality aspects (e.g. risk perception and estimation).

3.2.2.7 Enhanced Ergonomics and Functionality

Enhanced design of the hardware and test software was an important developmental aspect in order to reduce stress, enhance user acceptance, guarantee maximum standardisation and provide fair test procedures for all subjects. A consequent ergonomic design was realised based on principles, such as structural clarity, consistency and simplicity, clarity of presentation, practical use of acquired knowledge, e.g. high tone/light button, deep tone/dark button, start/green color, error/red color. Quantitative aspects, e.g. number of information units which are presented on the screen, as well as qualitative aspects, e.g. position of information units, use of same terms, sentences and their position. Size and color help to perceive the information due to their importance. The aim is to ease learning in the instruction phase as well as to ease handling in the instruction and test phase.

3.2.2.8 Multimedia-Assisted Test Instructions

As a matter of fact the instruction phase plays a vital role in order to get valid test results. Therefore, the approach was not only to optimise the design of the hardware and test software, but also to introduce new ways as to how to instruct testees. Thus, we developed the concept of multimedia-assisted test instructions. Multimedia-assisted test instructions refer to the concept of observational learning (Bandura, 1986) or learning by model imitation. In this respect, Teichmann (1997) used the term ‘demonstration for imitation’. Since early childhood people observe and imitate models apart from cultural and ethnical background. Later on in the professional career observational learning is an important method in different training programs. And all of you are familiar with video and life presentations of safety instructions for airline passengers.

Multimedia-assisted test instructions explain the individual task of the tests visually and acoustically while at the same time it is demonstrated on the monitor of the test device using digital video. This concept combines the advantages of both the traditional test instructor and the standardised computer-based instructions. It provides higher test fairness for people who learn in different ways, e.g. visual, acoustical (see also Kubinger’s critique of computer diagnostic, 1993). Moreover, it provides also higher test fairness from a cross-cultural point of view.

The concept of multimedia-assisted test instructions has been realised as follows:

Multimedia-assisted test instructions start with a short trailer which introduces the device to the subject giving information on the test procedure in general. At the same time relaxing music is played to reduce test stress.

Each test is then introduced by a test specific multimedia-assisted demonstration and instruction (visually and acoustically) followed by a practice phase where the subject has to give a defined number of correct reactions, answers, etc. before he or she enters the test phase.

An evaluation study on the multimedia-assisted test instructions had been carried out recently and proved a better understanding and learning of the tests, stress reducing effects and significant motivational support (Wenninger and Bukasa, 1998). The concept of multimedia-assisted test instructions will be demonstrated now.

3.2.3 Outlook

Due to the main concern of the KfV, the assessment of drivers, the developmental activities focussed on the realisation of the above mentioned innovations including the establishment of norms and doing validation studies for this group. Concerning ATCO candidates, we are going to adapt and transfer the existing test battery, taking into account the innovations provided by the possibilities of multimedia-assisted test device ART 2020.

Adaptation and transference of the ATCO tests will be finished by the end of the year followed by a first establishment of norms study with a group of ATCO tested several years before. Thus, construct validity based on correlation coefficients between the results of the former and the new test battery will be established. Studies on discriminative validity are planned. In the longer run, new test concepts for the ATCO group will be realised.

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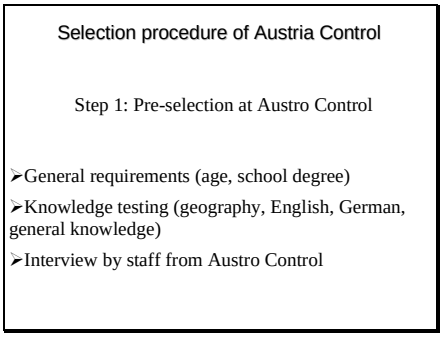
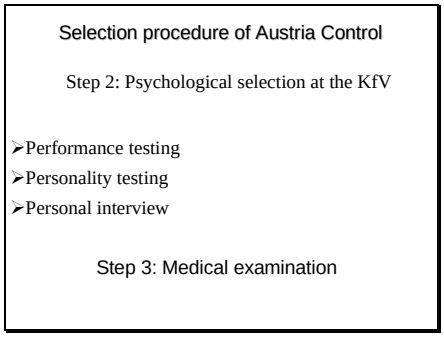
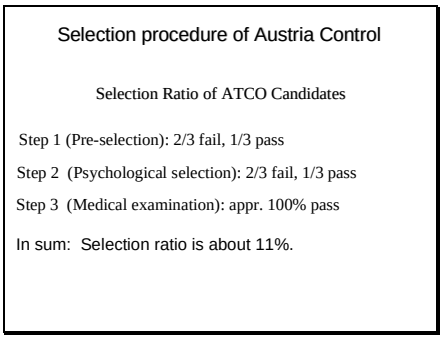
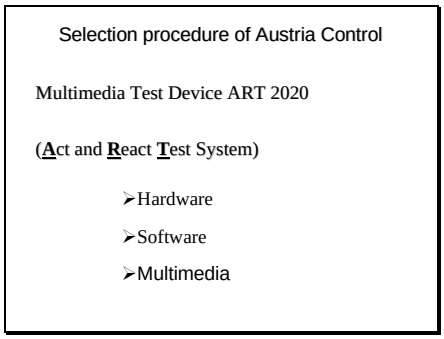
3.2.5 Slides Used During the Presentation









3.3 NATS Selection and Future Development, Selection of Student Air Traffic Controllers, by Mr. Andy Hutchinson, Recruitment Services Manager, Recruitment Services, National Air Traffic Services Ltd (NATS), UK.

3.3.1 Background

In 1983 Saville and Holdsworth Ltd. (SHL), a firm of occupational psychologists was engaged by the UK NATS to research the selection of Student ATCOs. They carried out a detailed job analysis study involving position analysis questionnaires, critical incident technique, repertory grid interviews and observation of ATCOs at work. The job analysis established a model of ATC core skills and based on this they developed a set of selection criteria and recommended tests to measure the required skills. A concurrent validation study was undertaken towards the end of 1983 on a group of experienced ATCOs, to measure the effectiveness of these criteria.

An on going predictive validation is used by Recruitment Services NATS (RS NATS) to measure the effectiveness of the components of the selection procedure. The focus of the study is on predicting Student success during training by examining whether significant relationships are present between the selection criteria and training progress.

3.3.2 Current Selection Procedure

The selection process, which has been audited and approved by the British Standards Institute under International Standards Organisation (ISO) 9000, used by RS NATS has four stages:

- Pre-selection,
- Ability Testing,
- Interactive Computer Tests,
- Interviews.

3.3.2.1 The Pre-selection Criteria are

- Be aged between 18-26 years of age. Candidates over this age limit may be considered if they have extensive aviation experience either as a military controller, civil or military assistant or pilot.
- Hold a minimum of 5 General Certificate of Secondary Education (GCSEs) at grade C or above including Maths and English.
- Have completed a period of post GCSE study, for example 2 General Certificate of Education (GCE) 'A' levels, Business and Technician Education Council (BTEC).
- Have the right to work in the UK.
- Satisfy the Authority's eyesight requirement.

The validation study has shown that age is a significant predictor of success, with similar results in the USA confirming that older applicants are less likely to succeed in training. Educational qualifications other than the number of 'O' levels have shown not to be a significant predictor of success in training.

However this does not mean that candidates with higher qualifications fail to apply. Of the candidates recently selected for training 40% were graduates, a marked increase from the previous levels.

Those applicants who meet the pre-selection criteria are invited to attend a test centre to take the ability tests, Personality questionnaire, Learning Styles questionnaire, ATC knowledge test and have a group presentation from an operational ATCO.

3.3.2.2 Ability Tests

In line with tests best practices, we provide all candidate with a practice leaflet.

The following tests are used.

3.3.2.3

Test	Measuring
- Basic Checking	Speed and accuracy of checking two sets of printed information.
- Numerical Computation	Arithmetic Computation using the four signs.
- Spatial Reasoning	Spatial visualisation, mental picture.
- Diagramming	Short-term memory, convergent thinking, complex instruction, coded information.
- Learning Styles	Measures the candidates motivation towards study and to fit Questionnairein with our learning environment.
- ATC Motivation Tests	Basic knowledge of ATC based on information provided to the candidates in our information packs, this also gives an indication of motivation. Candidates must achieve a minimum score of 60% to be invited to interview.
- Personality Questionnaire	Various personality traits.

The average scores on the cognitive tests for those candidates who are accepted onto the Scheme, place them at the 90 percentile when compared to a composite group of all graduates. Intellectually Student ATCOs equate to the top 10% of graduates in the skills that these tests measure.

The results from the most significant tests are combined together with three of the Personality scales, to produce a Stanine score which indicates the probability of success if selected for ATCO training. A cut-off figure is then applied, those above the cut-off are invited to attend the final interviews, those below are eliminated from the selection process. Data from the remaining tests is monitored as part of the process of reviewing the effectiveness of the process.

The cut-off score was originally established at 6 and above as these candidates had acceptable probability of succeeding in training. However 'top down' selection has been used from August 1991 with candidates with Stanines 10, 9, 8 7 being invited for interview provided they have achieved a motivation test score of at least 60%.

With a cut-off at 6 and above approximately 41% of the candidates passed the test stage, this has fallen to around 35% for Stanines 7 8, 9, 10. Comparison of groups of Students selected before and after the application of the Stanines score shows a relative improvement of 26% of those still on their original course, with a corresponding reduction in the proportion Terminated or Recoursed to another training course. It was expected that in line with the results of the predictive validation study application the cut-off at Stanine 7 and above would produce an increased success rate at the College. The first course comprised almost entirely of high Stanine scores started in 1992 and to date we have seen an average increase in those still on their original course of just under 5%.

The validation process for the ability tests and Personality Questionnaire is continuing and refinements to the process, and the Stanine equation will be made in the light of future results.

The process is also regularly reviewed to ensure that there are no gender or racial bias in the system. The selection of Student ATC has been equated as a best practice case study in the Commission for Racial Equality publication "Towards Fair Selection".

3.3.2.4 Interactive Computer Tests

In 1992 NATS introduced a second phase of the testing procedure with the development of computer-based tests. The development of the tests arose because the original tests did not measure the following skills:

- ability to absorb information simultaneously from multiple sources;
- ability to absorb new information whilst making decisions;
- ability to project forward using current information;
- ability to make adjustments constantly to the whole picture.

The tests were developed by SHL and trials were conducted on candidates at the interview stage and existing Students, to validate the tests, before they were used for selection of our Students. The three computer-based tests, are:

a) Sort Task

The task requires candidates to sort objects (coloured shapes and numbers) into categories by given rules. The candidate must take account of occasional messages which alter the way objects are sorted and monitor whether the object to be sorted matches a given stimulus which changes from time to time.

b) Relative Direction Task

This is a two part test, in the first the candidate is presented with a dot, an arrow and words left or right. The tasks is to say whether the word correctly describes the position of the dot relative to the arrow. The second part is similar except sometimes the arrow is shown from behind (represented by the arrow in outline) but the task is still to describe the position of the dot for someone standing in front of the display.

c) Moving Objects Task

In this test a series of objects (represented by numbers) move across the screen at constant speed in different directions. The task is to identify which if any of the objects will collide and to remove the minimum numbers of objects to prevent all collisions. In the second part of the test multiple choice arithmetic questions appear at the bottom of the screen simultaneously with the main tasks to introduce an element of multitasking.

Initial feedback from those who took the tests was very encouraging and significant correlation's with progress have been achieved for tests ‘a’ and ‘b’ which now form part of the selection process. Test ‘c’, the moving objects task has not yet shown any significant correlation, however this is due to the relatively small sample size rather than any problems with the test.

The correlation between the computer-based tests and the original paper-and-pencil tests are mainly low but generally positive. This confirms that there is sufficient independence between the computer-based tests and the existing tests to ensure that the skills being tested are not adequately measured at present.

3.3.2.5 Interviews

For those candidates who are selected for interview, a personality profile is generated by a computer "expert system" from the data collected at the testing stage and this is available at the interview. The interviews are conducted against criteria drawn from the original job analysis. There are two interviews, a technical interview conducted by an operational ATCO, and a Personnel interview. Emphasis is placed at the interview stage on the motivation for a career in ATC and previous examples of achievement orientation. The interviews follow a structured format and measure:

- Motivation/Achievement Orientation
- Reasoning Skills
- Team Skills
- Communication Skills
- Ability to Fit into a Regulated System
- Domestic Mobility
- Multitasking
- Tenacity
- Stability
- Maturity
- Aviation Focus
- Flexibility
- Integrity
- Problem Solving

3.3.3 The Future

The whole recruitment process is regularly reviewed and changes have to be made in the light of many factors. Internal factors, such as the results of the predictive validation study, the nature of the job of a controller and external factors e.g. the UK economy, changes in Education (the push towards National Vocational qualification), changes in employment legislation.

The immediate challenges that NATS Recruitment faces over the next few years are:

1. To increase the number of well qualified applicants.

2. To reduce the number of training failures at the college and hence reduce the training failure cost.

3. Respond to the future needs of the Air Traffic System in terms of the type of controller.

4. Improve the efficiency of the selection system and hence control recruitment costs.

3.3.3.1 Applicant Numbers

As can be seen from the table below, over the last few years NATS has enjoyed a healthy level of applicants. The quality of these applicants has also been reasonably good and finding the required recruitment target has not been a particular problem, that is up to now.

Application numbers

Year	1994	1995	1996	1997
Number of applicants	2209	2842	3671	3166

In the past 12 months we have seen a significant drop in the return rate of applicant forms following National Advertisement campaigns. The rate of requests for our information pack remains high but the return rate of the application forms has dropped from a steady 50% to around 30% - a loss of between 500 and 1000 candidates per advertisement. Added to this we have also seen a slight reduction in the quality of the applicants, the success rate at testing has dropped by just over 10%.

