DOT/FAA/AM-91/9

Office of Aviation Medicine
Washington, D.C. 20591

Selection of Air Traffic Controllers: Complexity, Requirements, and Public Interest

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May 1991

Final Report

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-91/9		

4. Title and Subtitle	5. Report Date
SELECTION OF AIR TRAFFIC CONTROLLERS: COMPLEXITY, REQUIREMENTS, AND PUBLIC INTEREST	May 1991
	6. Performing Organization Code
7. Author(s) Edited by: Hilda Wing, Ph.D., and Carol A. Manning, Ph.D.	8. Performing Organization Report No.
9. Performing Organization Name and Address FAA Civil Aeromedical Institute P.O. Box 25082 Oklahoma City, Oklahoma 73125	10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Office of Human Resource Management Federal Aviation Administration 800 Independence Avenue, S.W. Washington, D.C. 20591	13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

CAMI work was performed under task AM-D-HRR-112.

16. Abstract

The essays in this technical report represent presentations made as part of a symposium entitled "Selection of Air Traffic Controllers: Complexity, Requirements, and Public Interest." The symposium was presented at the 98th Annual Convention of the American Psychological Association, August 10-14, 1990, in Boston, MA. The presentations address the diverse process of valid selection for a highly demanding occupation in the career Federal civil service: the air traffic control specialist. Although the military services and a growing number of colleges and universities provide training in air traffic control, the Federal Aviation Administration has up to now maintained fairly strict and restricted access to most of the required selection and training for this highly visible job whose occupants are perceived to hold the nation's air traffic and safety in their hands. Each of the accompanying reports discusses a different component of the selection process for air traffic controllers.

17. Key Words	18. Distribution Statement
Air Traffic Control Human Resource Management Planning Selection Procedures Evaluation	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	42	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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FOREWORD

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Although the military services and a growing number of colleges and universities provide training in air traffic control, the Federal Aviation Administration has up to now maintained fairly strict and restricted access to most of the required selection and training for this highly-visible job whose occupants are perceived to hold the nation's air traffic and safety in their hands.

Each of the accompanying reports discusses a different component of the selection process for air traffic controllers.

OVERVIEW OF NATIONAL AIRSPACE HUMAN RESOURCE MANAGEMENT PLANNING PROCESS

The modernization of the National Airspace System (NAS) was undertaken by the Federal Aviation Administration (FAA), industry, and the aviation community to meet increases in system capacity demands. Unprecedented growth in the number of aircraft operations is requiring improved, expanded services, additional equipment, improved work force productivity, and the orderly replacement of aging equipment.

To meet these demands, FAA has examined its operational, technical, and personnel requirements and designed one of the most ambitious technological and organizational transition efforts ever attempted. Over a 20-year period, new technological advances will be introduced involving higher levels of automation, in addition to major consolidation efforts which will transform all en route centers and 188 terminal radar approach control facilities into fewer than 30 major air traffic control facilities.

The success of the introduction of new systems and the consolidation of facilities are dependent upon 16,000 Air Traffic (AT) controllers, 8,700 Airway Facilities (AF) systems specialists, and thousands of managers and support personnel at the FAA Academy, Technical Center, and the Logistics Center. To transition smoothly from the existing air traffic control system to a modernized NAS will be dependent upon FAA's ability to develop and implement a long-range plan for managing the human resource aspects of the NAS modernization. Such a long-range plan will ensure that during the modernization FAA has adequate numbers of properly trained people in the right place at the right time.

The purposes of this paper are to (a) describe the context in which human resource planning must be accomplished, (b) describe the planning approach/analyses process that identifies (NAS) human resource requirements and strategies to address them, and (c) examine strategies to ensure ownership of institutionalization of the planning process.

The Planning Context. Figure 1 depicts the complex human machine system that we call our National Airspace System (NAS). Human resource planning has to be accomplished within the context of the systems that make up the NAS and the overall NAS performance requirements.

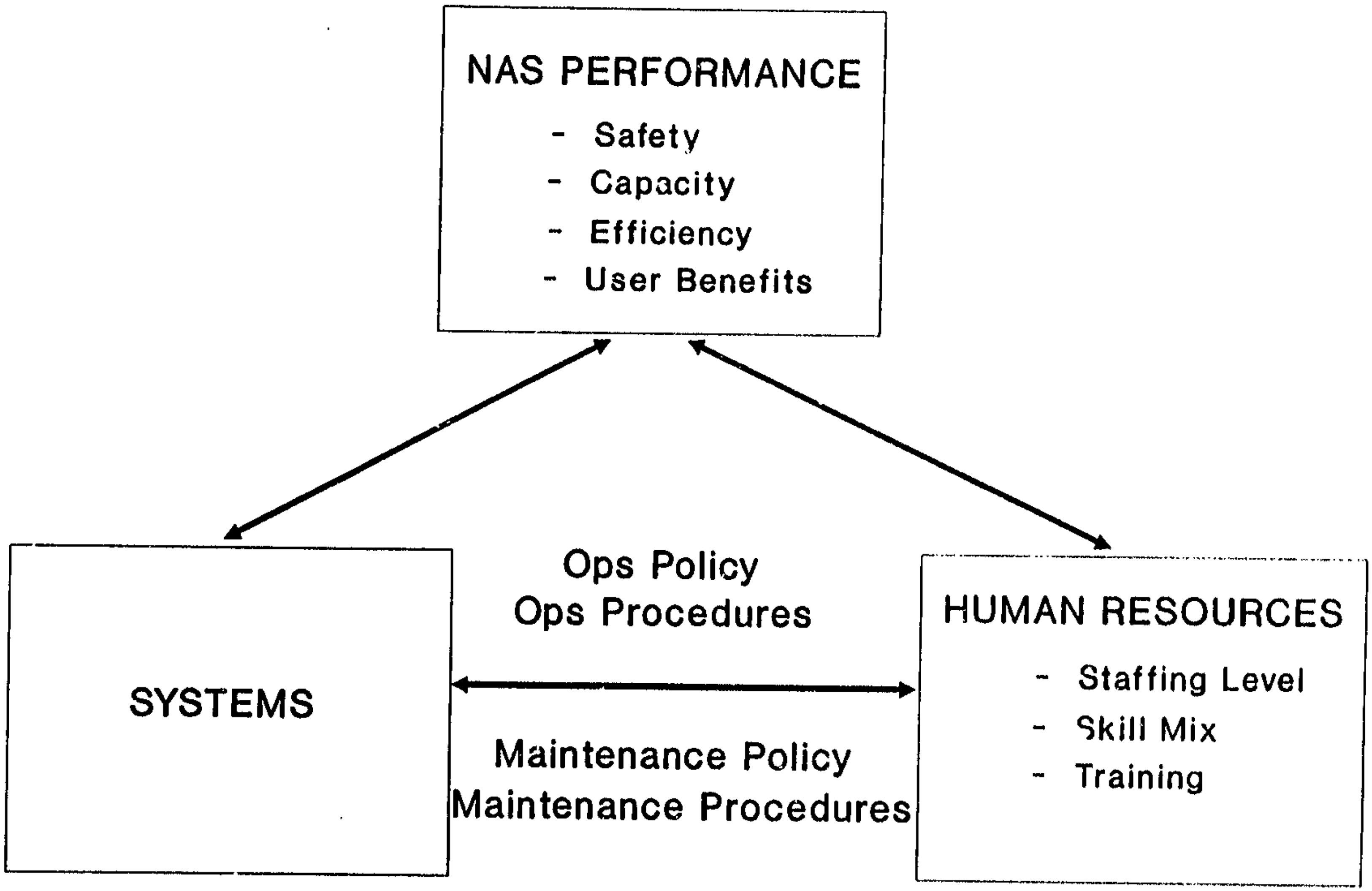
The three elements contained in Figure 1 are highly interactive, and as any two of the elements become "fixed" the requirements and constraints for the third element are clarified. For example, in planning for the NAS modernization, one of the basic assumptions is that there is no margin for reduction in either safety or capacity dimensions of NAS performance. Given these fixed performance requirements, as the design of the systems in the NAS becomes fixed, the performance requirements for the human resource element in the NAS also become fixed. For this reason, it is important that the human resource element be considered as early as possible in the design of systems. Ideally, human resource analyses can be conducted before systems designs are "fixed" so that potential limitations or costs of the human resource component can be considered in systems design.

Even under conditions of fixed systems design, there is still an opportunity to enhance the human contribution to the overall system performance by developing good operational/maintenance policies and procedures. Operational policies and procedures and maintenance policies and procedures, along with software, define the allocation of work between the systems and the human. A second opportunity to enhance the contribution of the human is the human resource pipeline itself. FAA must ensure that adequate numbers of properly trained people are available.

Within the described context, it is essential that human resource planning be based on analyses that incorporate data and assumptions regarding technology, people, and systems performance requirements.

The Approach. Figure 2 illustrates the basic approach to NAS human resource planning

Figure 1. NAS Human Resource Planning Context



that FAA began in 1988. The approach is based upon four major phases with associated analytical processes.

The first phase, contextual analysis, identifies the end state(s) or the planning target for the human resource planning process. The principal objectives of the contextual analyses are to define the future work environment and to identify the critical human resource management issues that must be addressed in the planning process.

The principal analysis conducted during this phase is an alternative futures analysis. The objective of the analysis to identify critical events and trends that will impact the human resource (i.e., operational concept for future control of air traffic, future maintenance concepts, etc.). The output is a set of "alternative futures" scenarios defined by future operations and maintenance concepts as well as future systems capabilities and specifications.

Once the planning targets have been identified, the next phase, human resource analyses, is conducted to: (a) identify the human resources required to support the projected future environment; (b) project the capacity of the human resource pipeline to meet the projected demand.

In identifying the human resource "demand", the pertinent analyses focus on estimating the basic workload for air traffic controllers and AF systems specialists who will operate and maintain the components of the future NAS. The resulting workload estimates form the basis for answering the question of how many people are needed to operate the new systems.

Attention is then given to the knowledge, skills, and abilities (KSA's) that are required to effectively operate and maintain the future NAS. Concurrently, analyses focus on the viability of different organizational structures as a function of variables such as management structure, shift schedules, location of human resources, etc.