The question that faces us is, why has this occurred. It is likely that there is no one simple answer. The information pack sent to candidates has not change significantly in the last couple of years so that is unlikely to be a cause. The probable causes are:

1. Lack of awareness of the role of an ATCO.
2. Poor publicity in the recent press about ATC.
3. Uncertainty caused by the potential privatisation of NATS.
4. Claims that the UK is moving towards recession thus making those currently in employment (one of our largest sources of applicants) more cautious about placing themselves on the job market.

Clearly there is little that can be done about item 4, however item 1 to 3 can be influenced by NATS, items 3 and 4 at a more corporate level, with item 1 falling directly under the remit of Recruitment.

Recruitment is attacking the problem of awareness at several levels, firstly with the potential applicants of the future and secondly with those who provide careers advice, both in school, college and externally.

NATS has just released a CD-ROM, called “Airspace- the art and science of Air Traffic Control”. The programme which has been sent to every secondary school, college, university and careers service in the UK, describes in detail the function of NATS, and the role of ATCO, engineers and support staff.

It allows you to talk through the computer to real people performing the functions described, run through a career choosier programme to find which career in NATS is best suited and a fun interactive quiz. The CD contains sound and video clips as well as recording of real Radio Telephony (RT). There is also a printable application form on the CD to speed the application process.

Following the release of the CD the second phase of the project will be to transfer a significant parts of the CD to the internet and link it to the NATS web site. This would then allow on-line application.

To better inform the careers advisers on the opportunities in NATS, a series of regional presentations is planned at NATS airports and centres. Groups of careers advisors will be invited to attend the presentations and have a tour of the ATC facility.

It is hoped by these two strategies that the long-term careers awareness in ATC will be raised and therefore there will be an increase in the number and quality of applicants. However as stated these are long-term measures, to remedy the problem in the short-term NATS is reviewing its advertising strategy and media.

3.3.3.2 Reducing the Numbers of Failures

The cost of training failure in both financial and human terms is high. NATS continually strives to seek ways of reducing the failure rate both through its predictive validity study into its existing test system and by investigating new and alternative selection methods. Recent and proposed developments are as follows.

3.3.3.3 Increase in Checking Test Cut-off Score

Analysis of the validation study continues to show that the checking test CP7.1 has the highest correlation and training success of the ability test. The cut-off score applied to CP7.1 has therefore been raised to reflect this. The historical data indicates that this could potentially produce a relative reduction in the number of failures at the College of 28%. This in turn could lead to an overall increase of 4% in the College success rate.

3.3.3.4 “Stickability”

Evidence from the training failure revues indicated that one of the reasons for failure was the student “Stickability” i.e. when the going got tough they tended to give up. NATS in conjunction with a team of consultants “Top Team” set out to try and measure this factor. A series of group and individual exercises were

developed and were trailed on a population of 159 pre-selected students prior to the start of their college course.

Four main competencies were proposed:

"Stickability"	Workload Threshold
Character	Work to Structure.

These were then subdivided into the following individual competencies.

Overcome setbacks	Group Compatibility
Determination	Mental Agility
Confidence	Mental Capacity
Assertiveness	Effective Intelligence
Positive attitude	Task Focus
Attitude to criticism	Acceptance of Rules.

Initial analysis of the results of the trials has been disappointing with only one of the competencies "Attitude to criticism" and two of the exercises showing a significant positive correlation with training success. However, further analysis of the data will be undertaken to see if any refinements can be made to improve the predictability of the process.

3.3.3.5 Wombat-FC and Selector

In view of the predicted future trends in the development of ATM systems NATS is planning to trial some additional computer-based testing system.

The first is Wombat-FC. Developed by Aero Innovations, it is based on the pilot version of Wombat (Wombat CS). It is a test of situational awareness, tolerance and attention management.

The test consists of a main task- the Tracking task and three bonus tasks. Normally in the tracking task, the targets are tracked by the computer in an "autotrack" mode- thus allowing the candidates to attempt the bonus tasks and score more points.

However, the "autotrack" is prone to failure and occasionally lose track of a target. The candidates task is to notice the missing target and remember where it should be. The initial results of the trial will be available this time next year.

The second system is called Selector which is produced by Selector PAS, New Zealand and is a complete computer-based assessment programme, including aptitude tests and personality. It is hoped that the trial will commence shortly and that results will also be available next year.

3.3.3.6 Technical Interview

As discussed, the second stage of the NATS selection process consists of two interviews, a Technical interview and a Personnel interview. Part of the remit

of the Technical interview is to examine the candidates reasoning and decision making skills by the use of various ATC scenario questions.

In order to obtain a more structured approach to the assessment of these two criteria and improve the reliability, NATS is investigating in conjunction with external consultants Psytech Ltd the possibility of computerising the scenario questions to form a “Scenario based selection test”.

It is planned that the final version of the test will include:

- Fully automated scenarios including sound which typifying the decisions that ATCOs have to make. The scenarios will not require prior ATC knowledge and skills.
- Fully automated scoring processes.
- A replay facility of an applicants responses so that the applicants decisions can be further explored by an interviewer.

It is hoped that a pilot version of the test will be available by the latter half of this year. A concurrent validation study will be initially conducted on a group of around 50 Student ATCOs. This data will be used to refine the test and it will be followed by a larger predictive validation study.

3.3.4 Improving the Efficiency of the Selection System

As has been previously stated, a large percentage of applicants (65% plus) are eliminated at the first ability test stage either through a low ATCO equation score or a low motivation test score. This failure rate represents a considerable cost to the selection system both in terms of time and test materials, answer sheets etc. Recently analysis of the data base has shown that there is a significant positive correlation between the motivation test scores and the overall ability test scores. The higher motivation test scorers are more likely to pass the ability tests.

It is therefore proposed that the motivation test be given to candidates first at the initial test stage. The test would be marked whilst the candidates waited and only those who have achieved the required 60% would be permitted to sit the ability tests. By this method it is calculated that some £15K in wasted test material could be saved.

3.3.5 Conclusion

The NATS recruitment process is constantly monitored and regularly reviewed to ensure that it is meeting its objectives.

The recruitment process has been designed to provide Operations with the best possible *ab initio* Students, drawn from a population who have little or no previous aviation or ATC experience, so that NATS can meet its manpower requirement.

In order to achieve the target pass rate out of the College without recoursing Students, each individual module to the course would have to achieve a minimum of a 90% success rate. In this context it can be seen that a high standard is being aimed for.

For any further information on the selection of Student ATCOs please contact:

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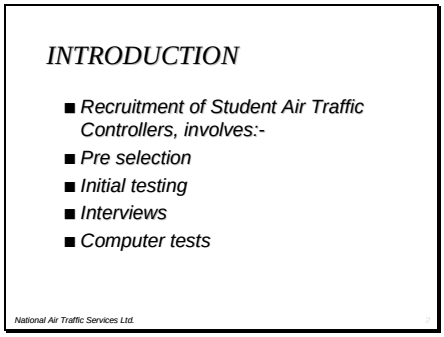
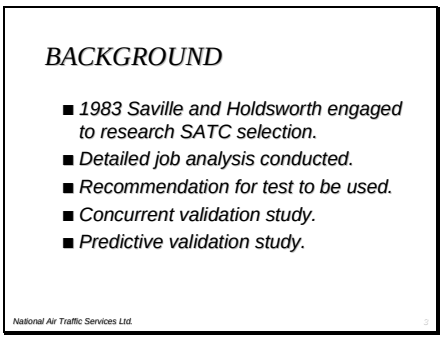
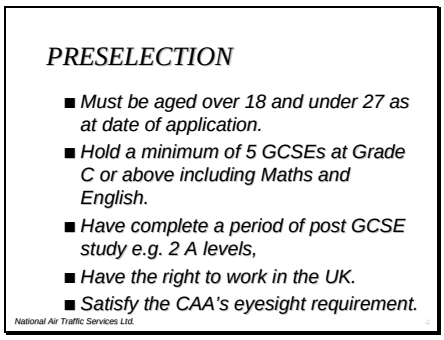
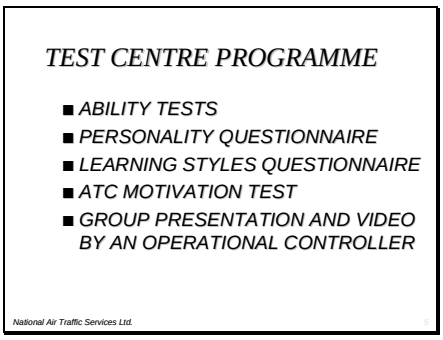
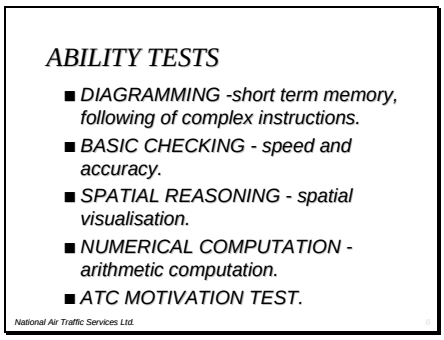
3.3.6 Slides Used During the Presentation











PERSONALITY

- CONCEPT 5.2 OCCUPATIONAL PERSONALITY QUESTIONNAIRE - various personality traits.
- LEARNING STYLES QUESTIONNAIRE - motivation towards study.

National Air Traffic Services Ltd.

TECHNICAL INTERVIEW

- 1 CONTROLLER - from operations.
- LASTING 1 HOUR.
- LOOKING FOR:- motivation towards ATC; reasoning skills; decision making; and acceptance of rules.

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PERSONNEL INTERVIEW

- Member of the recruitment team.
- Lasting 1 hour.
- Looking for:- past achievement, team skills, flexibility, integrity, tenacity, maturity, problem solving and multi-tasking.

National Air Traffic Services Ltd.

COMPUTER TESTS

- 3 TASKS LASTING 1 HOUR.
- SORT TASK - sorting of objects (shapes and numbers) by given rules.
- RELATIVE DIRECTION TASK - left and right test conducted at speed.
- MOVING OBJECT TASK - identification of potential collisions.

National Air Traffic Services Ltd.

COMPUTER TESTS

- Ability to absorb information simultaneously from multiple sources.
- Ability to absorb new information whilst making decisions.
- Ability to project forward on basis of current information.
- Ability to make adjustments constantly to the whole picture.

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FUTURE CHALLENGES

- Increase number of good candidates
- Reduce training failures
- Respond to future ATM needs
- Improve efficiency of selection system

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APPLICANT NUMBERS

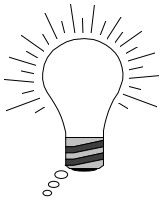
- PROBLEMS
- Reduction in number of applications
- Lowering of the quality of applicants

- CAUSES
- Lack of awareness of ATC
- Poor publicity about ATC/NATS
- Potential privatisation
- UK economy

National Air Traffic Services Ltd.

APPLICANT NUMBERS

- SOLUTIONS
- CD - ROM
- Web site
- Presentations to careers advisers
- Aggressive advertising



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REDUCE TRAINING FAILURES

- *Increase current cut-off scores - Checking test.*
- *"Stickability" trial.*
- *New tests - "Wombat -FC", "Selector".*
- *Computerisation of part of Technical interview.*

National Air Traffic Services Ltd.

IMPROVE EFFICIENCY

- *Motivation test to be taken first*
- *Low scorers to be eliminated*
- *Potential saving £15K per annum*

National Air Traffic Services Ltd.

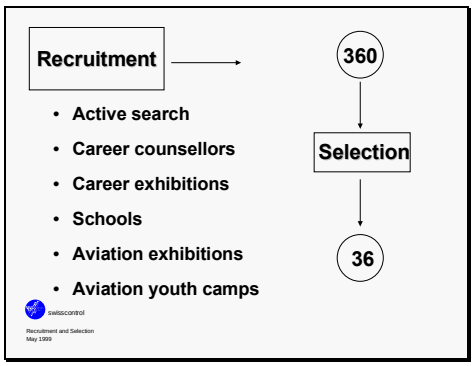
CONCLUSION

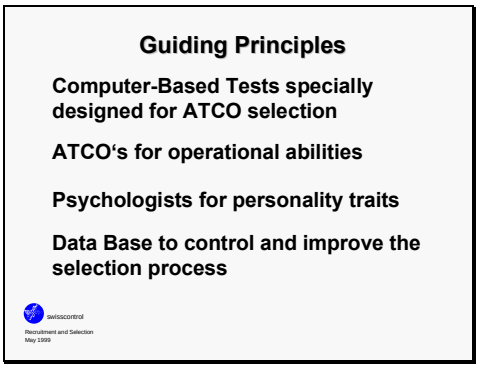
- *Recruitment process constantly monitored and reviewed.*
- *Target to provide Operations with the best possible ab-initio students*
- *How - by restoring applicant numbers and quality to the previous levels and beyond; by increasing the predictability and efficiency of the selection system*

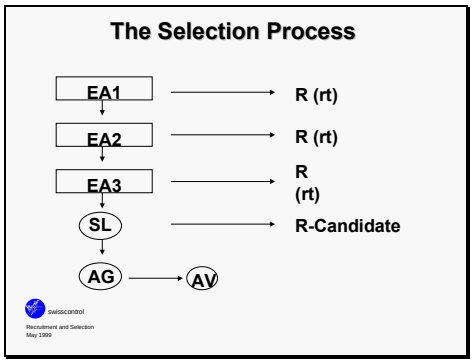
National Air Traffic Services Ltd.

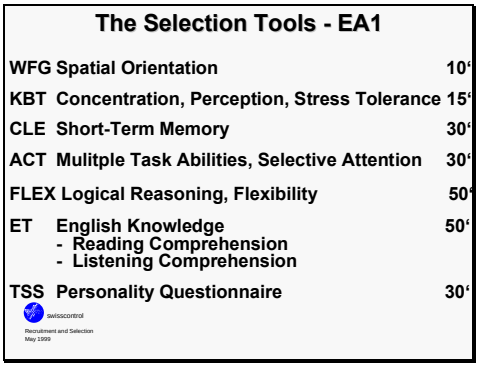
3.4 swisscontrol's Selection Procedures, by Mr. Louis Tomaschett, Head Personnel Recruitment and Selection, swisscontrol, Switzerland.

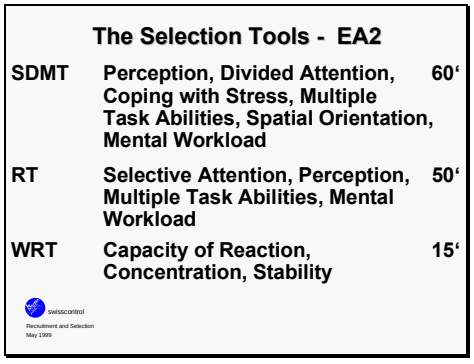
3.4.1 Slides Used During the Presentation

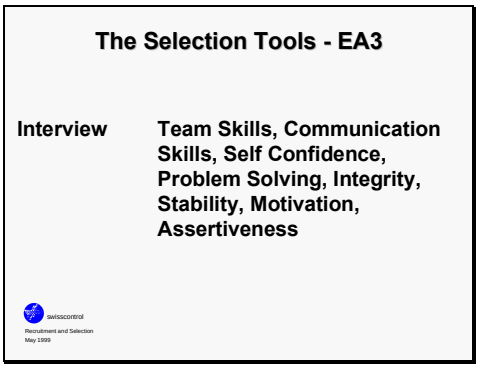


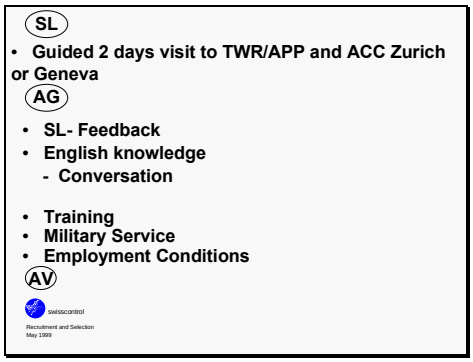












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3.5 The Recruitment and Selection Procedures in Denmark - "The Right Person", by Mr. Jørgen Lund Hansen, Head of Recruitment, Danish CAA Academy, Denmark.

3.5.1 Introduction

This is my debut in an international perspective regarding my daily job as Head of Recruitment for the Danish CAA, so allow me to speak a little about the ins and outs of our job as I see it.

In every day life, expressions like: “She has a great personality” or “He is really a gifted and special boy” can be heard as part of conversations describing people we meet.

Behind these statements about personality are built in concepts of admiration and value, but also assumptions of general and unique structures of personality.

This brings us down to a very basic and philosophical questions:

- Does personality consist of basic building blocks?
- Are these building blocks common for all – universally – or are they created special in every human being – uniquely?
- Could it be a compromise - a mixture of the two?

What do these building blocks look like? How do we describe and measure them? Are they situation dependant? How can we be sure that the descriptions we make are not just words or fiction for something that does or does not really exists in personality?

What do these questions have to do with us as a group of selection experts within ATC?

These questions are important for us, because until now we must admit that we do not have a thermometer, a golden weight or some other measurement device, which we can use for the girls and boys who dream of being a future ATCO, and get a clear-cut valid and reliable readout of a fixed value that shows us and guarantees us that this person has the required abilities and potential to become a controller.

That does not mean we should give up the creation and sophistication of such a measurement device, but we need to be very aware that we are dealing with a complex matter, from which we have to put together the best possible “picture” of a person by means of different approaches based on different ideological assumptions.

Before getting into the establishment of any selection procedure, I find it worthwhile to consider at least a few of the following key aspects, because for many people, within an organisation dealing with ATC, it can be very difficult

to understand why we – the experts – just don't go out there and find the right persons.

It cannot be that difficult considering all the time and money we use.

Also, these points are important for our own understanding of, and professional approach to our job and its mechanisms.

Some of these key aspects include:

3.5.1.1 Profile and Criteria:

When searching for the right person - the *ab initio* trainee controller - we are looking for abilities or talents in the light of success- or failure criteria that suits the profile of a controller or a trainee controller. The critical words used in this sentence are **profile** and **criteria**.

Everybody knows the profile of an ATCO - just go and look at one and you have the answer. If it was so simple, we could forget about job analysis and job requirement analysis, because that is the way of getting a better defined picture and common understanding of the controller's profile.

The next thing you might hear are words like "right" or "wrong", "good controller" or "bad instructor" – criteria which we can call **conceptual criteria.**

There is nothing wrong in using these words, but their great disadvantage is that they cannot be measured.

We must carefully consider what is meant by a "successful" or a "good" controller in order to get something which can be measured.

We have to identify and define precise **actual/operational criteria,** which is based on observable behaviour, actions, results or products as a means of measuring performance – from test performance to final controller-performance and vice versa.

3.5.1.2 Description – The Quantitative and the Qualitative Approach:

In creation of a test battery we have to deal with the question of choosing a way of describing people.

If we choose only a **quantitative approach**, which means measurement of variables on a numerical basis: We count, we categorise, we separate or we differentiate – Peter's IQ is 135 while John's IQ is 107 - we will get data that is better with regard to objectivity, internal validity and reliability but lower on naturalistic setting/environment, realism and construct validity.

If we take the **qualitative approach**, which means emphasising meanings, experiences and description – what did Peter actually say or what was observed while John took the test - we get data which is higher on subjectivity,

realism, construct validity and data which is lower on internal validity and reliability.

ATScreen (HRI, Israel) is a good example of the quantitative approach and interviews are good examples of the qualitative approach.

If we want it all, then we have the best argument for making a compromise of using both approaches, and in my mind we cannot make any prediction or selection of a person before the **whole** person or as many aspects of that person is described.

An increasing use of the quantitative approach seems to be prevailing in the name of scientific and statistical demands, but let's not forget that personality itself seems to be at least an equal partner/joker in determining success or failure in ATC-training.

The price is that we have to deal with both objective and subjective data making it more difficult to make comparisons, weightings of data and decisions in selection.

3.5.1.3 Our Use of Words:

We have to deal with the semantics involved in this: We use words created in an academic environment but also words from the operational ATC environment. Through analysis of the controller job and its job requirements made in different countries, different countries have come up with different words, concepts or models. Are we speaking the same language?

Controllers feel they belong to the same tribe, and they actually transfer easily to other cultures and other ATC-standards. This could indicate the existence of universal concepts and common understandings of tasks and job requirements in ATC.

How is SIMULTANEOUS CAPACITY related to MULTITASKING and how is SITUATIONAL AWARENESS related to GENERAL VIEW and FORESIGHT. I think a bit of standardisation would be beneficial.

3.5.1.4 The Feedback Process:

When we apply a test battery, we also have to define a learning system, involving feedback from the educational environment. This feedback would be based on the same definitions of abilities, skills, job requirements, operational criteria, standards and scaling as used in the test battery and selection procedure.

If we do get feedback, we have to find ways of handling data from different courses with different levels of complexity in different ATC disciplines as Tower, approach and area control, and find ways to handle the subjective data from selection in combination with subjective data from education.

3.5.1.5 Controller Acceptance:

Finally, if we continuously get more and more scientific and academic on this matter, I see a great danger of controllers not understanding what we are doing, what we are talking about and maybe not accepting the selection procedures.

We cannot afford rejection or lack of acceptance, because we need controller participation – as the SMEs – and we need controllers taking responsibility for selecting their future colleagues.

After this let us look a little on the Danish Selection procedure, not in detail but in general terms.

3.5.2 The General and Specific Background for the Danish Selection Procedure

A test battery is considered to be a sequence of systematic and standardised procedures, which makes it possible to observe behaviour or measure abilities of a person or a group, and to describe the observed behaviour or measured abilities on a scale, in a system of categories or in plain text.

To know what behaviour/abilities to look for, it is important to know what abilities a person must possess to be successful in education and job.

After a number of persons have completed the same education it will, via statistics, be possible to say something about the predictive validity of the test battery concerning success or failure.

Therefore, a Danish analysis of controller job requirements was done in combination with the attempt to develop a dynamic, PC-based radar screening test during the period from 1990 to 1994. The group consisted of 3 controllers (including myself), 2 aviation psychologists and the former Head of Recruitment, Mr. Per Knudsen. The manager of this group, the Radar Test Workgroup 90 was Aviation Psychologist, Dr. Per Byrdorf, who in general for a decade has been our professional advisor, support and designer of the Danish test battery and selection procedure.

100 Danish controllers were questioned via the Critical Incident task analysis method, and the result of this analysis is the basis for our test battery and selection procedure.

As a result, we identified 15 job requirements, which were defined individually by the group followed by a feedback process of recognition or rejection of definitions by the controllers.

They are the backbone of the Danish controller-profile and a few examples look like this:

- **Simultaneous Capacity**: apprehend multiple information and execute multiple actions and tasks simultaneously.
- **General View**: apprehend and maintain a situation in its entirety.

- **Planning**: to think up and lay down methods and actions based on given information.
- **Co-operation**: willingness to co-ordinate own activities with the activities of others, on a mutual basis.
- **Co-ordination**: ability to receive and pass on relevant information and actions.
- **Order of Priority**.
- **Foresight**.
- **Stress Tolerance**.
- **Drive, energy**.

The attempt to create the dynamic radar screening test was completed, but due to a cost-benefit analysis it was replaced by ATScreen from Israel. However, we use the 15 job requirements as outlined, as the basis for our selection procedure and also the whole way through the educational system, including final practical training.

One of the interesting extra lessons I learned from this project was:

It is extremely difficult to interpret objective PC-data from a high fidelity simulation into concrete identification and measurement of specific job requirements and also very difficult to define the criteria for success or failure.

3.5.3 Scale

In the entire selection procedure we use the same scale – the Stanine Scale. That makes it possible to compare test data throughout the procedure.

In the perspective of quality assurance we are right now discussing how to use the Stanine scale in all aspects of selection and education, in order to monitor both aspects more closely and also to validate the test battery.

The critical part is not so much to give students grades in the ATC-school environment, but to give students grades in the final phase of practical education is a sensitive question of making it visible that controllers may be performing differently – let us say from 5 to 9 on the Stanine Scale.

It is recognised that a pass-fail criterion is insufficient.

3.5.4 Test Battery and Selection Procedure:

We have adopted the EUROCONTROL Quality assurance and Control Guidelines, which means that we try to live up to the principles given.

The test battery, which can be categorised as a multiple hurdle strategy – the successful applicant has to pass each hurdle and is thus ultimately hired, looks like this:

- Application
- ATScreen (CPS)
- Aptitude-test

- Interview
- Final selection – commission.
- Medical examination.

- The application:

Is registered in a database, which handles the administration of all phases of the test battery and selection procedure.

The initial screening based on data from the application is recently cut down to a minimum, to make it open for as many as possible in the initial phase.

Allow me not to go into detail in this presentation.

- ATScreen (CPS):

ATScreen is an individual, PC-based test, which is delivered by HRI in Israel. It has been used in Denmark as the first screening of applicants since mid 1996.

To put it short: ATScreen tests the cognitive and the dynamic abilities identified and recognised via international job analysis and job requirement analysis among controllers.

It is well known, documented and rated as number 1 among more than 30 tests by EUROCONTROL already, so no need for further details from me.

We have now tested and looked into the statistics of test results from 950 applicants with the following conclusions so far:

- We have a clear picture of the cut-off values for passing or failing the test in Denmark.
- We are ready to re-standardise the test norms within 1999.
- The internal reliability is good.
- We have not looked into the predictor-related validity yet, but by the end of this year the first controllers, who have taken the test, should be fully licensed.
- Our general impression is that our candidates are of a higher standard than previously.
- We are ready to use the new Windows-version.

Test result is given in a feedback-session immediately after the test, and the criterion of passing is at least a Stanine 5 on the Stanine Scale. However - in practice, we select from the top, the best 30% of the applicants who go on to the Aptitude test.

The test is a good example of the quantitative approach of measuring well-defined variables.

- The Aptitude test:

Is a simulation test based on the principles of the situational test method and the assessment-centre method. It takes place in a tower simulator with 8 participants for 3 days, and the participants are tested in performing the role of landing controller, departure controller and pilot.

The test environment, which is a modified copy of Copenhagen, Kastrup Airport, is close to reality, and it gives the participants a chance to try out the controller job while 3 ATCOs educated as test managers, independently do their observations and grading of the test performance.

The basic assumption in the assessment centre method, is that, if you create a test situation close to the real job situation, the behaviour of a person, seen in a critical relation to success- or failure criteria of the job, will react and behave the same way in a test situation as in a job situation.

The participants are assessed individually on the identified job requirements using the Stanine Scale. Assessors have the option of making remarks/specifications in plain text.

The test result is by nature based on subjective data. Within the last 5-6 years much has been done to meet most of the psychometric requirements by using test manuals, standardised briefings and test runs, training of test administrators in observation, interpretation and grading, etc.

Right now we have 10 controllers/test managers, working with behavioural test data/test observations collected through aptitude tests in 1998.

The goal is to document the test behaviour by recognising and categorising a specific observed test behaviour or test result as an actual or operational criterion for one or more of the identified job requirements.

The ultimate solution could be to create a behaviour anchored scale – we will see how far we can go.

The present predictive strength of the Aptitude test is based on the test managers up-to-date daily experience and knowledge of success- and failure criteria in the controller job.