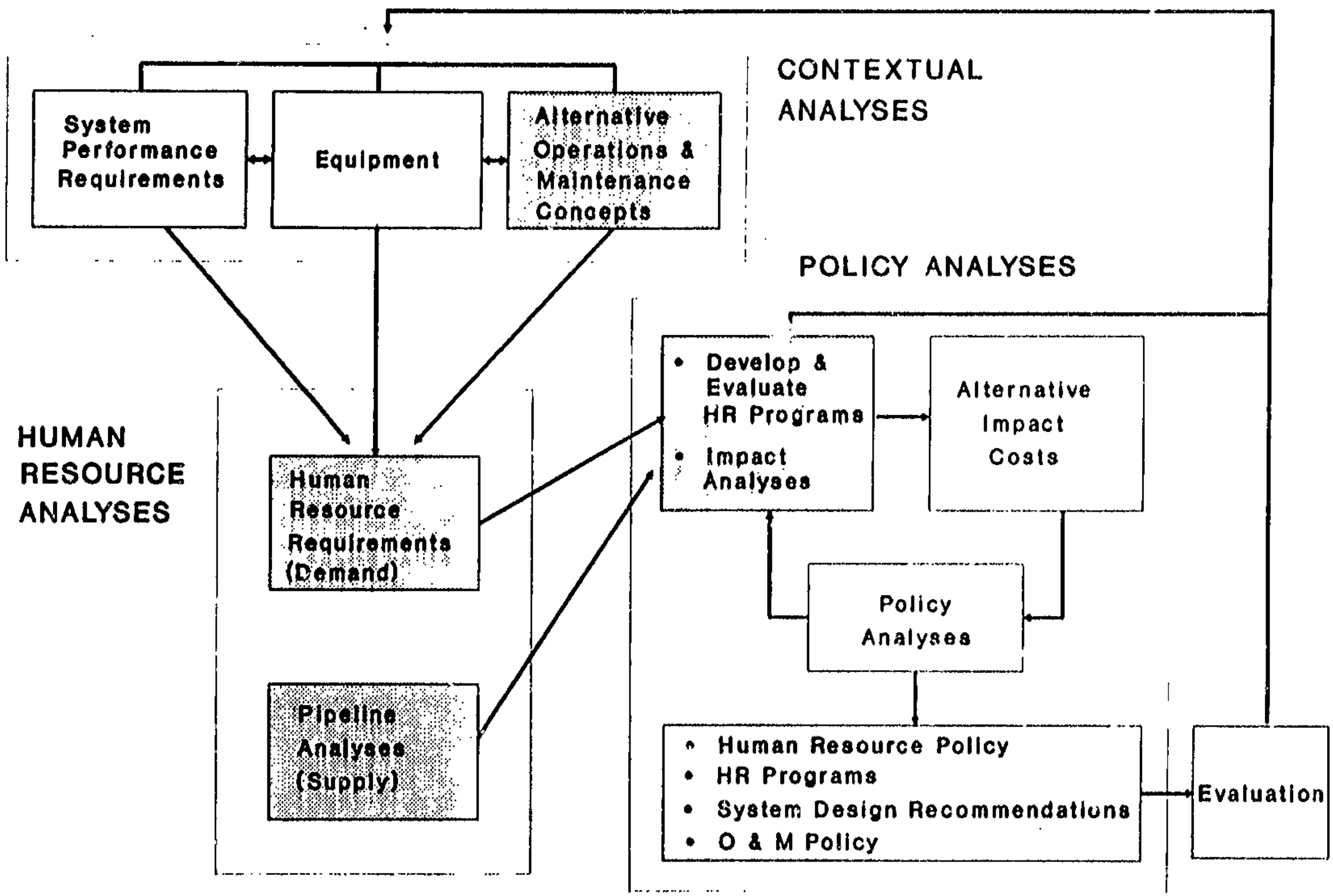
The analyses conducted in the first two steps of the human resource analyses phase address the operational human resource requirements for the future state. A third set of analyses are conducted to identify the resources for transition-specific related activities such as transition training, operational test and evaluation, shadow operations during equipment installation and shakedown.

The ability of FAA to meet the projected human resource requirements is analyzed through sets of pipeline analyses focused on the "supply" side. Separate analyses are conducted to examine the recruitment, selection, and training systems for various work forces. In addition to addressing issues such as selection rates, attrition rates, and lead times required for various selection and training activities, the pipeline analyses should examine the potential capacity of various systems in the pipeline to meet demands and requirements for additional resources such as staffing.

Additionally during this phase, analyses focus on the training resource requirements and scheduling implications associated with alternative training strategies. The analyses conducted in this portion of the human resource planning program do *not* address content and media selection for specific training programs. Instead, the analyses are focused on issues such as the number of personnel required for training in a given period of time, timing, and length of training under alternative training strategies. Analyses will be conducted to provide separate and combined resource requirements for the AT and AF work forces.

Once the planning targets of the future environment have been defined and the human resources required to support that environment have been estimated, the FAA then must be able to determine how it will meet the identified needs. As illustrated in Figure 2, the policy analysis phase of the approach involves a three-step iterative process that eventually produces outcomes such as human resource policies, recommendations for human resource management programs, future system design recommendations, and recommendations for operations and maintenance policies. The iterative policy analysis process begins with the development of alternative human resource programs that represent alternative courses of action to resolve issues identified through the human resource analyses.

Figure 2. Human Resource Planning Approach



The alternative programs are then subjected to impact analyses which produce estimates of the system impacts and costs associated with each human resource program alternative. Policy makers then examine these alternative human resource programs and their associated costs and performance impacts within the context of other operational policy factors known to the policy makers. These individuals may suggest revisions in the alternatives which are then subjected to the impact analyses and examined by the policy makers during the next iteration of the policy analysis process. When the policy makers have examined all feasible alternatives, they develop the appropriate recommendations regarding human resource policy, programs, etc.

The final phase of the planning approach illustrated in Figure 2 is an evaluation phase. During this phase, human resource policies and programs, as well as system design recommendations, are evaluated for feasibility, practicality, and cost. This evaluation is an ongoing process and provides feedback to allow for adjustments to HR programs that have been developed, as well as system performance requirements, systems design, and operations and maintenance concepts that have been established. The information from these evaluation efforts is then fed back into the planning process and considered as part of the context for future iterations of the planning cycle.

Institutionalizing the Planning Process. In 1988 the FAA initiated the NAS Human Resource Management program. This program's primary goal is to support the FAA in developing an effective, efficient process for managing the human resource aspects of the NAS modernization. Through use of the planning approach described in the previous section, the FAA will be able to achieve this goal because it will have a mechanism to do the following:

Develop and implement an integrated strategy for recruitment, selection, training and management of human resources;

- Provide FAA managers with accurate information to estimate training requirements and evaluate alternative training strategies;
- Provide FAA managers with data required to project and obtain adequate funding to implement the required human resource management programs;
- Provide managers in the field with the appropriate data and planning tools to develop and implement solutions for human resource challenge;
- Provide the FAA work force with information which established realistic expectations and effective means to cope with changes resulting from the NAS modernization; and
- Establish an ongoing human resource planning process that is integrated with and sensitive to the evolving requirements and changing schedules of the NAS modernization effort.

The management of such a comprehensive planning program in an agency such as the FAA represents a considerable challenge with changing operational requirements, time and budget constraints. The requirements of the program and the existing FAA management culture suggest the need for a management process that is highly participative and highly integrated. The success of such a management process is highly dependent on good communication and buy in to the planning approach by all major stake holders.

Given the management requirements cited above, the FAA developed and implemented a management process for the NAS HRM Program that operates with the following philosophy:

- The most immediate and essential requirements for human resource planning exist in the operational environment of the FAA;
- Human resource planning is the responsibility of FAA line management;
- The office of the Associate Administrator for Human Resource Management (AHR) can

provide methodological expertise for NAS human resource planning and develop programs to facilitate change in the FAA, but the executive directors are the policy makers and policy implementers; and

- Ownership of the NAS Human Resource Plan must reside with FAA line management.

The emphasis on line management responsibility for human resource planning which pervades the assumptions above is not only consistent with existing FAA culture, but also has been associated with successful human resource programs in other organizations. Such a management philosophy does, however, require a significant investment of time and other resources *by senior managers involved in FAA operations* and system development.

To assure involvement by FAA managers in providing direction and establishing management policy on the continued development and implementation of the planning process, the FAA Executive Board chartered two management committees--the NAS HRM Steering Committee and the Working Committee. The NAS HRM Steering Committee is tasked with making decisions regarding policy development and implementation. The NAS HRM Working Committee is tasked with providing data, subject-matter experts, and coordinating planning activities for each participating line organization.

The Office of Human Resource Development and the line organizations develop a Memorandum of Understanding (MOU) that documents what needs to be accomplished in support of the planning process. The MOU's give detailed information on project activities, critical milestones, resources required, and organizational points of contact.

Status. The first iteration of the NAS HRM Plan will be published in October 6, 1990. Development of the 1991 NAS HRM Plan is underway.

NOTE: The technical support for the development of the 1990 NAS HRM Plan was provided by FU Associates, Ltd., under the very able direction of Dr. Barry Rieglehaupt.

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EMPLOYING AIR TRAFFIC CONTROLLERS

The process of recruiting, selecting, and placing air traffic controllers is in many ways a model personnel problem. It has several features that make it similar to the large scale military and heavy industry selection situations from which much of classic personnel testing is derived. At the same time, it has other features that reflect the problems we all face in personnel selection today.

I will describe how the FAA hires controllers, and as I do, I will point out the kinds of problems and parallels that I just mentioned.

The FAA currently employs about 17,000 air traffic controllers in terminal facilities and en route centers. These controllers are civil servants. They have civil service appointments, just like IRS agents, Social Security clerks, and Park Rangers. We hire between 1800 and 3400 new controllers each year using civil service procedures. The FAA trains all these people as controllers. Thus, we engage in mass entry level hiring and training, like the military and some industries. We have to use procedures that can help us screen and sort large numbers of people for the ability to learn the job and perform in it.

The controllers' strike in 1981 resulted in the firing of over half of the controller work force. Because of the importance of aviation to this country and public concerns about safety, our ability to rebuild that work force is the object of intense public and Congressional scrutiny. This constant scrutiny is one aspect of the environment in which we conduct our daily business of employing controllers. Partly in reaction to the pressure to rebuild the work force as quickly as possible, the FAA has become a leader in developing streamlined civil service hiring procedures.

Recruitment. We begin with recruitment. We recruit in a number of ways. Our controllers recruit their sons, daughters, cousins, nephews, nieces, and friends. They also make presentations at schools and meetings of community groups. Besides the controllers themselves, we have a growing staff of full time recruiters in our human resources offices who go to schools, community organizations, job fairs, and air shows in search of likely candidates. We also advertise. We use newspaper ads, magazine ads, television ads, and in some places toll free numbers to obtain responses.

We must recruit constantly. In recent years, the controller job has received a great deal of negative publicity, particularly with regard to the stress in the job.

More than that, as a Federal employer, we have an affirmative action obligation that only recruitment can help us meet. A piece of that Congressional scrutiny I mentioned before concerns our EEO posture. I cannot over emphasize the level of interest by Congress and minority groups in the FAA's hiring of controllers or the seriousness with which we take that interest.

Finally, aggressive recruitment is necessary because it is hard for us to find young people with the combination of abilities needed for controller work. By civil service policy, we do not hire anyone under 18 years of age, except that we could hire a 16 year old who had graduated from high school. We also have a maximum entry age for terminal and en route positions. Applicants may not have reached their 31st birthday prior to initial appointments to those positions. Our preferred applicants are in their twenties. That younger population is declining in this country. The baby boom is long over for us. We are competing with the military, other public safety jobs that have maximum entry ages, and business for an increasingly scarce human resource. This is a real problem that our recruiters grapple with every day.

Age. Let me point out that the maximum entry age is not popular with the people it excludes from employment. A good portion of my time as a policy maker is spent responding to criticism of the age limitation rule. We have numerous studies supporting the fact that people do not do well in the controller occupation as they get older. This holds for a variety of criterion measures. Moreover, the maximum entry age is specifically provided for by law and the government has successfully defended the rule against legal challenges.

Along with the maximum entry age, controllers have a mandatory separation age of 56. By law, controllers must be removed from positions requiring direct separation and control of air traffic by that age. The law is actually somewhat more complex than I have described it. It also entitles controllers to full retirement much earlier than the average civil servant. They regard this as a significant benefit. The effect of these rules is that we recruit people who are young and they leave the occupation relatively young.

Selection. The Federal Civil Service is a merit system. We are supposed to find the best available people for jobs. For this reason, air traffic controllers are normally hired under competitive procedures. That means we must have an examination by which all qualified applicants can compete on the basis of their ability. Applicants compete by taking a written civil service test battery designed to select controllers.