After the 3 days together every person is debriefed on the test performance and the pass criterion is 5 on the Stanine Scale. 25% of the applicants obtain this result and go on to the Interview.

The Aptitude test is a good example of the compromise between the quantitative and the qualitative approach.

- The Interview:

The interview is delivered by Institute of Aviation Psychology, Denmark. As this is not a product of the Danish CAA, I will just list the ingredients in the standardised interview:

- A personality test
- A self biography
- A sentence completion test
- A short-term memory test
- A tapping test

The result of ATScreen and data from the application – passed exams and grades, etc. – are available data for the interviewer.

The interview tries to clarify:

- If the applicant is/could be a good friend or colleague.
- Motivation – short and long-term. Why and how deep.
- Potential of leadership, communication skills and stress tolerance.
- A general personality description.

The result of the interview is a written conclusion including a grade on the Stanine Scale. The pass criterion is 5 on the Stanine Scale, which is obtained by approximately 80%. The interview is a good example of the qualitative approach.

- Final Selection – Commission:

It is here that the **whole** person is described based on the test results from ATScreen, The Aptitude test and the interview.

Members of the commission are therefore the people involved in the test battery and chairman is the Chief of CAA-Academy and ATC-Chief instructor of the CAA-Academy.

Their job is to make the final selection of *ab initio* controller trainees based on the information, test data and test conclusions presented.

- Medical and security:

The final selected candidates will be sent through the required medical exam to obtain the medical certificate. A security clearance is required too.

The result is:

Approximately 6 out of 100 applicants are finally hired. For the time being approximately 3 out of the 6 become fully trained controllers 3 years later.

3.5.5 Wishes and Visions for the Future

In a small country like Denmark it takes many resources out of few resources to design a new test or test battery, to collect enough data and to work out all the statistics involved in validating a new test or selection procedure.

Coming from a small country like Denmark I think we have an excellent test and selection procedure.

In this aspect we are probably not so different from other countries.

Coming from a small country like Denmark I can see that many other countries also put a lot of effort and resources into this field.

Should we, in a globalised world, leave it like that or start using each other – through EUROCONTROL – or is it too naive to believe that we are ready to give up our own national approaches and feelings.

If we have a common desire, we could, within our membership of the same organisation, develop, set up and offer, off-the-shelf products and support ,in the form of for example - a European test or test battery including the know-how and support involved in all this.

As I see it, we are already offered a lot of paper with recommendations and guidelines, which freely can be used. I consider this as a good start and an excellent offer, but maybe we could go further in creation of offers, which are free but irresistible.

3.5.6 Final Remarks

In Denmark the applicants will be treated in an atmosphere of respect and co-operation to make it easier to relax and to demonstrate the potential one truly has.

Our philosophy is that every applicant has general abilities and talents that are measured, but also that everyone contains unique resources, which are important in social relations in the workplace and in stressful situations requiring maximum co-operation and teamwork.

A clear message from our job requirement analysis was that the ability to co-operate came in as the number one job requirement.

In my opinion it will be too optimistic to believe that we can create a 100% foolproof test battery. We have to recognise and respect all the variables not only in testing and selection, but also in our educational environment, in our operational environment and in the culture, values and attitudes of our organisations as a whole.

All these factors are critical for the success or failure throughout all phases of the process selecting between those coming from the street up to the stage of having a fully trained controller.

Jørgen Lund Hansen
Head of Recruitment
Danish CAA Academy Copenhagen
April 1999.

3.5.7 Slides Used During the Presentation

The recruitment and selection procedures in Denmark

"The right Person"
by
Jørgen Lund Hansen
CAA-Academy, Denmark.

Why selection ?

- Often more applicants than needed.
- Cost/benefit considerations
- Safety reasons.
- Possible match between the applicant and the organization.
- Special abilities/characteristics identified, e.g.:
- - Perceptual ability: Perception and speed.
- - Mental ability: Memory, Multitask, reasoning, etc.
- - Physical ability: Health.
- - Emotional ability: Stress tolerance, personality in general.

Everyday describing statements !

- **She is intelligent** - in this presentation it does not necessarily mean Beautiful.
- **She has a great personality** - don´t start searching now, you are in the middle of a presentation.
- **She is really a gifted and charismatic girl** - don´t panic now: This presentation only takes about half an hour.

General and/or unique structures of personality !

Important - but not new - basic questions:
Does personality consist of basic building blocks ?
- How do they look like ?
- How do we describe and measure them ?
- Are they situational dependant ?
- Descriptions - fiction or reality ?

The answers to these questions are important for the establishment of a valid and reliable Measurement Device.

Profile and criteria.

What are we doing ?
We are looking for abilities or talents in the light of success- or failure criteria that suits the profile of a controller or a trainee controller.

How are we doing it ?
STEP 1: Profile
Job analysis/job requirement analysis.

Profile and Criteria - cont..

STEP 2: Definitions and criteria.

- Conceptual criteria:
  "Good" controller, "bad" instructor, "excellent" football player, etc.
  Concepts which cannot be measured !
- Actual/operational Criteria:
  Behaviors, actions, results, products, etc.
  Means of describing the concept of a "successful" or a "good" controller - means of measuring performance.

Profile and Criteria - cont..

The choice of how to describe:

- The quantitative approach:
  Measurement of variables on a numerical basis:
  We count, categorize, separate, differentiate - via PC-based test data - for example ATScreen.
- The qualitative approach:
  Meanings, experiences, description - what was said or what behavior was actually observed while taking the test (interview, assessment centers, etc.)

Profile and Criteria - cont..

- Let´s make the compromise of using both approaches, in order to make the description as complete as possible.
- This is our material for well documented decisions of selection.
- The price is that we have to deal both with subjective and objective data.

Words / models / concepts.

Taking cultural differences into account:

- Are we speaking the same language ?
- Standardization - YES - if we want to exchange and use knowledge and information across borders.

The feedback process.

If interested in Quality Assurance:

- Definition of a learning system is a MUST.
- Feedback from the educational/operational environment.
- Same definitions/"picture" of:
  Abilities. Skills. Attitudes.
  Job requirements.
  Operational criteria.
  Standards and Scale.

Controller acceptance.

We cannot afford rejection or lack of controller acceptance:

- Controllers are the subject matter experts.
- Controllers are our source and resource of information and know how.
- We must give controllers faith in the selection procedures in order to focus on selection and training at the right time.
- We need controllers taking interest and responsibility for the selection of their future colleagues.

Job requirements.

To know what behavior/abilities to look for, it is important to know what abilities and characteristics a person must possess to be successful in education and job.

Job requirement analysis in Denmark

Job requirements - cont..

- Simultaneous capacity:
  Apprehend multiple information and execute multiple actions and tasks simultaneously.
- General view:
  Apprehend and maintain a situation in its entirety.
- Planning:
  To think up and lay down methods and actions based on given information.
- Coordination:
  Ability to receive and pass on relevant information and actions.

Scale.

In the entire selection procedure we use the same scale - The Stanine Scale.

In the perspective of Quality Assurance our goal is to use the Stanine Scale in as many phases of selection and education as possible.

Test battery and selection.

A multiple hurdle strategy:

- Application.
- ATScreen (CPS).
- The Aptitude test.
- Interview.
- Final selection - Commission.
- Medical examination.

The Application.

- Is registered in a database which handles the administration of all phases.
- The initial screening based on application data is cut down to a minimum to make the process and the test battery open for as many applicants as possible.

ATScreen - CPS.

Tested approximately 1000 applicants.

Conclusions so far:

- Knowledge of cut-off values for passing/failing.
- Ready to re-standardize the test norms.
- Internal reliability is good.
- By the end of 1999 to look at the predictor related validity.
- We are ready to use the new windows-version.

The Aptitude Test.

- A simulation test based on the situational test method and the assessment center method.
- Basic assumption:
  Seen in a critical relation to success- or failure criteria of the job, a person will react the same way in a test situation as in a job situation.
- The predictional strength is:
  Based on the test managers up-to-date daily experience and knowledge of success- and failure criteria in the controller job.
- The future: …… !

The Interview

- Ingredients in the standardized interview:
  A personality test
  A self biography
  A sentence completion test
  A short term memory test
  A tapping test.
- Purpose - clarification of:
  Motivation, Potential of leadership, communication skills, stress tolerance, social abilities and a general personality description, etc.

Selection - the Commission.

- The test results from ATScreen, the Aptitude test and the Interview are presented - the WHOLE person is described.
- Final decisions of selection are made by the the Chief of CAA-Academy and the ATC-Chief Instructor of the CAA-Academy.
- Approximately 6 out of 100 applicants are hired.
- Approximately 3 out of 6 become controllers.

Critical factors.

- Critical factors determining success or failure:

- Test battery and selection procedure.
- Educational environment
- Operational environment
- Organizational culture, values and attitudes as a whole.

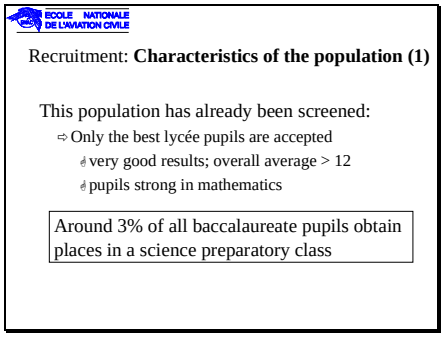
3.6 ENAC Selection Procedures, by Mr. Jean-Michel Pubellier, ATC Department Deputy Manager, École Nationale de l'Aviation Civile (ENAC), Toulouse, France.

3.6.1 Abstract

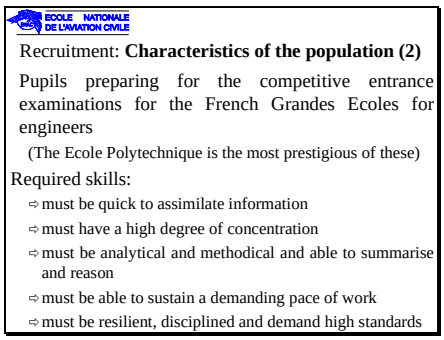
In 1991 a new organisation of the French ATCO training has been decided. The main objective was to produce a new ATCO called "air traffic control engineer" (ICNA) able in the future to face the challenge of increasing sectors and airports capacity while maintaining a high standard of safety. This short presentation tries to give a general view of the system including recruitment, selection, training and rating.

3.6.2 Slides and Notes Used During the Presentation

ECOLE NATIONALE DE L'AVIATION CIVILE EUROCONTROL SELECTION SEMINAR Luxembourg - 19 May 1999 Air Traffic Control Engineers **Recruitment & Selection** **Jean-Michel Pubellier, ENAC (France)**	Not being a specialist of selection procedures and tests, I am going to briefly present to you "the French way to become a controller". There is a selection procedure to become ATCO but only based on knowledge testing and medical requirements. In 1991 a new organisation was introduced in order to produce a new ATCO : an ATC Engineer. A person in the system able, in the future, to face the challenge of increasing capacity while maintaining a high standard of safety. The new program was a compromise, a good articulation between selection, training, operational operations and rating in the French context (civil aviation). It took a long time to built the whole thing, we only finalised it last year, but as we are in a changing world, we are already having to review it. The difficulty today is that we do not know exactly how future control will be (we may be just imagining it will be difficult to adapt the older controllers).
ECOLE NATIONALE DE L'AVIATION CIVILE **Outline** • **Recruitment** • **Selection** • **Training plan** • **Results** • **Review of future systems** • **Outlook**	My presentation tries to give a general view of our system. I propose to speak about the following points: From what population the controllers comes? A quick look of the training plan and the results that are quite correct concerning our success rate. A word about the review of future systems. This is a stake for the future; our success will depend on the way we will handle the transition to the new system. Finally I will give my outlook in the field of selection. When we talk about selection, I mean the subject comes up when we have to face a trainee in big trouble. We work on training solutions and it happens that some people request selection procedures who could have avoided the situation. The problem is to know if the procedures that are to be implemented will improve our system and how to prove it?
ECOLE NATIONALE DE L'AVIATION CIVILE Recruitment: **Specific population** **Applicants must show proof of:** • either holding a **University degree** in a scientific discipline • or having followed 2 years' science preparatory classes for the Grandes Ecoles (**CPGE**) **In practice, recruitment is homogeneous - more than 90% of recruits come from the preparatory classes for the Grandes Ecoles (CPGE)**	Applicants must be under 27. Information about ATC jobs is made trough • booklets • posters • participation of our senior ATCOs in job forums. Information is available in all student orientation and information centres. Please note that students from the scientific university have to continue to learn English and French language if they want to apply for the selection.



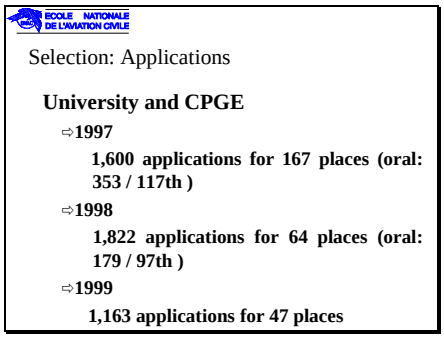
Today little more than 70% of a generation get its baccalaureate and between 15,000 to 20,000 students entered the science preparatory class, which represents less than 5%.



From May to July pupils have competitive examinations for *grandes écoles.*

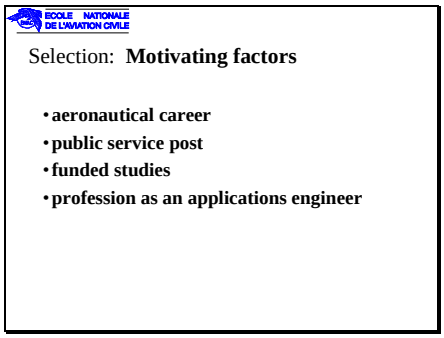
Concerning required skills here, after the aptitudes we can read from the school application forms.

Can we make a correlation with ATCO abilities?



Since 1991 we used to recruit 180 students each year. Now we have cut down to stabilise at 124 places in 4 groups of 32 students.

We have a waiting list around 3 times the number of places; this is because quite a lot of laureates choose another school and another job.



We have some people who wanted to become a pilot but couldn't (e.g. for medical reasons), we also have students who have parents or friends working in ATC.

Getting a public service post in this period of unemployment and well paid is taken into consideration. Despite that, 116 applicants refused the place last year and preferred an engineer school.

ECOLE NATIONALE DE L'AVIATION CIVILE

Selection: **Tests and marking**

Competitive examination for engineering

- **Written**
  Maths (2), Physics (2), French (2), **English (3)**
- **Oral**
  Maths (2), Physics (2), French (2), **English (2)**
- **Eliminatory marks**
  - ⇨ **Written**
    - 5/20 and 6/20 in English
  - ⇨ **Oral**
    - 8/20 in English

We have knowledge testing, using multiple choice items.

Please note the importance of English.

ATC students will have to reach the mark of 14 for their diploma, that is why we introduced an eliminatory mark of 8. But we have trainees who have to get extra time and new evaluation during their training.

ECOLE NATIONALE DE L'AVIATION CIVILE

Selection: **Medical fitness standards**

Applicants must meet the required standards in the following:

- **General medical examination**
- **Mental aptitude tests**
- **Ophthalmological examination**
- **ENT examination**

Once they have passed the oral exam students have to cope with medical fitness standards.

They are quite high to be above the one requested to become a private pilot.

ECOLE NATIONALE DE L'AVIATION CIVILE

Selection : **Psychotechnical tests**

There are no skill or psychotechnical tests!

It doesn't mean that we have no "psycho" competence in the school. We have a psycho team who do the selection of student pilots and ATC but for foreign administration.

In fact they participated a lot in training for pedagogical assistance and these will not decrease in the future.

ECOLE NATIONALE DE L'AVIATION CIVILE

Training plan: **Objectives and duration**

A new system was introduced in 1991

The aim is to train students:

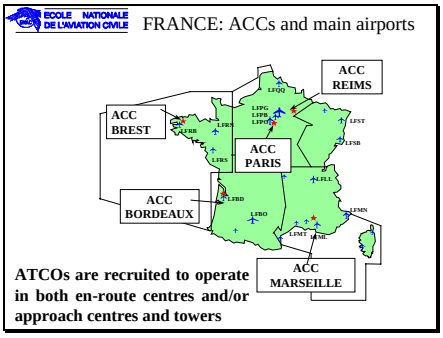
- safely to provide air traffic services
- to adapt to changes in the profession
- to perform training and supervisory duties
- to perform research and design duties

"Engineer"-type training over 3 years → **Time required to qualify: 3-18 months, depending on the centre**

The choice has been made for an "engineer" type training which will appear to be quite long and may be considered expensive, but this is a renewed system more complete than before.

It takes a long time to be qualified, but we have a big amount of training and you have to consider that controllers have to be qualified on many sectors in a French facility.

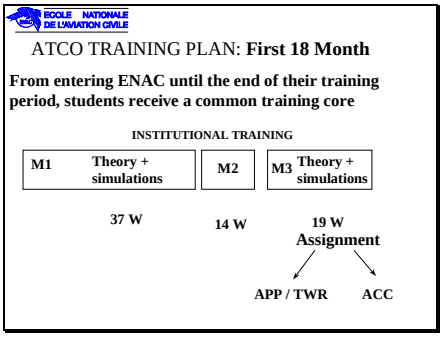
This training is also new in the pedagogical view, it always tries to integrate theoretical and practical subjects. It prepares for an operational qualification and at the same time for performing other duties in the future.



This is a view of the French airspace, quite large compared with the other European countries. 2 millions flights use it for the moment.

We have more than 3500 controllers working in 5 ACCs, 12 big regional airports and around 46 airports with Approach control. Airports who have only tower service are handled by government employees, who are not ICNAs.

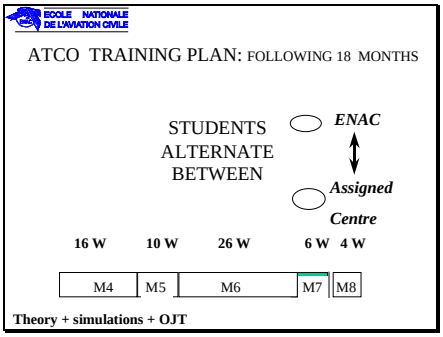
This is an important point because it permits to adapt trainees, who fail in large centres, with a smaller place less busy and less complex.



MODULE 1 goes through aerodrome control, then ACC control, radar but low sector without vectoring, then Approach Control only procedural, finally advanced aerodrome control. Each phase use its adapted simulator:

Tower simulator; SCANOR which is a procedural simulator and CAUTRA, the duplication of the French automated system, radar and data processing.

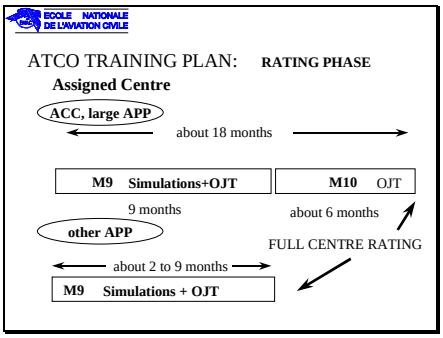
MODULE 2 permits to get a private pilot licence, which represent 45 hours of flying and 4 weeks on a small airfield to take Visual Flight Rules (VFR) OJT. At the end of MODULE 3, students are assigned to a centre (roughly 75% for ACC and 25 % for airports) according to their rank.



MODULE 7 is a 6 week period in an English language country.

MODULE 8 ends by the defence of a dissertation.

At the End of MODULE 8, the student receives an academic diploma.



The ENAC psycho team has helped ATC assessment specially to set up behavioural items which have to be observed during the tests.

ECOLE NATIONALE DE L'AVIATION CIVILE

Overall results

- **< 1% failure rate before end of Module 8**
- **< 10% failure rate in large centres**
- **practically all students qualified in small centres**

These are the first results among more than 1000 students since 1991.

ECOLE NATIONALE DE L'AVIATION CIVILE

Training: Characteristics

- **Training (not selection/training)**
  - ⇨**no set duration**
  - ⇨**extensive pastoral care**
  - ⇨**counselling available to those who fail**

Students may switch team, they are not forced out .We try to bring down the pressure and at the end when everything has been done, even the impossible, a new assignment is given to the trainee.

ECOLE NATIONALE DE L'AVIATION CIVILE

Training plan: Future systems

- **Introduction to the modules:**
  - ⇨**ODS**
  - ⇨**TRM**

The first step of the new French operational display system has been inaugurated at the Brest ACC last week and Paris is following. This new equipment makes it necessary to transform qualifications. ENAC participates at the elaboration of a special course for operational staff and will adapt it afterwards for *ab initio* students. At this stage, it is difficult for us to prepare trainees for future methods and procedures, which we do not know today. Anyway students who start training today will work on the new system, so we want them to be prepared for mouse, electronic strips and assistant tools. Concerning the equipment, we fight to be equipped like operational centres with the new ATC furniture and with the new simulator ELECTRA. We will have a new block in ENAC in 2002, which will regroup all our simulation tools. Concerning TRM, our idea is to prepare trainees to learn how to manage their errors, because good controllers are people who do make some errors but have to manage them. We recently introduced environment items to persuade controllers that they have something to do with the environment.

ECOLE NATIONALE DE L'AVIATION CIVILE

Analysis

- **We are aware of the social implications of our procedures**
- **The current failure rates do not prompt us to make any changes**
- **We are keen to take account of European recommendations**
- **We would have to reach a social consensus in order to change our procedures**
- **We have selection procedures for other populations at ENAC**
  - ⇨ **Airline pilots and foreign controllers**

ECOLE NATIONALE DE L'AVIATION CIVILE

Airline pilot selection

- **psychotechnical tests (aptitude)**
- **psychomotor tests**
- **psychological tests (human qualities)**

- **approx. 60% eliminated by each of these filters**
  - ⇨**in 1998**
    - ☝**1,200 applicants for 18 places at ENAC**
    - ☝**31 selected for flight trials**

ECOLE NATIONALE DE L'AVIATION CIVILE

ENAC point of view

- Keep our present system which is working
- Introduce new psychotechnical tests for the oral examination in order to indicate the candidates their ability to become a controller (*in correlation with behaviours objectives set up for rating tests*)

ECOLE NATIONALE DE L'AVIATION CIVILE

Selection: WAITING LIST

- 1997: 284 th picked up
  - 1,600 applications for 167 places (oral: 353 / 117th)
- 1998; 161 st picked up
  - 1,822 applications for 64 places (oral: 179 / 97th)
- Our success rate shows that almost all classified students can become a controller
- CAN WE DO MORE ?
  - Among these people try to select the more able to become ATCO

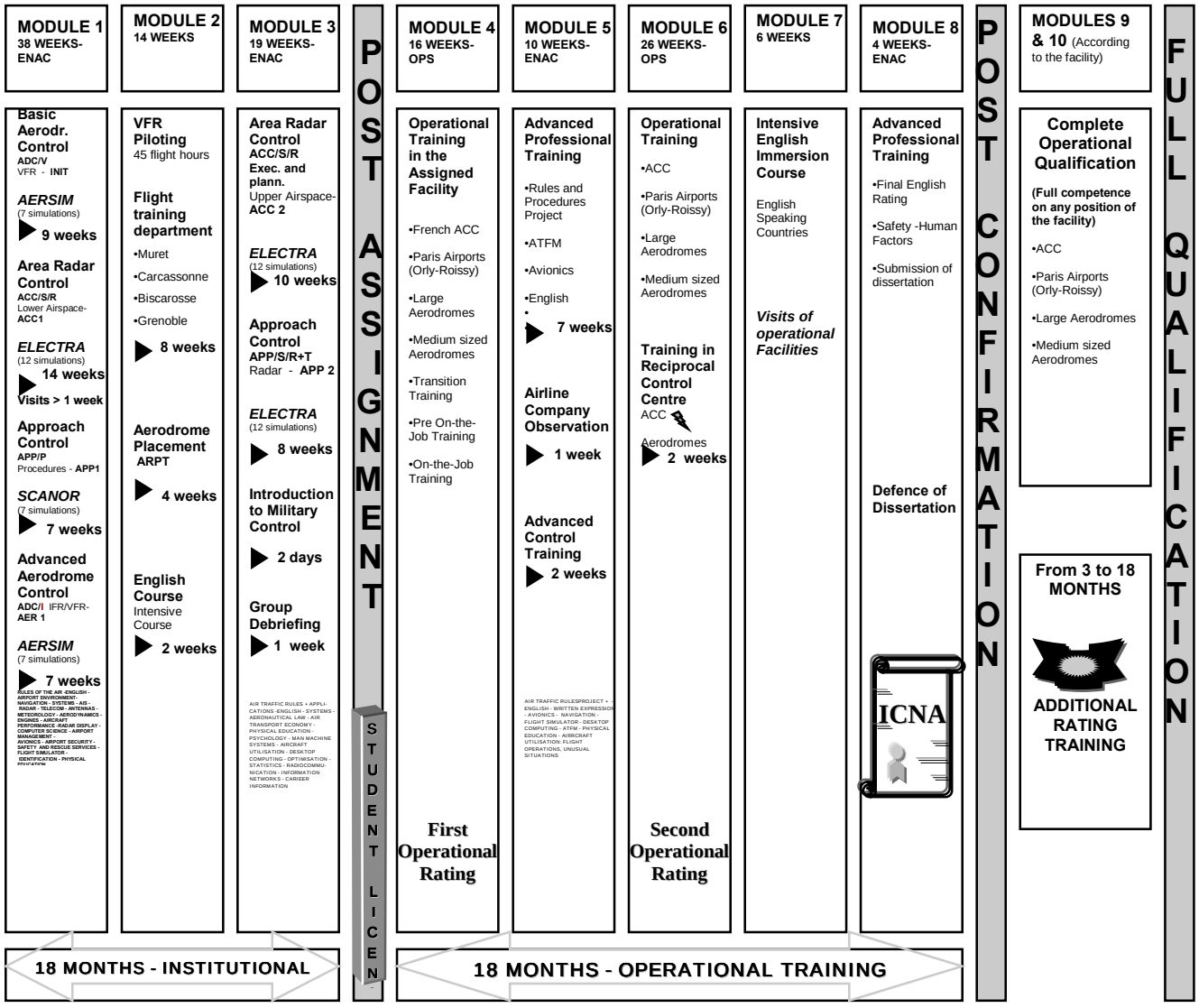
If we look at the waiting list, we have some evaporation.

ECOLE NATIONALE DE L'AVIATION CIVILE

Potential Benefit

- Introduce psychotechnical tests and give results to the applicants
  - those who did not made up their mind will get additional elements to decide
    - this will encourage the best applicants to join and discourage the others
    - this will permit to further validate the tests

Thank you for listening to me.