The government usually does not use off-the-shelf commercial exams for civil service tests, partly for test security reasons. The tests in the battery were developed by the Office of Personnel Management (OPM) and the FAA. Normally, these civil service tests must be validated prior to implementation as operational exams. This was the case with our exam. Further, civil service tests are subject to the Uniform Guidelines on Employee Selection Procedures and all the attendant court decisions, interpretations, and data collection requirements imposed on any large employer, government or business, in the United States.

Our current test consists of three parts. One part is composed of figure classification and letter series problems. Another part consists of drawings which simulate a radar scope depicting patterns of air traffic. A table containing flight information about the aircraft, like speed, altitude, and route is also provided. The examinees answer questions that use the information provided by the drawings and tables. For example, they answer questions about which aircraft are likely to conflict with each other and the distances between aircraft. This part of the battery does not require that the applicant know or apply air traffic control knowledge. Knowledge is assessed in the third part of the examination. The knowledge test is intended to give extra credit to those who have previous air traffic control experience or extensive aviation experience, for example, people who have been air traffic controllers for the military.

The OPM has responsibility for civil service testing. Both the FAA and OPM administer the test. OPM delegated the FAA authority to administer the test to help us reach more applicants. Together, we test between 25,000 and 100,000 people a year. We try to offer the exam throughout the U.S. If we make people travel long distances to take the test, we are, in effect, discriminating against those from lower socioeconomic strata who cannot afford to travel.

The test is sometimes subject to criticism because members of certain minority groups and women generally do not score as high on the test as we would like. This is not an unusual situation for an employer. In addition, as with some other examinations for government jobs and some college entrance examinations, there are a number of companies now offering books and seminars on how to take the test. We have data showing that portions of the battery are subject to practice effects and this is a subject of concern.

When applicants sit for the test, they also fill out a computer form that lets us determine if they are probably eligible for employment as controllers. In addition to the age restrictions I spoke of, applicants may not be former controllers fired for striking, they must be U. S. citizens, and have three years of general work experience of any type or four years of college or a combination of the two equaling three years of work experience.

All Civil Service tests must be scaled for a passing score of 70 and a maximum of 100. An exception here is veteran's preference. The veteran's preference rules require that extra points be added to the test scores of certain veterans in order to produce a final rating. Veteran's preference points can take a rating over the 100 mark. A score of 75.1 on the test is passing for those with no prior aviation experience. Those with certain kinds of aviation related work experience or certain educational qualifications need only score 70 on the test.

We rarely consider people with final ratings in the 70's. Those are low scores. Our preference is to hire people with scores of 90 or above. When sufficient numbers of people with scores in the 90's are not available, we will consider people with scores in the high 80's.

The answer sheets are scored first in the FAA office responsible for testing in that state. This unofficial initial scoring is done with a portable computer scanner. We identify the candidates who appear to have high scores. If their other forms make them appear to be eligible, we send them pre-employment papers to complete. All candidates' answer sheets and computer forms are then sent to an OPM facility in Macon, Georgia, for official scanning and entry into the computer inventory of examinees.

Candidate Interview. The high scoring candidates who appear to be eligible are asked to contact certain FAA towers or air route centers near them to schedule an interview. We have trained a large number of supervisory and management level air traffic controllers throughout the country to serve as job interviewers. The training includes a number of areas, including EEO.

The candidates complete the papers we sent them and bring them to the interview. This paperwork helps us determine if the candidates are eligible for the job. Also at the interview, applicants are given a tour of the facility in order to help them understand the work of a controller. The interview consists of both information gathering by the interviewer and time spent explaining and showing the job to the applicant. We find this necessary because often young people have an idealized image of the occupation and later drop out of training claiming they discovered "it isn't for them." For example, we have been surprised by the small number of young people who really understand what we mean when we say that controllers work rotating shifts, as well as weekends and holidays.

Medical Examination. If the interviewer is satisfied with the applicant, he or she will schedule the person for a medical examination either with an FAA physician or an aviation medical examiner under contract with the FAA.

We have a strict set of medical standards that applicants must meet. The vision and hearing standards are especially tough. The FAA has done work to validate its medical requirements, although some are still controversial.

A part of the medical requirements has to do with emotional health. Generally, Federal agencies are prohibited from using personality tests in selection. However, at the interview, we administer two forms of the 16PF as part of the medical examination. It is scored in the Office of Aviation Medicine in Washington, D. C. using a "controller key." The test indicates who must go on for further evaluation by a clinical psychologist and psychiatrist. It is not used as an absolute screen-out. About 2 percent of all applicants must go on for further evaluation.

Applicants also undergo urinalysis for drug use.

One reason that an interviewer may not be satisfied with an applicant is that the person may have at some time taken illegal drugs. We ask candidates about that specifically. If they have something like drug use in their background, we will delay the medical examination until completion of the background check.

Background Investigations. All controller applicants are subject to a thorough background check before we hire them. The FAA tends to be wary of people with driving while intoxicated convictions, drug convictions, most criminal convictions, other than honorable discharges from the military, and large numbers of minor traffic violations. The background check can be a time consuming process. Much of the work used to be done by other agencies. One way the FAA has expedited hiring has been to take over the routine portions of that investigation on behalf of these agencies.

If the interviewer recommends the applicant, or at least does not object to the person, the person's medical exam indicates no problems, and the background check is clear, then the person will probably be hired if positions are available.

The Screen. However, that is not the end of the matter by any means. The next step is to send the person to the FAA Academy in Oklahoma City, Oklahoma. We hire the individuals, that is, give them their civil service appointments, when they start the Academy. Because of the vagaries of the federal budget process, it is not uncommon for good candidates to wait to be given a firm job offer in the form of a date to report to the Academy. The wait can last several months if there is a backlog of cleared candidates waiting to report.

When the candidates finally do report, they enter an unusual program called the FAA Academy screening course. This program was begun in 1976 at the direction of Congress. The purpose of the screening course is to reduce attrition in the field training by identifying those candidates with the greatest potential for success in the occupation. Students who do not pass the Academy screening program have their employment terminated.

The screening program is a selection device. It is a second stage to our selection system, designed to eliminate those people unlikely to succeed in the field training. The Screen, as we call it, is effectively a mini-training and evaluation procedure. We teach newly hired individuals a simplified set of air traffic rules. Then, they apply those rules in a simulated air traffic control environment.

The OPM civil service test is a fairly good predictor of success in the screening course. Even so, since 1985, the pass rate at the Academy has been about 60 percent. In part, this is because we do not always have the luxury of hiring only those people in the very highest score ranges on the test. For a number of reasons, we have not had enough of those people available in the past.

The Screen has been the subject of considerable criticism recently. In part, this is because it is easy to confuse this personnel evaluation procedure with training. There are other criticisms. It is resource intensive. The entire process takes about 9 weeks. During this time, the FAA is paying these persons a salary, plus a certain amount for living expenses. It costs the government about $10,000 to send someone to the Academy screening course. Moreover, we hire people, then conduct a selection activity, then terminate the employment of those who do not pass. Some criticize the content of the Screen activities. For example, the Screen tasks are not radar simulations and since the Screen was developed, much more ATC work is done with radar. The FAA is responding to these issues.

We have a project in process to develop a three to five day second stage pre-hire screening procedure. This project will address the issue of whether we should be testing with a more radar-like simulation. Most people see computers as a remedy. However, any computer simulation system will have to take into account possible adverse impact that could occur due to applicants' lack of familiarity with keyboards and CRT's. It will also have to take into account the logistics of fielding and securing computer testing systems to screen several thousand people a year.

Developmental Assignments. For those who graduate from the Screen, there remain placement and training. Students are hired by specific FAA regions and sent to the Academy as that region's employees. If the students pass the Screen, they are placed in facilities within the region according to three factors: agency need, how well they did at the Academy, and the student's choice. Usually, the primary concern is: "Where do we need people?" However, we try to place those who do better at the Academy into en route centers and the more difficult terminals. Those who do not do as well we try to place in less complex terminals. Sometimes, we are able to accommodate student's choices of facilities by giving them a choice within a range of facilities of equal complexity.

After the placement phase at the Academy, the students attend some further Academy training to prepare them for the type of facility they will be attending. Then, they move on to their first facility assignment. Those who go to facilities that use radar will return to the Academy later for radar class. Developmental controllers receive the bulk of their training in their facilities. This is a combination of classroom and on-the-job training.

Our field training is conducted on what we call an "up or out" basis. That means that students must continue to progress in their training or have their employment terminated. We do not have permanent intermediate positions short of full performance level controllers. However, we do have some facilities with more difficult work than others. Therefore, we have a program that allows students to be given a chance to succeed in less complex facilities before terminating their employment. Not everyone gets that second chance. It depends on the availability of positions and on where the person was in the training before he or she failed. Someone who cannot succeed at the very early training in a complex facility is unlikely to be able to handle the work in a less complex facility. Someone who succeeds in the early stages of training at a complex facility but who cannot handle radar work might succeed in a non-radar facility.

When you consider that our potential applicant pool is shrinking, it begins to make economic sense to try to make sure that every person who could possibly succeed does succeed. Studies that the FAA has commissioned of its field training indicate that the current training probably does not do that.

For this reason, the FAA is redesigning its training programs.

Many large companies will be facing this kind of problem in the future, if they are not already. When you have large numbers of very capable applicants available, you can emphasize selection and de-emphasize training. When the available applicant pool is small, you will still want to select judiciously, but you will find yourself with a greater training task if you plan to fill your vacancies.

That is not our only approach. We are also looking at alternative sources of applicants to try to develop a pool of those who have training already. We are helping colleges and universities develop programs to train people to be air traffic controllers and we are looking at how we can best use those trained as controllers in the military.

While the current controller test accommodates those with experience as air traffic controllers, it may be that as we develop these alternative sources of candidates we will want to select them using other procedures.

In summary, the FAA's employment of controllers is representative of a cross section of issues facing personnelists and selection experts. We conduct large scale entry level hiring into a hi-tech occupation. We rely on a shrinking pool of young people for applicants so we must recruit aggressively. We have to comply with civil rights rules. We have mental ability testing, medical standards, drug testing, background investigations, and age restrictions. We try to use realistic job previews. We have to gauge the value of computers in our examining. We have to judge the proper mix of selection and training. As we seek alternative applicant sources, we may have to develop alternative selection procedures that suit those sources.

PROCEDURES FOR SELECTION OF AIR TRAFFIC CONTROL SPECIALISTS

The Air Traffic Control Specialist (ATCS) occupation in the Federal Aviation Administration (FAA) consists of three specialties, the en route, terminal, and flight service station (FSS) options. En route and terminal ATCSs ensure the separation of aircraft traveling between airports (en route) and approaching or departing from airports (terminal) through the issuance of clearances (instructions regarding allowable altitudes and directions of flight) to pilots. FSS specialists are another type of ATCS who provide such pilot services as giving weather briefings, filing flight plans, and helping locate lost aircraft. However, because FSS specialists are not responsible for ensuring aircraft separation, the procedures used to select them differ. This presentation will address only selection procedures used to hire en route and terminal specialists.

First stage of selection: The OPM ATCS selection battery. A short history of ATCS written selection batteries: Early ATCS selection research identified a number of commercial aptitude tests which predicted performance in ATC training programs. In addition to the commercial tests, other tests were developed (e.g., directional headings, air traffic problems [ATP]) which contained items representing activities performed on the job.