MODULE 1
38 WEEKS-ENAC
Basic Aerodr. Control
ADC/V
VFR - INIT
AERSIM
(7 simulations)
9 weeks
Area Radar Control
ACC/S/R
Lower Airspace-ACC1
ELECTRA
(12 simulations)
14 weeks
Visits > 1 week
Approach Control
APP/P
Procedures - APP1
SCANOR
(7 simulations)
7 weeks
Advanced Aerodrome Control
ADC/I IFR/VFR-AER 1
AERSIM
(7 simulations)
7 weeks
RULES OF THE AIR - ENGLISH - AIRPORT ENVIRONMENT - NAVIGATION - SYSTEMS - AIS - METEOROLOGY - ANTENNAS - RADIOBIOLOGY - AEROD YNAMICS - ENGINES - AIRCRAFT PERFORMANCE - RAD AR DISPLAY - COMPUTER SCIENCE - AIRPORT MANAGEMENT - AVIONICS - AIRPORT SECURITY - SAFETY AND RESCUE SERVICES - RADIO NAVIGATION - IDENTIFICATION - PHYSICAL
MODULE 2
14 WEEKS
VFR Piloting
45 flight hours
Flight training department
•Muret
•Carcassonne
•Biscarosse
•Grenoble
8 weeks
Aerodrome Placement
ARPT
4 weeks
English Course
Intensive Course
2 weeks
MODULE 3
19 WEEKS-ENAC
Area Radar Control
ACC/S/R
Exec. and plann.
Upper Airspace-ACC 2
ELECTRA
(12 simulations)
10 weeks
Approach Control
APP/S/R+T
Radar - APP 2
ELECTRA
(12 simulations)
8 weeks
Introduction to Military Control
2 days
Group Debriefing
1 week
AIR TRAFFIC RULES + APPLI-CATIONS -ENGLISH - SYSTEMS - AERONAUTICAL LAW - AIR TRANSPORT ECONOMY - PHYSICAL EDUCATION - PSYCHOLOGY - MAN MACHINE SYSTEMS - AIRCRAFT UTILISATION - DESKTOP COMPUTING - OPTIMISATION - STATISTICS - RADIOCOMMU-NICATION - INFORMATION NETWORKS - CAREER INFORMATION
POST ASSIGNMENT
STUDENT LICEN-
MODULE 4
16 WEEKS-OPS
Operational Training in the Assigned Facility
•French ACC
•Paris Airports (Orly-Roissy)
•Large Aerodromes
•Medium sized Aerodromes
•Transition Training
•Pre On-the-Job Training
•On-the-Job Training
First Operational Rating
MODULE 5
10 WEEKS-ENAC
Advanced Professional Training
•Rules and Procedures Project
•ATFM
•Avionics
•English
•
7 weeks
Airline Company Observation
1 week
Advanced Control Training
2 weeks
AIR TRAFFIC RULESPROJECT + ENGLISH - WRITTEN EXPRESSION - AVIONICS - NAVIGATION - FLIGHT SIMULATOR - DESKTOP COMPUTING - ATFM - PHYSICAL EDUCATION - AIRCRAFT UTILISATION: FLIGHT OPERATIONS, UNUSUAL SITUATIONS
MODULE 6
26 WEEKS-OPS
Operational Training
•ACC
•Paris Airports (Orly-Roissy)
•Large Aerodromes
•Medium sized Aerodromes
Training in Reciprocal Control Centre
ACC
Aerodromes
2 weeks
Second Operational Rating
MODULE 7
6 WEEKS
Intensive English Immersion Course
English Speaking Countries
Visits of operational Facilities
MODULE 8
4 WEEKS-ENAC
Advanced Professional Training
•Final English Rating
•Safety -Human Factors
•Submission of dissertation
Defence of Dissertation
ICNA
POST CONFIRMATION
MODULES 9 & 10 (According to the facility)
Complete Operational Qualification
(Full competence on any position of the facility)
•ACC
•Paris Airports (Orly-Roissy)
•Large Aerodromes
•Medium sized Aerodromes
From 3 to 18 MONTHS
ADDITIONAL RATING TRAINING
FULL QUALIFICATION
18 MONTHS - INSTITUTIONAL
18 MONTHS - OPERATIONAL TRAINING

3.7 Introducing Quality Control into Selection and Training by Mr. Elías Gissurarson, Chief ATS School, Iceland Civil Aviation Administation, (ICAA) and Mr. Gary Palen, Learning and Communication Consultant for ICAA, Iceland.

3.7.1 Background - Unsatisfactory Selection Process and Training Results

1. Selection consisted of four academic skill tests, psychological tests, the Taxi Test (Denmark's Fly Test) and unstructured interview conducted by management. It was in this interview that the selection decisions were made.
2. The criteria used in the unstructured interview were vague, subjective, and inconsistently applied.
3. Therefore, selection decisions could not be defended when challenged by candidates – dealing with these challenges was taking up a lot of the Director's time.
4. A low rate of success with Basic Course and subsequent Rating training.
5. All this resulted in a costly, emotionally stressful, and ineffective process, with management losing confidence in the School.
6. In consultation with Chief ATS School, Senior management made the decision to focus on quality and contract an outside consultant to provide objective advice and direction for improving selection and training.

3.7.2 Remarks on Quality

1. Quality is when a process or object fulfills its purpose.
2. Quality Control in ATS Selection and Training is dependent on feedback from clients – students, and ATS Operations.
3. Quality is a measured process of continuous incremental improvement.
4. The Quality of the Process = the Quality of the Product.

3.7.3 Implementing Quality Control in Selection

1. Removed the four academic tests as they were not directly relevant.
2. Changed from an unstructured to a structured interview process.
   - predetermined questions with standardised evaluation criteria.
3. Interview run by School rather than management.
4. Relied on the Taxi Test to provide evidence of applicants core cognitive skills relevant to Controller tasks[10].
5. While candidates have to pass the psychological tests and the interview, the final Selection decisions are based on the students rank ordering on the Taxi Test results.
6. We now have an objective selection process which can be validated and improved.
7. Selection decisions can be easily justified.

[10] EATCHIP Human Resources Team, (1998). *Integrated Task and Job Analysis of Air Traffic Controllers, Phase 1 – Development of Methods,* HUM.ET1.STO1.1000-REP-03 Brussels: EUROCONTROL, page 12.

8. We have begun evaluating other commercial selection tools – have evaluated one product and rejected it, and are now contracting to evaluate a second selection tool.
9. We are taking part in EUROCONTROL Workshops and Conferences to share research and findings with other countries.

3.7.4 Implementing Quality Control in Training

1. The concept of Quality is an integral part of a Systems Approach to Training – the idea of feedback loops to ensure the process is on track with the desired results.
2. All aspects of training are now evaluated by the students using a simple questionnaire – Theory modules, Exams, Simulation Training, Simulation Evals, OJT, and Final Evals.
3. The questionnaire asks three questions:
    a) What did you like?
    b) What would you change to improve?
    c) Any other comments?
4. The Quality Control Questionnaires are given out during the training so improvements can be integrated into the existing training process.
5. Following the distibution and collection of questionnaires, a facilitator leads a class discussion on their comments and suggestions, usually with the instructors present. This allows ideas to be commented on, clarified, and often resolved right away.
6. We are conducting up-to-date training task analyses to determine if the training courses and the evaluations are focussed on relevant skills. We are trying to ensure that the training needs, the training objectives, the training evaluations and the operational standards are all aligned. This is the foundation of a quality training system that supports the operational system.

3.7.5 Impact on Selection Success

1. Our current Basic class that was selected using the new process is a higher performing group – they share a common focus on learning.
2. Because the current process is clear and objective, students are more confident that they have the skills required, and that all candidates have been treated equally. There is high group morale and the students work cooperatively as a team.
3. We de-selected two students one third of the way through the Basic course because they failed to meet test standards, and displayed distracting personality traits. Paradoxically, they both achieved high scores on the Taxi Test. Their failures seemed to be due to erratic motivation, and social immaturity. We are interested in learning how to better detect these undesirable characteristics during the selection process.

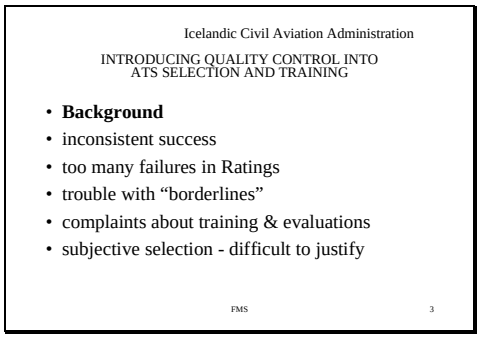
3.7.6 Impact on Training Success

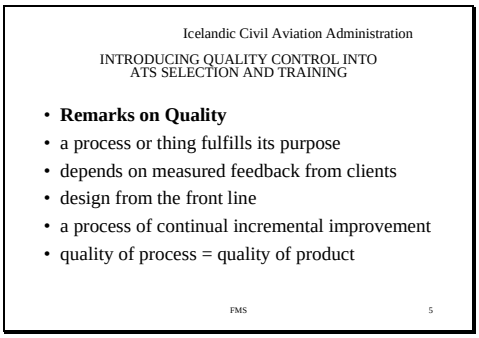
1. It is too early to say what the final training results will be, but this class looks promising.
2. We are identifying learning and training problems early and are resolving them as we go along.
3. The students are commenting that the training is highly professional. They like being asked their opinions on how to improve the training, and then consequently seeing some of these suggestions quickly implemented.

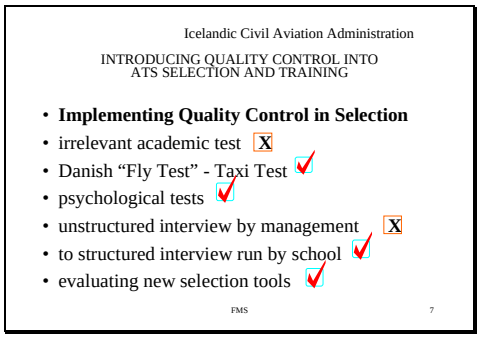
3.7.7 Impact on Culture

1. The credibility of the school is increasing among the management and controllers – we have received many comments from controllers that the school is getting better day by day.
2. Our task analyses and design workshops involve much discussion with active controllers – the process is open – and this contributes to the validity of the process as well as improving attitudes towards the School.
3. Issues are now being addressed that have been neglected and frustrating the controllers for years – e.g. standardising application of separation; addressing long standing complaints about equipment; resolving gaps between training and operational practice, and between operational practice and evaluation.
4. We are beginning to build a "Learning Organization" which extends beyond selection and training, moving into Operational practice, and overall ATS management.

3.7.8 Some of the Slides Used During the Presentation







Icelandic Civil Aviation Administration

INTRODUCING QUALITY CONTROL INTO ATS SELECTION AND TRAINING

- **Impact on Selection Success**
- selection perceived as objective & fair
- students are confident they have the ability
- higher performing group - morale + team
- shared focus on learning
- 2 out - high Taxi scores but erratic performance

FMS 9

Icelandic Civil Aviation Administration

INTRODUCING QUALITY CONTROL INTO ATS SELECTION AND TRAINING

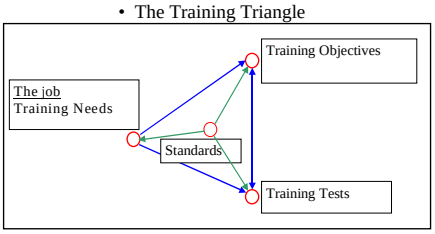
- **Implementing Quality Control in Training**
- Quality is an integral part of Systems Approach
- feedback loops to ensure on line with target
- students evaluate all aspects of our training
- instructors and clients evaluate training
- conducting up to date training needs analyses
- ensure job requirements, training, evaluation, & standards are aligned = valid training design

FMS 11

Icelandic Civil Aviation Administration

INTRODUCING QUALITY CONTROL INTO ATS SELECTION AND TRAINING

- The Training Triangle



Icelandic Civil Aviation Administration

INTRODUCING QUALITY CONTROL INTO ATS SELECTION AND TRAINING

- **Impact on Training Success**
- too early to say but looks promising
- problems in learning & training identified early
- we resolve them as soon as possible
- students like the continual feedback process
- motivating - they are part of design process
- they feel respected - that their ideas are valued

FMS 14

Icelandic Civil Aviation Administration

INTRODUCING QUALITY CONTROL INTO ATS SELECTION AND TRAINING

- **Impact on Culture - learning + quality**
- increasing attention to quality is evident to all
- open design process involves controllers
- increases validity of design & increases support
- neglected issues are being addressed
- on line with goal to more effective training
- developing a **learning culture** - extends beyond training into operations and management

FMS 16

3.8 CAS – ATCOs, "Computerised Assessment System for the Selection of ATCOs", by Ms. Mª Jesús Alava – Development and Professional Project, *(Aeropuertos Españoles y Navegación Aérea* (AENA), Spain), and Mr. Julio Álvarez - Professor (Universidad Autónoma de Madrid), Spain.

3.8.1 Objective

To develop an efficient tool to assess the applicants for the training course for ATCOs, selecting the ones who best fit the success standards require, trying to discriminate the applicants who will successfully finish the learning process to become an ATCO from those who will fail, for any reason.

3.8.2 The EATCHIP Dimensions

In order to select the relevant attitudinal and personality variables we reviewed the documents of different countries that collaborate with the EATCHIP program. Below we summarise the suggested variables and placed within brackets the percentage of the countries that mention them.

3.8.3 Attitudinal Dimensions

- Memory
  - Short-term memory (79%)
  - Long-term memory (54%)
- Attention
  - Concentration (75%)
  - Vigilance (58%)
  - Divided Attention
  - Selective Attention
- Logical Reasoning
- Arithmetical Calculus (67%)
- Perception (71%)
- Spatial Comprehension
  - Spatial orientation
  - Visualisation
- Multitask Performance (63%)

3.8.4 Personality Dimensions

- Motivation And Achievement (67%)
- Decision Making Behaviour (59%)
- Social Behaviour
- Stress Management

3.8.5 Labour Performance Predictors

After a review of different studies of labour performance we concluded that the best of them are:

- intelligence quotient (IQ) r = .53 (G factor, perceptive ability, and general psychomotor ability);
- test period r = .44 (small samples);
- biographical inventory r = .37 (correlate with intelligence and personality test (Smernou and Lautenschlager, 1991));
- reference informs r = .26;
- labour experience r = .18;
- interview r = .14 (this predictor increase to .45 in later studies due to a better interview structure with a strong cognitive component);
- training and skill ratio r = .13 (not very reliable because of the few data about the number of subjects and the features of the analysis sample);
- academic achievement r = .11;
- educational level r = .10;
- interests r = .10;
- age r = -.01.