As a result of this research, a selection battery consisting of tests of Arithmetic Reasoning, Spatial Relations, Following Oral Directions, Abstract Reasoning, and Air Traffic Problems was implemented in 1962 as the first Civil Service Commission (CSC) selection battery for ATCSs. Prior to that time, the only selection criterion was prior experience in controlling air traffic (which would have occurred in a military environment).

The version of the Office of Personnel Management (OPM) selection battery currently in use was implemented in October 1981, about two months after the ATCS strike. This battery consists of the Multiplex Controller Aptitude Test (MCAT), the Abstract Reasoning Test (retained from the CSC battery), and the Occupational Knowledge Test (OKT).

MCAT: The MCAT was developed to replace the written aptitude tests included in the previous version of the CSC selection battery with a test having higher predictive validity. MCAT items were developed to require examinees to use many of the skills required for the control of air traffic in a simulated air traffic setting.

The MCAT provides a set of air route maps showing routes of flight through a sector of airspace. Aircraft locations are indicated on each air route map, as are locations where the routes of flight intersect. A table accompanies each map which includes other relevant information, such as aircraft altitudes, speeds, and planned routes of flight (see Figure 1). Many MCAT items require identifying aircraft that may conflict with other aircraft. Other items involve computing time-distance functions, interpreting information, and analyzing spatial relations. The MCAT contains 110 items and is speeded. Sixty-five minutes are allowed for taking the test.

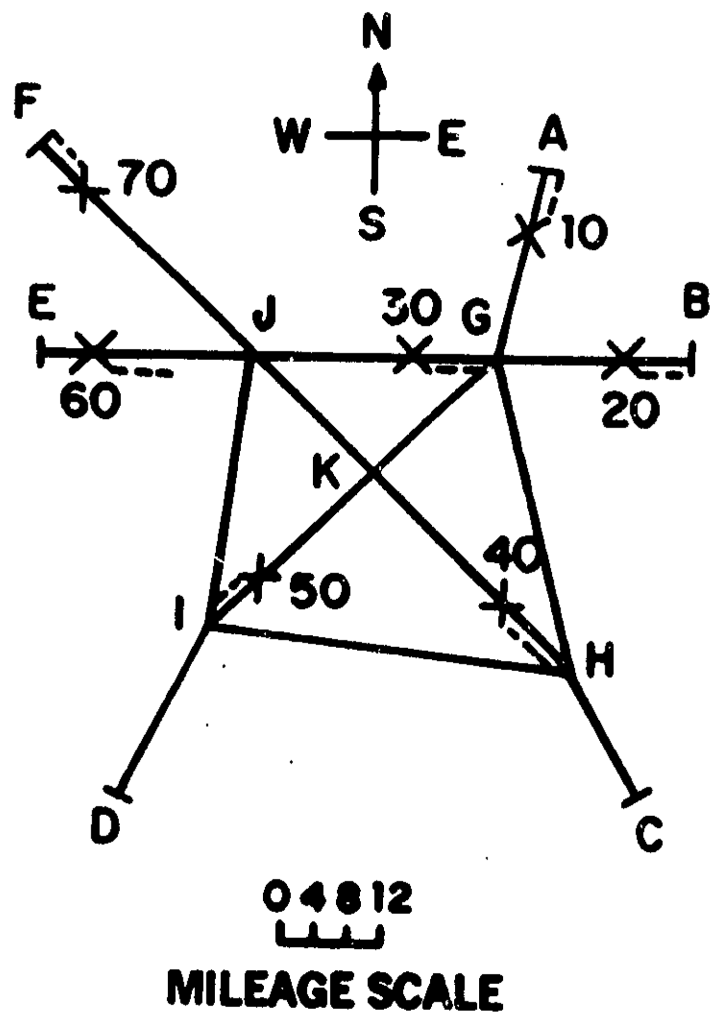
Harris (1986) conducted a construct validity study to identify the underlying dimensions of the MCAT by correlating performance on it with performance on a set of cognitive marker tests. She found high correlations between the MCAT and tests of Integrative Processes, General Reasoning, Spatial Orientation, Logical Reasoning, and Spatial Scanning. The results of a factor analysis suggested that MCAT had equal loadings on two factors: a dimension emphasizing the organization, definition, and manipulation of the perceptual field (.31), and a cognitive dimension emphasizing verbal and nonverbal reasoning (.32).

ABSR: The Abstract Reasoning Test (ABSR) was the only test retained from the original CSC battery. ABSR is a 50-item paper-and-pencil test, which assesses the ability to infer relationships between symbols. Both letter series and figure classification items are included in the test (see Figure 2). Thirty-five minutes are allowed to take the ABSR.

FIGURE 1

MULTIPLEX CONTROLLER APTITUDE TEST (MCAT)

AIRCRAFT	ALTITUDE	SPEED	ROUTE
10	7000	480	AGKHC
20	7000	480	BGJE
30	7000	240	AGJE
40	6500	240	CHKJF
50	6500	240	DIKGB
60	8000	480	DIKJE
70	8000	480	FJKID



SAMPLE QUESTION

WHICH AIRCRAFT WILL CONFLICT?

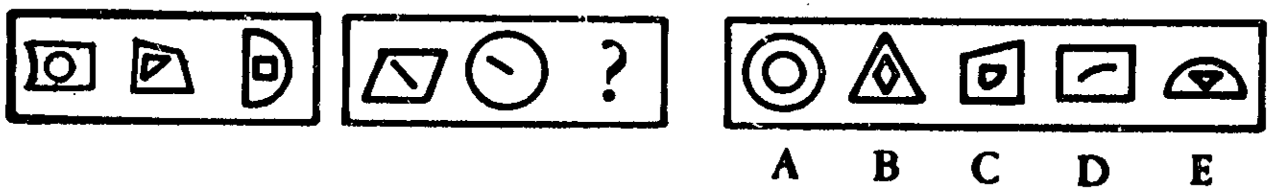
A. 60 AND 70
B. 40 AND 70
C. 20 AND 30
D. NONE OF THESE

FIGURE 2

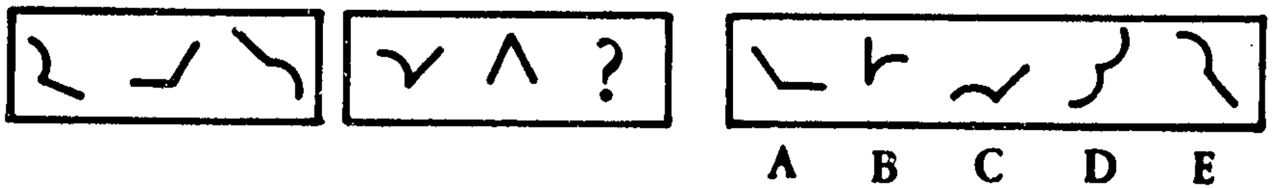
ABSTRACT REASONING

Symbols

1.



2.



Letters

1) XCXDXEX A) FX B) FG C) XF D) EF E) XG

2) ARCSETG A) HI B) HU C) UJ D) UI E) IV

TABLE 1: Applicant OPM ATCS battery performance
April 1985 - September 1985 applicants
N=8,826

Measure	Mean	Std. Dev.
MCAT	73.0	16.6
ABSR	31.5	9.3
OKT	29.2	11.6
TMC	75.5	12.5
Rating	76.4	13.3

OKT: Before 1981, extra points were awarded to an applicant's CSC rating based upon their claim of prior job-related experience. The Occupational Knowledge Test (OKT) was developed to provide a more objective and reliable measure of ATCS job knowledge. Items on the OKT cover seven knowledge areas related to air traffic control. The OKT contains 80 items and 50 minutes are allowed to take this test.

The earned OKT score does not count toward qualification, but provides additional points for applicants who already qualified on the basis of their performance on the other selection tests.

Computing the OPM rating: To obtain an OPM rating, the number of MCAT items answered correctly is weighted .8 and the number of ABSR items answered correctly is weighted .2. The sum of the weighted scores is transmuted so that the result (the Transmuted Composite; TMC) is from a distribution having a mean of 70 and maximum of 100. If the applicant's performance on the aptitude test battery results in a score of at least 70 (or 75 for those applicants without previous aviation experience), then extra credit points are added to the TMC for Veteran's Preference and for sufficiently high performance on the OKT. The result is the OPM Rating (RAT).

Table 1 shows the means and standard deviations for the component tests included in the OPM ATCS battery. These data were collected from a group of applicants who took the tests between April and September 1985.

Over 170,000 applicants have been tested using this procedure since 1981. The FAA has experienced several problems with this test. First, the MCAT appears to be learnable. VanDeventer (1984) found that mean MCAT scores increased as applicants repeated the test. He observed about a 7 point increase for those who repeated the test once and about an 11 point increase for those who repeated the test twice. Smaller increases (no more than 2.5 points) were observed for those repeating the ABSR and OKT tests. However, the score increases related to test repetition were not associated with corresponding improvements in Academy scores. As a result of this research, OPM, in October 1985, limited testing repetitions to once every 18 months for those applicants who earned a passing score.

In recent years, a number of independent organizations began offering courses to prepare candidates to take the OPM battery. An issue now facing the FAA is how to assess the effect of these courses. Preliminary analyses suggest that those taking the preparation courses have lower Academy pass rates than other candidates with similar OPM scores who did not take preparation courses. However, the identification of those who took the courses was based on self-report data; thus, additional studies must be done to better understand the effects of taking these courses.

Second stage of selection: The ATC Academy Screen program. A short history of the ATCS Screen program: In 1975, congressional hearings held by the Committee on Gov-

TABLE 2: Academy student performance
October 1985 - September 1986 entrants

Measure	N	Mean	Std. Dev.
Block Average	902	93.2	8.0
Comprehensive Phase Test	902	91.1	6.9
Laboratory Average	848	66.6	12.7
Instructor Assessment	848	79.0	9.8
Technical Assessment	848	45.3	15.7
Controller Skills Test	847	76.8	12.1
Final grade	847	73.8	10.0

ernment Operations concluded that the FAA's basis for selecting ATCSs was inadequate to reasonably identify individuals with the potential to complete training successfully. They also determined that ATCS trainee attrition from the occupation (which typically occurred about two to three years into training) was unacceptably high.

The Congressional Committee recommended the development of a standardized, centralized program designed to identify and remove from training those candidates who did not demonstrate sufficient aptitude to become ATCSs. As a result of these recommendations, the FAA developed a program designed to lower the costs of attrition by improving the selection of ATCSs. Screening of ATCS applicants began in 1976. Originally, the screening process included two programs, one for those selected to enter the en route option, and the other for those selected to enter the terminal option. In 1985, the two programs were consolidated into a single screening program. In this program, students are not assigned to an option or facility until they complete the Screen. Scores earned in the Screen contribute to the placement decision.

The nine-week Academy Screen program is designed to assess the aptitude of individuals having no prior knowledge of the occupation by having them learn a set of nonradar-based air traffic control rules and principles, then providing a series of laboratory simulation problems in which the student demonstrates the application of those principles. Students complete the laboratory problems by performing the duties of an ATCS during standardized, timed scenarios encompassing the movement of aircraft through a specified airspace. During the problem, another student performs the roles of the aircraft pilots and other "controllers" participating in the scenarios. Instructors, former ATCSs who have been trained to observe and rate student performance, grade the performance of the students. Laboratory grades are comprised of two parts, the Technical Assessment (based on numbers and types of errors made) and the Instructor Assessment (based on the instructor's judgment of how well the student performed the problem as compared with other students the instructor had rated previously.)