3.8.6 Computerised Assessment System for the Selection of ATCOs

We constructed the CAS-ATCOs taking into account the following points:

1. It is possible its inclusion in other similar selection and training processes.

2. Its relevance for the professional performance of the ATCO's (Johnston, McDonald and Fuller, 1997).

3. The demands of *AENA,* the enterprise in charge of the selection process.

    3.1 The selection process should last less than 3 hours.
    3.2 The system should avoid the test reconstruction.
    3.3 Immediate and automatic correction.
    3.4 Scientific guarantees of each test.

Therefore the CAS – ATCOs is composed of a variety of tests which assess attitudinal and personality dimensions.

3.8.6.1 Attitudinal Variables

3.8.6.1.1 Spatial Orientation

This is a part component of the Visual spatial ability, which its main characteristic is the perception of objects, figures or symbols placed in the space. The spatial abilities relate to the capability of the subject to follow the trail of the visual field, to apprehend the shapes and positions and the mental manipulation of such visual displays. There is a great number of studies which prove the spatial ability importance as a primary ability clearly different from intelligence (Hunt, 1987), moreover there is a great evidence suggesting that the spatial ability tests can be considered good predictors of performance in some technical learning processes. The ATCO has to handle the traffic in his/her airspace sector (for instance, managing arrivals, departures, over flights, changing flight levels or routes in response to requests or situational considerations, in short, ATC is based on a huge amount of different skills).

We constructed the Spatial Orientation Test to assess this ability, which significantly correlates with sub-scales of paper-and-pencil spatial orientation test like the Jigsaw puzzle Test (TEA), solid pieces test (TEA), BFA (MEPSA) and Trajectories (IMPAP).

3.8.6.1.2 Visualisation

It is defined as the ability to generate a mental picture, to transform it and to memorise the changes (Lohman, 1979). Among the basic tasks and jobs of an ATCO we consider the necessity to get the mental picture of the traffic situation, to make quickly decisions, to derive plans, problems and to avoid conflicts (for example, changing the path of the aircraft, the flight levels, providing separations, and so on). The Visualisation Test significantly correlates with sub-scales of paper-and-pencil spatial orientation test like the Jigsaw puzzle Test (TEA), solid pieces test (TEA), BFA (MEPSA) and Trajectories (IMPAP).

3.8.6.1.3 Divided Attention

The capability to draw the attention simultaneously to different tasks in an effective and efficient way. An optimal performance in this test would show that the subject has a good capability to execute and to give priority to multi various activities at the same time. The divided attention is one of the present dimensions in every selection processes of ATCOs, and also in the basic studies that analyse the ability involved in complex tasks like ATC (Juan Espinosa, 1996). This variable was asses with the Divided Attention Test.

3.8.6.1.4 Maintained Attention

It is the capability to draw the attention to one task for a long time, either to a monotonous task or to a distracting or difficult one. The normal way to assess this capability is to face the subjects with a long task, thus damage in the performance could appear. The Maintained Attention Test is based on the **Continuos Attention Task (CAT)** by Tiplady (1985, 1988) validated by the same author (Tiplady, 1992) as an appropriate measure of the ability to maintain the attention on a single information source.

3.8.6.1.5 General Intelligence

Intelligence can be described as a capability to mentally process the information in the way that a person can reason, resolve problems and make decisions. Nowadays, we have a big amount of evidences about the great predictive power of performance of the general intelligence tests in the labour world. The correlation between performance tests and labour performance ranges from .30 to .60 (Hunter, 1986). Specifically about the ATCOs' profile, Ackerman and Kanfer (1993) denote that the general intelligence variables are the best predictors. The General Intelligence Test of CAS-ATCOs shows a .443 correlation with the paper-and-pencil Bonardel's Test.

3.8.6.2 Personality Dimensions and Interactive Styles

3.8.6.2.1 Frustration Tolerance

This interactive style is defined by the tendency of the subjects to maintain learning rates in a problematic situation in spite of consecutive failures trying to get the solution. Subjects with low tolerance frustration will reduce their learning rates after frustrating experiences. Considering the major role of the motivational processes and the importance of being able to overcome negative emotions, the dimension of frustration tolerance can be considered as one of the most relevant variables in the applicants' selection for ATCOs.

3.8.6.2.2 Persistence

This interactive style is defined by the tendency of the subjects to respond in a given situation in spite of the low rate of reinforcement, that's to say, to get the solution (Beck, 1983). Persistence is related to the motivational achievement, consider by almost all the selection processes of ATCOs in Europe.

3.8.6.2.3 Controlability

This interactive style is defined by the tendency of the subjects to try to find solutions in a problematic situation in spite of non-existence of contingency relations between his/her answers and the solutions of the problem. According to Anderson's results (1977) and Bandura's data (1977), we would expect that a success (reinforcement) should increase the internal control of the subjects. However, the failure should emphasise the lack of control of the subjects with external control.

3.8.6.2.4 Tendency to take Risks

The tendency of the subjects to choose, among a variety of responses, the riskiest answer (the one with the low probability to be reinforced but with the highest reward). In the CAS-ATCOs the tendency to take risks is assessed by two tests: The Dices Test and the Crossing Street Test.

3.8.6.2.5 Transgression of Rules

We try to assess the degree in which a person executes certain behaviour even when he/she has been told not to do it. Even considering that following the rules can diminish the efficacy to solve the task. This dimension is relevant because it can predict the adjustment to highly structured environments. To assess this variable, the CAS-ATCOs uses the Transgression of Rules Test.

3.8.6.2.6 Meticulously

This is one of the "five factors models" of the personality (Digman, 1990; Goldberg, 1990). The meticulously factor, according to the NEO-PI-R (Costa and McCrae, 1992a, 1992b; Costa and McCrae, 1995), consider the degree of organisation, persistence and motivation in the targets directed behaviour. A

subject with high scores in this dimension can be described as a well-organiser, reliable, good-worker, self-control and punctual (Pervin, 1996). From an applied point of view, Barrick and Mount (1991) show a consistent correlation between meticulously and labour performance efficiency. The CAS-ATCOs assess this dimension by the Meticulously Test.

3.8.6.2.7 Extraversion-Introversion

This is a classic dimension in the personality study from the trait psychology perspective. It is included in the most common assessment tools like the EPQ (Eysenck, 1959), the 16 PF (Cattell and Eber, 1962), the NEO-PI-R (Costa and McCrae, 1992a) or the BFQ (Caprara, Barbaranelli, Borgogni and Perugini, 1993). This dimension is joined to the quantity and intensity of interpersonal relations. The subjects in the extraversion pole are more capable to establish interpersonal relationships, are more active, dominant and like stimulating places. They also tend to feel positive emotions like joy and happiness. The extraversion scale of the 3 D - Personality Test of CAS-ATCOs correlates significantly (r= .662) with the E scale (energy) of BFQ.

3.8.6.2.8 Emotional Stability

This is a classic dimension in the personality study from the trait psychology perspective. It is included in the most common assessment tools like the EPQ (Eysenck, 1959), the 16 PF (Cattell and Eber, 1962), the NEO-PI-R (Costa and McCrae, 1992a) or the BFQ (Caprara, Barbaranelli, Borgogni and Perugini, 1993). This dimension refers to the emotional adjustment. Low scores in emotional stability show a tendency to feel tension, fears, frustration, loneliness, guilty feelings, sadness, and embarrassment. The scale of Emotional Stability of the 3 D - Personality Test of CAS-ATCOs correlates significantly (r= .637) with the EE scale (emotional stability) of BFQ.

3.8.6.2.9 Responsibility

This is one of the “five factors models” and it is included in assessment tools like the NEO-PI-R (Costa and McCrae, 1992a) or the BFQ (Caprara, et al., 1993). This dimension shows the degree of organisation and motivation to the target directed behaviour. Subjects with high score in this dimension tend to feel confidence in task performance. They are meticulous and methodical, with a high sense of duty, and a great ambition. The responsibility scale of the 3 D - Personality Test of CAS-ATCOs correlates significantly (r= .662) with the ES scale (scrupulous) of BFQ.

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3.8.8 Slides Used During the Presentation

C.A.S. - ATCOs
Computerised Assessment System for the selection of Air Traffic Controllers

- By: Ms. Mª Jesús Alava
  - *Development and Professional Project*
  - *Aena* (SPAIN)
- By: Mr. Julio Alvarez
  - Professor
  - Universidad Autonoma de Madrid - U.AM. (SPAIN)

Objective

- To develop an efficient tool to assess the applicants for the training course for ATCOs, selecting the ones who best fit the success standards required, trying to discriminate the applicants who will successfully finish the learning process to become an ATCO from those who will fail, for any reason.

The EATCHIP dimensions

- **In order to select the relevant attitudinal and personality variables we reviewed the documents of different countries that collaborate with the EATCHIP program.**

Attitudinal dimensions

- MEMORY
  - Short term memory (79%)
  - Long term memory (54%)
- ATTENTION
  - Concentration (75%)
  - Vigilance (58%)
  - Divided Attention
  - Selective Attention
- LOGICAL REASONING
- ARITHMETICAL CALCULUS (67%)
- PERCEPTION (71%)
- SPATIAL COMPREHENSION
  - Spatial orientation
  - Visualisation
- MULTITASK PERFORMANCE (63%)

Personality dimensions

- MOTIVATION AND ACHIEVEMENT (67%)
- DECISION MAKING BEHAVIOUR (59%)
- SOCIAL BEHAVIOUR
- STRESS MANAGEMENT

Labour Performance Predictors (I)

- Intelligence quotient (IQ) r = .53 (G factor, perceptive ability, and general psychomotor ability)
- Test period r = .44 (small samples)
- Biographical inventory r = .37 (correlate with intelligence and personality test –Smernou and Lautenschlager, 1991-)
- Reference Informs r = .26
- Labour experience r = .18

Labour Performance Predictors (II)

- Interview r = .14 (this predictor increase to .45 in later studies due to a better interview structure with a strong cognitive component)
- Training and skill ratio r = .13 (not very reliable because of the few data about the number of subjects and the features of the analyse sample)
- Academic achievement r = .11
- Educational level r = .10
- Interests r = .10
- Age r = -.01

Computerised Assessment System for the Selection of Air Traffic Controllers (I)

1. Its possible inclusion in other similar selection and training processes.

2. Its relevance for the professional performance of the ATCOs (Johnston, Fuller y McDonald, 1995).

Computerised Assessment System for the Selection of Air Traffic Controllers (II)

3. The demands of *Aena*, the enterprise in charge of the selection processes.

3.1. The selection process should last less than 3 h.
3.2. The system should avoid the test reconstruction.
3.3. Immediate and automatic correction.
3.4. Scientific guarantees of each test.

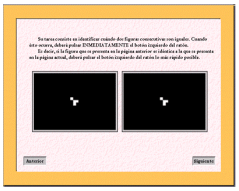
The following slides were animated during the presentation and showed examples of tests:

Spatial Orientation Test

Visualization Test

Divided Attention Test

Maintained Attention Test



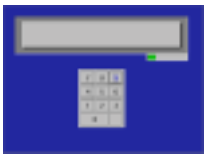
Risk Test I: Dices Test

Risk Test II:
Crossing the Street Test

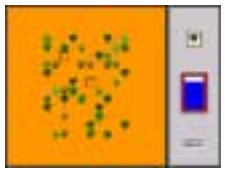
Transgression of Rules Test

Controlability Test

Persistence Test

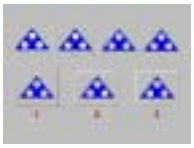


Meticulously Test



Frustration Tolerance Test

General Intelligence Test



4. SEMINAR CONCLUSIONS

4.1 Current Issues and Concerns in ATCO Selection

From the papers presented and the discussions following the keynote presentations, the Open Forum presentations and the Expert Panel's discussions, it seems that the current issues and concerns in ATCO selection are the needs:

- **To integrate MP, marketing, recruitment, selection, training and licensing within an overall MP of the HRM system.**

An integrated approach of these "Inflow Processes" to fulfil the target of having a sufficient number of qualified controllers available in time is necessary. There are constraints in terms of time needed for marketing, recruitment, selection and training, the time to start the processes and the likely numbers of applicants at each of the stages. This concerns mainly the selection ratios at different stages of recruitment and selection (including medical examinations) and the success rates at different stages of training. These constraints and conditions need to be taken fully into account in overall MP.

For example, medical examination of candidates before training is based on requirements set for obtaining a license after training. Higher medical requirements or other changes need to be investigated with regard to their impacts on MP and selection. Specific concerns have been raised by several experts with regard to medical failures, after selection, e.g. due to application of Electroencephalogram (EEG).

- **To assure that selection and training work "hand-in-hand" to decrease a still high failure rate.**

Success in training cannot only be ensured by effective and efficient selection. Savings can be gained if training is geared towards success. The change of attitudes and behaviour of training instructors and of the training climate and culture are powerful means to achieve this.

A "systems approach" to selection and training (establishing appropriate feedback loops) - as a means to quality management - should be adopted aiming for continuous, incremental improvements in all or many stages of the process from marketing to training.

- **To integrate a pre-selection stage to save resources and time and to increase the selection ratio.**

There is value in developing "fully fledged" methods to pre-select candidates after application and before further testing in terms of resources (money, staff) and time. Pre-selection can also lead to a higher selection ratio at the end of the recruitment and selection process.