Table 2 shows means and standard deviations for the individual graded components of the Screen program. These data were collected for students who took the OPM test before the change in administration procedures was made in October 1985, and entered the Academy program on a competitive basis between October 1985 and September 1986. Numbers of observations differ for the components because some people withdrew from the program before its completion. It is clear that most candidates do well in the academic portions of the program, but do not perform as well on the laboratory problems.

Student performance on the best five of the six graded laboratory problems administered comprises 60% of the final grade, in the current

TABLE 3: Correlations of OPM and Academy Performance Measures with Status in Field Training for 402 1986 Screen Graduates Assigned to En Route Option

OPM Tests	unadjusted r	adjusted r
MCAT	.09	.24
Abstract Reasoning	.03	.04
OKT	.06	.04
Transmuted Composite	.08	.24
Rating	.09	.35
Academy Tests		
Block Average	.06	.10
Comp. Phase Test	.07	.09
Lab. Problem Average	.21	.36
Inst Assessment	.22	.37
Tech Assessment	.21	.30
Controller Skills Test	.16	.26
Final Score	.24	.44

version of the program. 20% of the final grade is contributed by performance on academic, paper-and-pencil tests. Another 20% of the grade is contributed by performance on the Controller Skills Test, which is designed to duplicate the activities required of the controller in a paper-and-pencil format. Figure 3 shows the weights of the individual components used to compute the final grade.

Field training: Candidates who are unsuccessful in the Screen are usually removed from the FAA. Those who pass (now called "developmentals") are assigned to an air traffic control facility. Facilities have differing levels of complexity (based on the number and type of aircraft that operate there) and perform different types of air traffic control services. Upon arrival at their facility, developmentals undergo training, conducted by the facility in a pass/fail mode, that emphasizes the procedures appropriate for that facility's functions and designed specifically for their airspace. The training program requires, on the average, 2.9 years for en route developmentals to complete and between 1 and 2.3 years for terminal developmentals, depending on the type of facility to which they are assigned.

Information on performance in field training has been collected by the FAA since the strike in 1981. The data were originally intended to be used as criterion measures against which to compare developmental performance on the selection procedures. However, these data have also been used to provide evidence for Equal Employment Opportunity (EEO) investigations, congressional inquiries, and also provide feedback into management decision making. The data collected regarding field training include information on developmental training disposition (attained FPL level, still in training, switched facilities, switched to a less complex option, failed and separated from the GS-2152 (ATCS) series, or left the FAA for reasons unrelated to performance). Other data include dates of occurrence, OTJ hours, grades, and global instructor ratings for specific training phases.

Predictive validity of the selection procedures: Some studies have been done to assess the validity of the selection procedures discussed here for predicting performance in later field

TABLE 4: Prediction of Field Training Status

Results of Multiple Regression Analysis
Predictors not Adjusted for Restriction in Range

Variable	R	R^2	R^2 Change	F	Beta	Partial Correlation
OPM Rating	.117	.014	.014	5.47	.06	.06
Academy Score	.274	.078	.064	16.63	.26	.25

training. VanDeventer (1981) obtained attrition information and supervisor ratings for a sample of successful Academy graduates about three years after their graduation. He found that the correlations between the Academy composite score and field supervisors' ratings were .56 (adjusted for restriction in the range of predictor scores) for those in the en route option. At the time he conducted the study, no CSC test scores were available for analysis. Manning, Della Rocco, and Bryant (1989), found a correlation of .46 (adjusted for restriction in range) between Academy score and both field instructor ratings and field training status.

Table 3 shows correlations, both unadjusted and adjusted for restriction in the range of predictor scores for both OPM tests and Academy performance measures with field training status for a group of students who graduated from the Academy in 1986. These students took the OPM test before the change in administration procedures was made in October 1985, and entered the Academy between October 1985 and September 1986. Field training status is an ordinal variable with the following categories: Reached FPL, Still in training, Switched options, and Failed. Those who separated from the occupation for reasons unrelated to performance were excluded from the analyses.

It is clear that the MCAT is the most predictive of the OPM tests. Interestingly enough, adjusting for restriction in the range of scores reduced the correlation between the OKT and field training status because the variability in OKT scores was greater for the sample entering the Academy than for the applicant population taking the test. This phenomenon can be explained by differentiated selection by experience level. While only 5% of applicants who earned no OKT points entered the Academy, over 20% of applicants who earned 5 or more OKT points were selected. The resulting sample had greater variability of OKT scores than the original population, in which 93% of applicants earned no OKT points.

With regard to the Academy tests, scores on laboratory problems are better predictors of field training status than are scores on the academic tests. The Instructor Assessment has a slightly higher correlation with the criterion than the Technical Assessment, because the range of IA scores for Academy graduates was restricted more than was the range of TA scores. The Controller Skills Test, a paper-and-pencil test designed to measure skills used in the laboratory problems, is a better predictor of field training status than are the more traditional paper-and-pencil tests (Block Average and Comprehensive Phase Test.)

Two multiple regression analyses were conducted to assess the relative contributions of the OPM and Academy tests in predicting field training status. The first regression analysis used correlations of OPM and Academy tests, unadjusted for restriction in the range of predictors, with field training status. The results, shown in Table 4, suggest that both variables contribute very little to the prediction of ATCS field training status, although Academy score accounts for more of the variance in field training status than does the OPM rating.

However, it must be remembered that the range of the OPM rating is doubly restricted.

TABLE 5: Prediction of Field Training S[illegible]s

Results of Multiple Regression Analysis
Predictions Adjusted for Restriction in Range

Variable	R	R^2	R^2 Change	F	Beta	Partial Correlation
OPM Rating	.353	.125	.125	56.94	.70	.29
Academy Score	.511	.261	.137	70.52	.38	.39

Only applicants with scores higher than 90 are chosen. Then, additional restriction occurs because of the second stage of selection. Because OPM scores are correlated with Academy scores, then restricting the range of Academy scores by selecting only those who score 70 or above further restricts the range of OPM scores present in the sample by the time they enter field training. The range of Academy scores is also restricted (but only singly) because only those who earn a grade of 70 or above are allowed to progress into field training. Thus, it is possible that the low correlation of the two predictors with field training status is an artifact of their restricted variability.

Another multiple regression analysis was conducted to determine what would happen to the relative predictability of the OPM rating and Academy final score if the predictor scores were separately adjusted for restriction in range (Thorndike, 1949). The OPM score was adjusted using Thorndike's 3-variable formula to account for the double restriction in range due to the two stages of selection. Table 5 shows the results of the analysis. When adjusted for restriction in range, both the OPM rating and Academy score contribute considerably more to the prediction of ATCS field training status than they did in the first regression analysis. By adjusting the OPM score for double range restriction, it appears that the OPM score contributes almost as much to the prediction of field training status as does the Academy score.

However, it must be remembered that the range of the OPM rating is doubly restricted. Only applicants with scores higher than 70 may be selected to enter the Academy, and usually, only those with scores higher than 90 are chosen.

These results must be interpreted carefully, because adjustment for restriction in range may bias the resulting correlations, especially if the distribution of the predictor deviates significantly from normality. Using biased adjusted correlations would bias the results of the regression analysis correspondingly. While the results of this analysis may be suspect, they provide some additional insight into the relationship of the two predictors with the field training status criterion.

Discussion. The Screen program receives a certain amount of criticism. One problem is that although the Screen program is a selection procedure (because the scores are used to make employment decisions about the candidates) several weeks of training are provided initially to prepare the student to take the laboratory problems. Some training must be provided because it is assumed that students have no prior knowledge of air traffic control. Thus, the program is often considered, even within FAA, to be a training program instead of a selection procedure. This creates some confusion and dissatisfaction within the FAA because 1) there is only a 60% pass rate in a program that many think should be training new hires to be ATCSs, and 2) the training provided involves only some of the job tasks performed by most of the controllers in the field (because the Screen program is based on nonradar en route procedures while the job, at most en route facilities, involves radar control procedures). If the program is considered to be a miniaturized training-testing environment for selection, the training that occurs should be

TABLE 6: ATCS Attrition by time of entry

Time period	*Academy*	*Field*
1971-1975	N/A	41%
1976-1981	29%	8%
1981-1985	42%	11%

viewed as related to the testing effort, and not to the career development of the controller.

Using this program has been of value to the FAA, because it resulted in lower field attrition than had been experienced before 1976. Table 6 compares attrition rates from the ATCS occupation for students who entered the occupation at three different time periods. Prior to the implementation of the pass/fail Screen program at the Academy, about a 41% attrition rate was experienced in field training, occurring on the average at about two years into training (Henry, Ramrass, Orlansky, Rowan, String, and Reichenbach, 1975). By using the Academy program to screen employees, the majority of the attrition was moved back to occur during the first three months of employment, instead of occurring several years after hire. Such a system reduces the burden on field facilities who expend fewer resources training people who will eventually fail, and also reduces the burden on the employees, who find out sooner during their tenure whether or not they will continue to be employed.

At the same time, it is clear that improvements can be made to the methods used to select ATCSs. It would certainly be less stressful for an individual to spend five days finding out whether or not he or she has a job than to spend nine weeks. The time required to train and test the candidates may be reduced if more generic tasks are measured instead of tasks requiring specific technical knowledge to perform. The inevitable problems associated with the reliability of having multiple instructors observe and rate the performance of students may be reduced by improving the rating scale or the training provided to raters or by automating the measurement and evaluation of performance.

It must also be noted that field training status, the criterion measure used for the predictive validity analyses described earlier, is not an ideal criterion for reasons often discussed in Industrial/Organizational Psychology texts, including unreliability and susceptibility to bias. It is used primarily because the data upon which it is based are easier to develop and obtain than other performance measures. The other training performance criteria discussed earlier are plagued with the same inherent problems. At present, no measures of performance on the job have been developed for ATCSs.

The FAA will soon sponsor a project to address the two problems described above. The outcome of the project will be two products: a more efficient second-stage selection procedure which will replace the current Academy Screen program, and a set of job performance measures which can be used as criteria against which to evaluate the validity of selection procedures. This work is important, not only to support the selection of today's controllers, but also to provide a basis for developing selection procedures and criterion measures of performance for the occupation as it will begin to evolve over the next 10-20 years.

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EVALUATION ISSUES IN THE SELECTION OF AIR TRAFFIC CONTROLLERS

The major occupation of the Federal Aviation Administration (FAA) is the Air Traffic Controller (ATC). Controllers perform a critical safety function for the FAA: They separate aircraft, from each other and from other objects. The strike by the Professional Air Traffic Controller Organization (PATCO) in 1981, that resulted in the firing of approximately 11,400 of *the 17,275 active controllers (Sells, Dailey &* Pickrel, 1984), instigated increased public concern and Congressional inquiries regarding airline safety. Deregulation is but one of several factors that continue to increase air traffic annually, that makes air safety both more difficult and more important to achieve. Many of the concerns that have surfaced about air safety involve the recruitment, hiring, and training of air traffic controllers.

The FAA has recently committed considerable resources to developing a national recruitment plan, designing new selection procedures, and improving training systems. These program development efforts have been initiated in an environment of rapid technological change. Air traffic control equipment is becoming increasingly automated, guided by the National Airspace System (NAS) Plan. Work on developing, implementing, and evaluating human resource management programs will not occur in a vacuum, however. The labor market has already begun to change from an abundance of qualified candidates to shortage conditions (Johnstone & *Packer, 1987)*.