- **To enhance marketing efforts (e.g. job information sessions) to attract more suitable applicants.**

Besides a still high, and in some States increasing failure rate in training, it has been noted that the selection ratio (number of applicants recommended after testing/interview : total number of applicants tested) is decreasing at the same time. Thus, there is evidence for the fact that the number of suitable applicants is decreasing. Together with an overall decreasing number of applications – which is observed in a number of States – the situation could create a heavy constraint for the recruitment, selection and training system.

Appropriate measures should therefore be taken in marketing and job information to make the profile of the controller job more visible and/or more attractive to applicants and to regain competitive advantages in comparison to other occupations and industries. It has to be noted that a less favourite success rate in training could work against it.

- **To identify common selection methods that could possibly work in different States, by e.g. conducting cross-national selection and validation.**

There is some evidence from cross-national/cross-cultural task analysis of controllers for a high similarity in the controller job and tasks. Efforts have been made also to apply and validate same or similar selection tests and other methods in cross-national settings.

The results of this and from further investigations could be used to identify and/or develop a test battery. Such a battery could be used especially by those (smaller) States that have not yet obtained advanced selection method, or have to face prohibitive development costs compared to the likely benefits to be gained.

- **To follow up more closely the great diversity in selection tests and methods.**

There is a great variety and diversity in current tools and methods in selection covering various abilities, skills, knowledge and behaviours. This is partly due to the testing and psychometric philosophy followed and/or differences as to what criteria selection should be geared towards (training criteria, job performance criteria). It is also somewhat unclear as to the weight that should be given to assessing cognitive abilities, or the ability to acquire knowledge and skills during training or job-related behaviour. These different approaches should be followed up more closely. The exchange of available results and information should continue as has been started within this 1st EUROCONTROL Selection Seminar.

- **To monitor the ever increasing coaching of applicants.**

Applicants have an ever increasing access to courses and books preparing for selection tests for controllers. This tendency present a challenge to traditional psychometric efforts.

4.2 Questions to be tackled

The Chairman summed up the questions that should possibly be tackled in the future:

- How can we increase the job profile of ATCOs to be more attractive?
- How can we fulfill the manpower targets?
- Coaching of applicants: Take the challenge or attack?
- How to decrease failure rate in training?
- How to increase selection ratio?
- What could possibly be done in terms of common efforts?

A still high failure rate in training and a low selection ratio (both with a tendency of getting even worse) need to be tackled as a matter of urgency. During the seminar and the following study session for a group of members from the former STFII (who discussed the conclusions and identified issues of concerns and proposed actions), a few ways for how we could possibly tackle the concerns and questions were mentioned:

- There is an urgent need in most ECAC States to attract more suitable applicants. Different States – despite a high unemployment rate – do not attract enough applicants. This can be done by increasing the job profile of controllers, to inform about the career prospective of controllers, to inform potential applicants better about the controller job etc. This should be done with the aim to gain higher competitive advantages.
- As one of the means to create a higher job profile, ways could be found as to how to credit trainees for their achievements after different training phases. Diploma/Certification of controller trainees should be widely recognised (ECAC wide) and be of real value to trainees/controllers.
- Adopt a systems approach to selection and training: establish feedback loops; continuous, incremental improvements in many stages of the process from marketing to training.
- Change attitudes, climate and culture in training. For example, it was felt that more use could be made of special expertise in training (e.g. by psychologists) to help students to cope with emotional or motivational problems during exams. The availability of such expertise could be beneficial for those obtaining good results in theoretical training but face difficulties in practical training or OJT.

Use of available expertise in selection in Europe and even abroad to learn from each other and to share the expertise, experience for mutual benefit.

- Study Groups (EATMP) to work on practical solutions, to share results and findings ECAC wide.
- Work together in establishing selection systems. Means and options should be investigated within EATMP to acquire and/or develop a “European Controller Test Battery” that could be used in those ECAC States that are in need of this, especially the “smaller” States. In order to identify the need for such a battery and to oversee possible implementation problems with regard to application of guidance material for selection procedures and tests produced by EATCHIP, there is the need for an ECAC Survey on Implementation of Selection Guidelines.

- It was felt that selection activities could also be co-ordinated on a bilateral (or trilateral) basis for the benefit of each State.

5. SEMINAR EVALUATION

Participants were asked to complete an evaluation form concerning the seminar. A summary of the results based on the 34 forms which were received is provided below.

	N	Min.	Max.	Mean	Std. Deviation
Seminar's subject	34	5	6	5,76	0,43
Recommend the seminar to others	34	3	6	5,64	0,70
Tell colleagues about the seminar	33	3	6	5,52	0,80
Hotel accommodation	31	2	6	5,42	0,92
Report on seminar within my organisation	34	1	6	5,41	1,16
Conduct of the seminar	34	3	6	5,41	0,82
Consider attending the next seminar	34	3	6	5,41	0,86
Facilities at the institute	33	3	6	5,39	0,86
Discuss applicability with colleagues	33	3	6	5,39	0,83
Info in the Seminar's folder	34	3	6	5,38	0,85
Opportunity to learn new findings	32	3	6	5,37	0,91
Use the handouts	33	4	6	5,36	0,70
Seminar's objective	34	3	6	5,35	0,81
Room signposting	33	3	6	5,30	0,92
Opportunity to meet other colleagues	33	2	6	5,24	1,03
Use notes which I took	34	2	6	5,24	1,07
Learn more about certain subjects	31	3	6	5,23	0,84
Programme outline	34	3	6	5,18	0,94
Food	32	4	6	5,16	0,81
Simulator tour	25	4	6	5,16	0,80
Coffee breaks	33	3	6	5,09	0,88
Panel discussion - relevance	33	3	6	5,06	0,83
Understand certain selection issues better	31	2	6	5,06	1,09
Presentations provided different aspects	34	3	6	5,06	0,78
Keynote speaker level	33	3	6	5,00	0,79
Keynote presentation relevance	34	4	6	5,00	0,78
Opportunity for networking	33	2	6	4,97	1,13
Open Forum presentations – relevance	34	3	6	4,91	0,83
Consider implementing specific items	32	2	6	4,81	1,23
Time allocated for panel discussion	33	2	6	4,79	0,99
Keynote speaker presentations	34	3	6	4,71	0,76
Keynote speaker list	33	1	6	4,45	1,33
Time allocated for open forum	33	1	6	4,36	1,39
Time allocated for each keynote speaker	34	1	6	4,29	1,53
Info provided by HRT representative	18	1	6	3,94	1,80
Info provided by my local focal point	17	1	6	3,82	1,67
Seminar's fees	31	1	6	3,74	1,95
Leaflet design	30	1	6	3,53	1,61
Information on web-site	22	1	6	3,45	1,57
Attractiveness of Luxembourg as a location	33	1	6	3,15	1,82

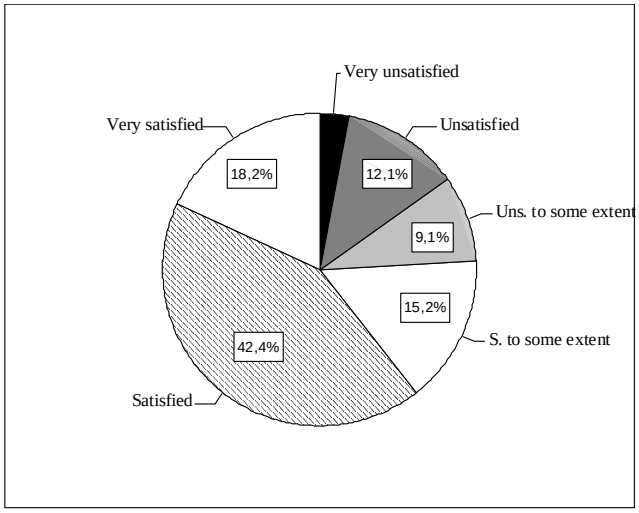
While taking the decision to participate at the seminar, 85.3% found its objective important or very important and 78,7% mentioned the opportunity to meet other colleagues as important or very important.

After the seminar, 71,6% were satisfied or very satisfied with the relevance of the keynote presentations and 75,7% were satisfied or very satisfied with the relevance of the Panel discussion. 85.3% of the answers were satisfied or very satisfied with the way the seminar was conducted.

More important are the future steps of the participants. 85,3% will certainly report on the seminar within their organisation; 87,9% will certainly tell colleagues about the seminar; 84,9% will certainly discuss applicability with colleagues; 77,4% will certainly understand certain selection issues better.

Regarding concrete practical actions, 62,5% will certainly consider implementing specific items; 80,7% will certainly learn more about certain subjects; 79,4% will certainly use notes which they took during the seminar; 87,9% will certainly use the handouts; 88,2% will certainly consider attending the next seminar and 93.9% will certainly recommend the seminar to others.

Opinions regarding the time management varied. The figure bellow shows e.g. the level of satisfaction with the time allocated for the Open Forum:



Responding to a question **"What I liked most at the seminar?"** 10 participants mentioned the opportunity to meet and network with participants with similar interests; 9 the variety of speakers and well balanced selection approaches; 8 mentioned the seminar's good management, conduct, organisation and planning; 6 the fact that they gained knowledge, ideas; 6 the presentations from a practical point of view and 3 mentioned the friendliness and openness of participants and presenters.

Answering the question **"What I liked least at the seminar?"** 8 mentioned the dense schedule, time pressure, too long sessions without a break; 5 found that some presentations were too theoretical; 3 found the introductions of speakers too long and 2 liked least the CAST presentation.

Response to **"What else could be improved?"** 7 would like to have more small breaks, 5 wish to have more discussion groups, discussion time, or discussion area; 3 suggested to provide text and figures of all transparencies before the seminar, 3 wish to have more time for demonstrations of tools; and 1 suggested to allow beverages in the meeting room.

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ABBREVIATIONS AND ACRONYMS

For the purposes of this document, the following abbreviations and acronyms shall apply:

ACC	Area Control Centre
AFS	Advances Functional Simulator
AENA	Aeropuertos Españoles y Navegación Aérea (Spanish Airport and Air Navigation Administration)
ANOVA	Analysis of Variance
ANS	Air Navigation Services
ASI	Aerospace Sciences Inc.
AT	Air Traffic
AT-SAT	Air Traffic-Selection and Training (USA)
ATC	Air Traffic Control
ATCO	Air Traffic Controller/Air Traffic Control Officer
ATCS	Air Traffic Control Specialist
ATM	Air Traffic Management
ATS	Air Traffic Service
BTEC	Business and Technician Education Council
CAA	Civil Aviation Administration
CAMI	Civil Aeromedical Institute (USA)
CAS	Computerised Assessment System
CAST	Consequences of Future ATM Systems for Air Traffic Controller Selection and Training
CAT	Continuos Attention Task
CBPM	Computer-Based Performance Measure
CD-ROM	compact disc read-only memory
CHAID	Chi Square Automatic Interaction Detection

COROM	Cognitive Competencies Model
CPCs	Certified Professional Controllers (USA)
CRT	Choice Reaction Time
CTI	Collegiate Training Initiative (USA)
DAC	Dynamic Air Traffic Control test
DEM	German Marks
DFS	Deutsche Flugsicherung GmbH (Germany's air navigation service provider)
DIS	Directorate Infrastructure, ATC, Systems and Support
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V. (German Aerospace Center)
EATCHIP	European Air Traffic Control Harmonisation and Integration Programme
EATMP	European Air Traffic Management Programme
ECAC	European Civil Aviation Conference
EEG	Electroencephalogram
ENAC	École Nationale de l'Aviation Civile (France)
ET	Executive Task
EUROCONTROL	European Organisation for the Safety of Air Navigation
EWP	EATCHIP Work Programme
FAA	Federal Aviation Administration (USA)
FJAS	Fleishman Job Analysis Survey
FPL	Full-Performance Level (USA)
GCE	General Certificate of Education
GCSE	General Certificate of Secondary Education
HCA	Human-Centred Automation
HRI	Human Resources International (Israel)
HRM	Human Resources Management

HRT	Human Resources Team
HUM	Human Resources Domain
IANS	Institute of Air Navigation Services (Luxembourg)
ICAA	Iceland Civil Aviation Administation
ICNA	Air Traffic Control Engineer (France)
ISO	International Standards Organisation
KfV	Kuratorium für Verkehrssicherheit (The Austrian Traffic Safety Board)
KSAOs	Knowledge, Skills, Abilities, And Other characteristics
LFS	Low-Fidelity-Simulation
MAS UAC	Maastricht Upper Area Control Centre (UAC)
MP	Manpower Planning
MRU	Projekt Marknadsföring Rekrytering Urval och Utbildning (Project for marketing, recruitment, selection and training for ATCO students, in Sweden)
NATS	National Air Traffic Services Ltd. (United Kingdom)
OCR	Optical Character Recognition
OJT	On-the-Job Training
OPM	Office of Personnel Management
PATCO	Professional Air Traffic Controllers Association (USA)
PC	Personal Computer
PHARE	Programme for Harmonised Air Traffic Management Research in EUROCONTROL
PTS	Pre-Training Screen (USA)
PV	Performance Verification
REP	Report
RS NATS	Recruitment Services NATS
RT	Radio Telephony

SACHA	Separation and Control Hiring Assessment (USA)
SD	Standard Deviation
SDE	Senior Director Principal EATMP
SHL	Saville and Holdsworth Ltd.
SJA	Strategic Job Analysis
SME	Subject Matter Expert
SSA	Smallest Space Analysis
STANINE	Standard Nine Score
STCA	Short Term Conflict Alert
STF	Selection Task Force
SWAT	Subjective Workload Assessment Technique
TMC	Terminal Control Centre
TRM	Team Resource Management
TWR	Aerodrome Control Tower
VFR	Visual Flight Rules
VRA	Veterans Readjustment Act (USA)