The purposes of this paper are to (a) describe a systems approach for evaluating the effectiveness of any new human resource management (HRM) program for an occupation, such as a selection system for air traffic controllers; (b) examine strategies for focusing the evaluation of *a single HRM program in the broader context of* inter-dependent HRM programs; and (c) explore trade-offs between technical, operational, and policy/management decisions in a specific HRM program area, such as selection.

A Systems Approach for Evaluating Selection. In a formal evaluation (e.g., Cronbach, *1982; Rossi & Freeman, 1989)* of an *HRM* program, such as a selection system, the review plan should consider the following:

1. The overall goals of the organization;

2. The development of an inter-dependent, operational system involved in recruiting, *selecting, training, and appropriately placing* controllers;

3. The effective monitoring and execution of a comprehensive research and development program that will serve as the vehicle for creating a new selection system;

4. The assessment of individual applicants for selection;

5. The evaluation of the relative costs and benefits of different components of the HRM system.

Figure 1 depicts the FAA's human resource management system for air traffic controllers. This system, composed of separate initiatives for planning/automation, recruitment, selection (technical and managerial), training, and organizational interventions highlights the need to examine the interrelationships among all components in the broader system. Let us consider each of these in turn.

1. The overall goals of the organization.

A recent summary of FAA goals includes the following:

a. Enhance U.S. aviation safety;

b. Build FAA culture;

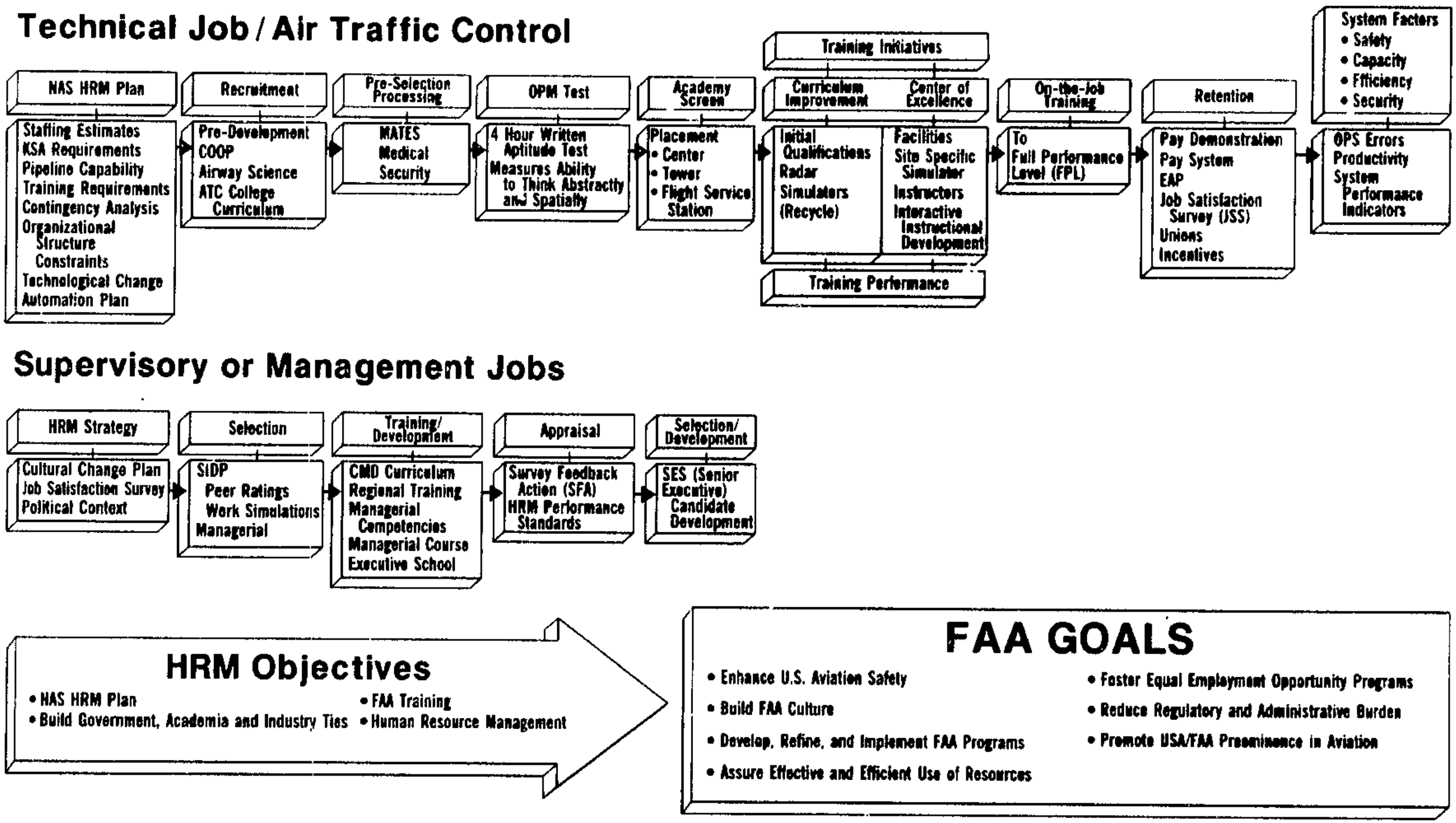
c. Develop, refine, and implement FAA programs;

d. Assure effective and efficient use of resources;

e. Foster equal employment opportunity

HUMAN RESOURCE MANAGEMENT

Program Linkage Chart



(EEO) programs;

f. Reduce regulatory and administrative burden;

g. Promote USA/FAA preeminence in aviation.

Every organization has goals and values, and in the FAA these are translated into mission requirements. Describing goals, and prioritizing them and changing them, are not easy tasks. However, goals are very important in understanding how an organization or agency works, and the HRM systems must reflect these goals. For example, the first goal of FAA is aviation safety. Controllers and other FAA personnel are in periodic tension with employees of other organizations, such as commercial airlines, over the relative riskiness of a specific set of aircraft procedures versus flight delays. Legally, FAA is the final arbiter of such choices, although the agency has been criticized both for being too strict and for being too lenient with the industry we are required to regulate. The selection process for controllers has to be able to find and train individuals who will, above all, foster aviation safety, and also control and monitor air traffic effectively.

While the unique requirements of a Federal regulatory agency are not easily replicable in the private sector, the aviation industry also has important goals and values, some of which may conflict with each other or with the regulatory mission of the FAA. The objectives of the HRM systems at FAA include the NAS Plan, FAA training, building ties between government, academia, and industry, and managing human resources. These are some of the ways FAA has chosen to meet its goals.

2. The development of an inter-dependent, operational system involved in recruiting, selecting, training, and appropriately placing controllers.

Perhaps the most important point about this component is the realization that parts of the personnel system that we might have historically considered independently, are not. An earlier speaker noted a shift in the relative emphasis from selection to training as the character of the applicant pool for hi-tech jobs has been changing. There are many other potential trade-offs to consider. Let us consider the components in somewhat more detail.

Automation. Automation is an important issue at the FAA and an expensive one. Recent and projected increases in air travel both here and internationally have created the need for procurements for new computer and radar systems. At FAA, we have instituted the NAS HRM Plan so that the new equipment can be assimilated into our on-going systems, with minimal disruption in the service we provide to the air traveler. In designing this equipment, however, who are we designing it for? Current controllers do not have to have the same kind of map of the sky in their heads, as did the early controllers who operated without radar. Can and should we design new equipment so that the controller job becomes less demanding? Or less interesting? What kinds of people can we expect to have as controllers in 1995, in 2000? How do we select a work force now with the appropriate skill mix and train them to perform evolving jobs in the year 2000?

Recruitment. A formal program of recruitment is relatively new at FAA, as it is for many organizations. Until recently we had many more well-qualified applicants than we needed, but no more. One operationalization of the FAA goal to foster EEO programs is more active and formal recruitment of women and minorities for controller positions, a traditionally white male occupation. The FAA is considering a variety of alternative recruitment approaches. One incorporates variants of the "realistic job preview" approach. For the Co-op Program (Co-operative Education), the FAA (and other Federal agencies) contracts with selected institutions of higher education to develop work-study programs for qualified undergraduates. Students have jobs at an FAA facility during their college years, and upon graduation have an experiential edge in the selection process if they choose to apply for the air traffic control occupation. The Pre-Developmental Program, on the other hand, recruits prospects from employees at the FAA, or at other Federal government agencies, to a controller upward mobility program. Overall, co-op students have been more successful than average in progressing through the controller career, while the Pre-Developmental students have been about average.

Another FAA recruitment approach is being developed at this time. A number of colleges and universities have developed curricula specifically tailored to the air traffic controller career. Many include courses that appear very similar in content to those the FAA offers at the FAA Academy in Oklahoma City or in facilities nationwide. Until fairly recently, graduates of such programs were given no special consideration in applying for air traffic controller positions. In 1989, however, Congress authorized the Mid-America Research Consortium, or MARC, to develop a program that would provide students the training necessary for them to enter at a step higher that the normal procedure. They are to be placed in developmental air traffic controller positions at the post-FAA Academy Screen level. Recently two or three additional institutions have signed formal agreements with FAA for similar arrangements. Part of the requirement assigned to MARC is to develop performance measures so that the capabilities of its graduates can be adequately assessed. In the meantime, they will be held to the standard admission requirements for initial entry applicants, i.e., an acceptable score on the OPM test battery.

Some have predicted that a possible outcome of these collegiate efforts could be the reduction if not elimination of preliminary controller training by the FAA. After all, so the argument goes, the Federal government accepts the graduates of medical schools on face value; why not graduates of air traffic controller schools? (The military services have, however, developed their own medical school as they were obtaining neither the quality nor quantity of physicians they required.) There are at least two problems with such proposals for independent entry, however: The first is the inadequacy of the current state of performance measurement for air traffic controller, an inadequacy that will take time and effort to remediate. There is little firm basis for concluding that the graduates of Program X are the same as, if not worse or better, than the graduates from FAA programs. Second, there is the policy of FAA accountability. Air traffic controllers have legal responsibility for operational and other errors, occasionally for others as well as themselves. It may be difficult to convince them that universities and colleges provide acceptable training and acculturation.

Selection - Initial. As a prior speaker described, the FAA uses a four-hour paper and pencil battery, assessing spatial and abstract reasoning as an initial hurdle for the 25,000 to 100,000 candidates applying annually for controller jobs. This is the selection instrument authorized by the Office of Personnel management (OPM) and is called the OPM test. The FAA has to meet the same and more EEO documentation and validation requirements as other employers (U.S. Equal Employment Opportunity Commission, U.S. Civil Service Commission, U.S. Department of Labor, and U.S. Department of Justice, 1978). We worry about adverse impact and the effect of more intense recruiting on adverse impact. We are concerned about differential prediction and the adequacy of our criterion measures. We have good evidence that the OPM test is a valid predictor of later success in the second phase of selection, the FAA Academy Screen. We are feeling external and internal pressure for criterion measures that are more performance-based and that are further along the career progression path (American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 1985; Society for Industrial and Organizational Psychology, Int., 1987).

There are two specific concerns that may not be unique to the FAA. The first is computerized testing. Computers provide the opportunity for greater job-relatedness or, at least, greater face validity, and their use has been urged by many quarters. However, the technical, logistical, and cost problems of establishing a standardized assessment program equivalent to the current decentralized system are formidable. The Department of Defense, with 10 times the applicant pool, has been working on such problems for over a decade, and they have not yet implemented a nationwide examining system. Also, the selection and implementation of computerized assessment must be sensitive to the variable levels of candidate experience and comfort with computers and aviation. White males tend to have more of both. Fostering EEO programs in this instance could have the outcome of identification of more women, minorities, and white males with this reduced experience who might not otherwise have considered, or been considered for, the controller job.

The second concern is a corollary to the first, and it refers to test training programs. During the past year or so, there has been a proliferation of programs whose goal is to help individuals become air traffic controllers, by providing them with information about passing the OPM test battery. Some of these programs are free; some charge the applicant a fairly sizeable amount of money. The test item types used in the OPM test are among those that are highly subject to practice effects. We have not yet completed a definitive study. Preliminary evidence suggests that such programs can be effective in increasing the test scores of at least some applicants for controller jobs without, however, concomitantly improving the underlying aptitudes required to succeed on the job. The FAA is considering further restrictions in an already restrictive policy on retesting. As more systematic data accumulate, other steps may be taken.

Pre-selection processing. The FAA has been delegated direct hire authority for air traffic controllers from OPM, so that only those candidates with sufficiently high OPM test scores (90 and above, depending upon the hiring region) will be contacted for further consideration. This stage involves the expensive and extremely time consuming processes of medical examinations, structured interviews at FAA facilities, security or background investigations, and an opening in the hiring quota. The FAA has been successful in speeding up this process, especially the security checks for candidates who are "squeaky clean," but this component can take from two months to two years, or more. This is a large amount of time in a young person's lifetime, and the FAA may be losing a number of well-qualified candidates to the private sector, who are unwilling or unable to wait for a controller's job.

Selection - Academy Screen. As described in other papers, the two-month long Screen at the FAA Academy is a selection procedure of the type "miniature training and test situation." Students, termed "developmental" controllers, are taught principles of (non-radar) air traffic control, and are evaluated on how well they know and can apply these principles, via knowledge tests and laboratory problems. The passing rate of Screen classes over the past few years has been slipping from 60 percent to 55 percent and, for the past few classes, to well under 50 percent. A long-term project to replace the Academy Screen with a week or so of more intensive assessment has begun, but will not be ready for implementation for several years. In the meantime, this component of the air traffic controller selection process appears to be at best inefficient. It could be that the increasing failure rate reflects a decreasing quality of applicants. Or, the current Screen is insufficiently adequate to the task of dealing with today's candidates for present and projected equipment.

Training initiatives. Screen graduates are currently placed in different facilities based primarily on the needs of the hiring region and the final Screen scores, and secondarily on the wishes of the developmentals. Operational placement systems typically do not have much leeway for applicant choice; perhaps the best approach is to be explicit about this to the developmentals. Some advanced training for Screen graduates is provided at the FAA Academy, but most is obtained at the facilities where the developmentals are placed. A second long term FAA project is to review and revise the entire training curriculum. It will be completed at approximately the same time as the project for the new Screen. The two projects will dovetail with each other, but it will not be easy to evaluate the individual contributions of each.

On-the-job training. The FAA has Instructional Program Guides (IPG's) listing the accomplishments each developmental controller must demonstrate before proceeding to the next phase of training and career status. Most facilities have training managers, whose assignment it is to develop materials and programs to implement the IPG. The goal of this training is for the developmental to achieve Full Performance Level (FPL) status. Training programs are not limited to developmentals, of course. There are refresher and remedial programs and there is training for new equipment and procedures for infrequent yet critical possibilities. Both developmental and FPL controllers have to be capable of learning what they have to with the time and resources available, while the available training programs should provide the most effective means of doing so for the current population of controllers. Evaluation should address (a) the standardization of the on-the-job training (OTJ) across facilities; (b) the quality of supervision received by developmentals; and (c) the effectiveness of OTJ program efforts in developing FPL controllers.

Retention. Retention is a critical issue in air traffic control, or any other occupation, because the more controllers you retain, the fewer you have to recruit and hire. Predictable attrition, possible when most of it is retirement, allows for control of applicant flow. It is far more efficient to produce a steady stream of new employees than the peaks and valleys that are common when the organization's recruiting budget can be changed midstream. A most important concern for controllers is pay. The FAA falls under the general schedule pay scale applying to the majority of federal employees, and unconnected to differential living costs across the United States. Facilities near the Pacific coast of California, in or around New York City, for example, face difficult problems in recruiting replacements because of housing costs. Frequently, individuals wishing to transfer from such facilities are prohibited from doing so until a replacement can be expected, which may take months if not years. The FAA currently has a Pay Demonstration project, in which some of these impacted facilities are permitted to provide a 20 percent retention allowance.

Other components of retention include job satisfaction, employee assistance programs, unions, and performance incentives. The controller's performance, linked as it is to automation equipment, radar, and telephones, is monitored continuously. Periodic performance evaluations are required, with mandatory reviews and possible retraining whenever operations errors or other serious mistakes occur. Further, the performance of the controller work force, in conjunction with other FAA safety-related work forces, impacts on broad aviation system factors such as (a) safety; (b) capacity; (c) efficiency; and (d) security. It is also legal for controllers to have randomly announced drug tests.

In summary, there are many components of the air traffic controller HRM system at the FAA. Selecting people to become controllers is influenced by all of them, and influences all of them, in turn. Evaluating any one component of the system, such as selection, requires consideration of all components.

3. The effective monitoring and execution of a comprehensive research and development program that will serve as the vehicle for creating a new selection system.

Even before the passing of the 1964 Civil Rights Act there were requirements for documentation of the usefulness of civil service examinations. Most jurisdictions including the Federal government, had a few or many jobs that were included in a merit system of employment. Merit hiring means hiring the best qualified person, rank-ordering candidates using their scores on an evaluation procedure directly linked to performance on the job in question. A traditional predictive test validation approach, including an examination of the psychometric characteristics of predictors and performance criteria, and the relationships between predictors and one or multiple measures of performance can be used to identify the measures that are most predictive of success at subsequent stages of career progression of an air traffic controller. The level of detail, the characteristics of acceptable evidence have, of course, changed greatly over the past three decades, but the basic requirement has been around a long time.

To some eyes the state of predictors has changed little in the past 50 years, which to others of us indicates that those eyes haven't kept up with the literature. For selection we will consider abilities in the cognitive domain such as mental abilities, and perceptual and psychomotor skills. We are also considering non-cognitive measures of personality, interests, and other aspects of personal history. For some occupations we look at physiological indices as well, such as age, color blindness, heart rate. A variety of procedures will be used for assessment, from low-tech paper-and-pencil to computers and simulators, frequently finding that the paper-and-pencil measure is the most effective in many (not all) situations. The content and procedures of the measures may be more or less similar to the content of the job. Finally, theoretical advances such as item response theory, constructed responses, validity generalization, generalizability theory, continually expand our horizons, deepen our understanding, and require review and rewriting of our documentation.

Before, we might choose a selection device based on a fairly general job analysis combined with a criterion-related validity study using supervisor ratings as criteria, perhaps with a sample size as large as 75 or 100. Those days are gone. While each individual personnel project will probably always require its own job analysis, it has become critical to coordinate the information obtained from successive job analyses of the same occupation for subsequent projects to build upon. The FAA is completing a multi-volume job task analysis of air traffic controller occupations, based on type of facility and character of equipment. Building a selection system directly on a job task analysis is difficult, but building a selection job analysis on a prior job task analysis makes a lot of sense.

While we still do criterion-related validity studies, we try to have much larger sample sizes, as we know all too well the hazards of small samples. And, while supervisor ratings remain the most popular criteria in published validation research, we have become increasingly uncomfortable with them. Ratings are loaded with components we aren't interested in and don't want to measure. In addition they can be biased and certainly are incomplete. Training measures, typically predicted with higher validity than supervisor ratings, are somewhat suspect, because we aren't sure how accurate a reflection the training is of the job. Some would prefer to keep training measures only as predictors of later performance. Measures of actual performance, either from work samples or simulations, or from incidentally maintained records, became more desirable even as they were acknowledged to be more expensive to develop and to obtain. During the 1980's, the Department of Defense sponsored a comprehensive, multi-service project to develop job performance measures, with the hope of linking these measures to selection standards. A Committee of the National Academy of Sciences provided oversight of this project, and their final report is due the end of this year. The major finding of this project is that reliable and representative job performance measures can be developed which can be predicted by entrance examinations. Argument remains over whether such performance measures are *the* performance of interest, or whether such performance measures are but *components* of a larger performance space.

Since the equipment and hence required behaviors of the air traffic controller job have changed at roughly the same frequency as the civil rights case law, it is necessary to continue monitoring and evaluating the entire selection system. This includes continual review of the performance measures the selection system is built to predict.

4. The assessment of individual applicants for selection.

Prior speakers have addressed some of the operational and logistical issues faced by the FAA in assessing candidates for air traffic controller jobs. What will be stressed here is the obligation of Federal employers to evaluate every candidate fairly and in the same way. Within legally specified constraints, such as age, education, and experience requirements, every American is entitled to apply for any Federal government job, irrespective of race, religion, gender, handicap, and ability. Every applicant must be treated courteously and with respect. Air traffic control candidates frequently ask their Representative or Senator to check the status of their applications, who in turn ask us. Members of Congress cannot have a Federal agency provide any special treatment for their constituents applying for employment in a merit system. Occassionally we, or others have erred, and we try to rectify it. More frequently, the applicant's predicament reflects ignorance of which one of apparently conflicting regulations takes precedence in his or her case.

Another restriction on public employers refers to the types of information they may request from applicants, as well as how such information might be obtained. Federal agencies are prohibited from asking direct questions about religious practices and political preferences, topics that might be addressed in sets of biodata items. Offensive and invasive questions, such as appear on some personality tests, can be used only with extensively documented justification, and under restricted circumstances. For example, controller applicants take the 16PF as part of the medical examination. Only those individuals with extreme scores are referred for more intensive psychological examination, which may include more of the offensive and invasive items. Finally, all candidates for sensitive positions in the Federal government, which includes air traffic controllers, are subject to security investigations that include checking with former employers, reviewing police records, and looking for indications of alcohol and/or drug abuse. Such investigations are far more extensive and expensive than administration of an honesty test. However, a critical component of all public selection systems is face validity which security investigations have. It is not just our managers and professional colleagues who review our instruments and procedures. Our reviewers include political appointees, Members of Congress and Senators, union leaders, and public interest groups of all kinds. The public employment system belongs to the American public, and each citizen has the right to question its operations.

5. The evaluation of the relative costs and benefits of different components of the HRM system.

Since air traffic control selection procedures will be developed and fielded in the context of other HRM program initiatives, the effect of novel recruitment strategies on the composition of the applicant pool, the role of different entry programs (for example, military, co-ops, other collegiate programs), and the redesign of training delivery systems will interact with changes in the selection procedures. The implementation of system-wide changes for the controller work force creates the need to evaluate the utility or cost effectiveness (Cascio, 1987) of recruiting strategies, staffing requirements, training requirements, and Academy attrition rates against levels of controller performance.

Indeed, we can only evaluate our HRM programs against levels of performance -- that is the common metric. We need to develop and refine measures of air traffic controller performance, using work samples, simulations, interviews, ratings, and archival measures. One or more sets of such measures that are accepted as representative of the controller job, by its incumbents and by FAA management, should be assembled. There is a need to link levels on such measures with levels on predictors, to identify possible cut scores and selection standards. If we can do this, and if we can attach dollar estimates to the component costs of our different HRM programs, FAA decision makers can make better-informed decisions about air safety and the use of FAA resources to achieve it.

Need for Program Evaluation. Since the PATCO strike, one of the key challenges of the FAA has been to improve and maintain the effective staffing levels of the Air Traffic Controller work force, particularly with respect to staffing high traffic load facilities adequately. The FAA has initiated a number of program efforts to tackle this challenge. Training systems are being revised to allow for specific simulator training that will shorten the on-the-job training time for new controllers. The amount of time to recruit and place applicants has been reduced substantially. Further, the planned research on the development of a new ATC selection Screen will strengthen the agency's ability to hire applicants who will have a higher probability of being successful in training and on the job. In addition to selection and training initiatives, the FAA has implemented pay demonstration projects to study the feasibility of providing geographically-based pay incentives and recruitment and retention allowances to controllers.

The development and implementation of these interdependent human resource management programs create a tremendous need for program evaluation. In a bureaucracy, evaluation can be undertaken for a variety of reasons. Some of these reasons are: (a) to make judgments about program worth; (b) to increase the effectiveness of program management and administration; (c) to assess the usefulness of innovative programs; and (d) to satisfy accountability demands and answer stakeholder (usually management) questions and concerns.

Strategies for Conducting Evaluation. Although there are a number of approaches to conducting evaluation, until recently the FAA focused primarily on compliance types of evaluation. Compliance evaluations ask the question, are we doing things right? FAA policy requires that comprehensive evaluations of all designated programs be conducted triennially to ascertain the effectiveness and efficiency of program activities, to verify internal compliance with established procedures and practices, and to examine the quality of services and products offered to FAA customers. In order to implement existing FAA policy and guidance on evaluation activities, noncompliance types of evaluation need to be asked: Are we doing the *right* things?

Generally, there are five broad phases in conducting an evaluation of any program. These phases are (a) planning; (b) scheduling; (c) execution; (d) follow-up and tracking; and (e) trend analysis. The focal point of any effective evaluation is the evaluation plan. The written evaluation plan should contain a problem statement and background information. It should clearly state the evaluation objectives and questions: What is it that management really wants to know? The audience for the evaluation findings should be identified so that there is upfront support and involvement in the evaluation process. Participation in the evaluation by management and other stakeholders will significantly increase the chances that the evaluation results will be used by the organization. The evaluation plan should also contain information on the scope, methodology, projected costs/resources needs, milestones and an outline of the report.

The scheduling phase of the evaluation addresses the coordination, logistics, and administration of the program evaluation. Paramount in this stage is assembling the correct team to perform the evaluation. The FAA, like most Federal agencies, is just starting to build a formal internal staffing unit to conduct program evaluations. Hence, the use of an internal evaluation team, composed of evaluation staff and other members of the FAA/HRM organization, will be the vehicle of necessity. Composition of the team in terms of skills and experience plays a large role in the quality of the evaluation product. Further, it is critical to establish effective ground roles for the operation of the team, so that objectivity and fairness are maintained and hidden agendas do not contaminate the execution of the plan or interpretation of findings.

The execution phase provides the opportunity for the scientific method to guide and temper fact finding in an operational, applied work environment. Numerous evaluation strategies can be adopted. However, several common procedures are consistently found in evaluations conducted in the FAA. The use of available existing data in the form of program records, statements of work, directives/orders, computer data files, and external evaluation reports is usually a starting point in most evaluations. Although 90 percent of all evaluations use existing data, the accuracy and reliability of this information are often difficult to determine. Another common strategy is the use of questionnaires and structured interviews. Formal evaluation training of team members is particularly crucial at this stage to address sampling plans, control groups, response rates, piloting of measures, and data analysis plans. Another important aspect of the execution phase is the review and organization of the information collected and its interpretation. The evaluation team should reach consensus on the meaning of information and data gathered and any recommendations that are made. This information should be incorporated into stakeholder/management briefings and the formal report.

An action plan, based on the recommendations, should be developed as part of the follow-up and tracking phase of the evaluation to insure that recommendations are implemented in an effective and timely manner. Then, applicable information data bases should be developed and maintained to conduct trend analyses, particularly in cases that involve applicant flow, training, and performance data.

Evaluation constraints. A variety of obstacles can impede effective program evaluation. The value management places on evaluation activities determines whether program evaluation is emphasized within the organization or indeed even conducted. Further, management's support of evaluation drives the perception and acceptability of these activities in the organization and determines the level of resistance that may be encountered. Time (short time suspense) and adequate resources (staff and money) are initial hurdles to overcome in designing and planning an evaluation. The skill and expertise of evaluators directly impact on the quality and credibility of the product. Other constraints could involve regulations that require certain types of data collections, access to information that is controlled or confidential, program policies that preclude making certain comparisons (or don't allow control groups) or requirements for prior approval by unions and other groups to gather information.

In the Federal bureaucracy, the success of evaluation activities depends on multiple interdependent factors: (a) a strong organizational mandate to conduct program evaluation; (b) managerial support (resources) for the function; (c) the ability of evaluators to act independently as internal consultants to the organization; (d) the ability of evaluators to deliver a quality product in a timely manner; (e) the development of constructive recommendations that are translated into action plans; and (f) effective follow-up to insure that findings are used by organizational decision makers.

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DISCUSSION OF SELECTION OF AIR TRAFFIC CONTROLLERS: COMPLEXITY, REQUIREMENTS, AND THE PUBLIC INTEREST

General Comments. The process of selecting air traffic controller specialists (ATCSs), as has been discussed today, is obviously a task of incredible complexity. In fact, this process is a prototype for applying psychological theory and research to real-world domains, given the fact that researchers and policy-makers must attempt to satisfy sources with sometimes antithetical interests – government (e.g., FAA), union (associations of ATCSs), public policy (e.g., concerns related to age, sex, and race variables in the selection process), psychological theory (e.g., inevitable conflicts between ongoing developments in developing new predictors for job performance and Office of Personnel Management (OPM) limitations on new tests, such as those that include a broad range of non-cognitive measures to predict performance), and so on. The speakers that preceded me today made it clear that excellent research and applications of psychology to public policy issues can, and are, being carried out. What I would like to do in my discussion, is to address some of the issues raised by the speakers today, and also mention some areas that I think need to be given attention by the FAA to both the basic research and applied psychology communities.

1. Focus on specific aspects of the selection process. One question that occurred to me in the context of the paper by Dr. Manning had to do with an examination of the full matrix comprised of the hypothetical states of the world and the selection decisions that are made regarding ATCS applicants. That is, as is outlined in **Figure 1** (and is common to both the Theory of Signal Detection, and Taylor-Russell tables), we can identify the two hypothetical states of the world (shown as failure or success as on-the-job (OTJ) performance for an ATCS. We can also look at the decisions that are made in the selection system ("fail" or "success" in the ATCS Screen).

With this perspective in mind, we have heard much about the "wash-out" rate in the ATC Screen. Such numbers describe the rate of "failure" in the Screen, but as can be seen from Figure 1, the numbers do not provide sufficient information to understand the full decision process. For example, I wonder a great deal about what is the distribution of *false negatives* in this system (i.e., what percent of Screen wash-outs are false negatives)? These are persons who would ultimately have suceeded as full-performance level (FPL) ATCs, but for the fact that they failed the Screen.

The importance of the information pertaining to false positives and false negatives is critical to making a fully rational (or optimal) set of decisions about cut-scores for Screen pass/fail determinations. The overall *utility* of the Screen can be examined with such information, as is illustrated in **Figure 2**. Clearly, positive utility values are associated with "correct rejections" and with "hits" –just as negative utility values (and thus the solution of the matrix) can only be established with input from a variety of sources, one should not ignore that such outcomes do indeed have differential utilities that may be used to optimize the system. Specifically, perhaps passing criteria for the Screen should be explicitly predicated on the relative utilities/disutilities of False Positives/False Negatives. *This is not necessarily a recommendation to take pass more applicants from the Screen, but to trade of the cost of OTJ training against the possible loss of qualifiable ATCs.*

2. General issues: What can basic research contribute to this process? From a theoretical perspective, several basic research themes seem to have potential for contributing to the problem of predicting individual differences in acquisition and maintenance of ATCS performance. These relate to: Dynamic changes in ability - skill relations during skill acquisition (e.g., Ackerman, 1989, 1990); Motivation and personality traits as predictors of job performance (e.g., see Kanfer, 1991); and Issues of metacognition and self-regulation skills (Kanfer,

Screen

	FAIL	PASS
O-T-J FAILURE	Failed/ Failure (C.R.)	Passed/ Failure (False Pos.)
O-T-J SUCCESS	*Failed/ Successful (False Neg.)*	Passed/ Successful (HIT)

Figure 1. Screen and On-The-Job Performance from the perspective of signal detection theory. (O-T-J = On-the-job; C.R. = Correct Rejection)

Screen

	FAIL	PASS
O-T-J FAILURE	++ (C.R.)	? - - ? (False Pos.)
O-T-J SUCCESS	*? - - ? (False Neg.)*	+++ (HIT)

Figure 2. Screen and On-The-Job Performance from the perspective of utility analysis. (O-T-J = On-the-job; C.R. = Correct Rejection)

1990; Kanfer & Ackerman, 1989). Each of these domains will be mentioned below, but the references cited here provide more extensive descriptions of the domains under consideration and their potential applications.

3. Age issues. Given changing demographics (i.e., an increasing median age of the U.S. population), maybe it is time to see what remediation there may be for older ATCSs -- either in terms of training, equipment (hardware/software) or some combination of both, rather than depend on an increasingly limited population of young adults to be selected and trained as ATCSs.

Note the history of human factors (fitting the person to the machine [pre-World War II] vs. fitting the machine to the operator [post-World War II]) (e.g., see Fitts, 1947; or see Sanders & McCormick, 1987 for a review of the history of human factors). What aspects of the older ATCS are problematic? (Much research is going on in other domains, for example, for pilots and for other demanding tasks.) This is a general issue that strongly suggests that the selection/training program design be integrated with hardware/software development and with information about a potential job applicant pool (e.g., a "systems" approach).

However, just because Congress has mandated age restrictions for the current system does not mean that given a change in the human-machine interface system, the age restrictions cannot be relaxed. New research is being conducted in this area that examines skill acquisition and retention issues in older adults (e.g., see Rogers & Fisk, 1990). The FAA should consider initiating research on the acquisition and maintenance of skills by ATCSs, perhaps in concert with other governmental agencies that focus on general issues of aging (e.g., the National Institute for Aging). The time to start basic and applied research in this domain is *now*, not after a serious shortage of qualified applicants for ATCS positions is encountered.

4. What is the role of confounding selection and classification, that is, using scores to assign students to tasks of differing challenge? Drs. Aul and Wing mentioned that assignment of Screen graduates is often done in conjunction with their performance scores on the Screen. That is, high-scoring developmentals are often assigned to the most challenging facilities across the country, and those with lower (but still passing) scores are often assigned to facilities that have lower demands (e.g., less traffic). One might assume that this process has the impact of reducing variability of OTJ performance, and thus attenuating predictive validities of selection measures. However, some attempt should be made to take this information into account statistically in order to get an unbiased assessment of the validity of the various tests and Screen scores.

5. Test coaching issue. Dr. Manning reported some information regarding the "learnability" of the OPM test. Many possibilities exist for a study of this phenomenon. Rather than just restricting access to repeated testing, it may perhaps be more fruitful to make test familiarization nearly universal (as with the Scholastic Aptitude Tests [SAT] and the Graduate Records Examination [GRE]), or design the test so that changes in test performance reflect actual changes on the "construct" of interest, rather than inappropriateness of the test. Dave Lohman (at the University of Iowa) and I have found some results in using test practice, coupled with informative feedback, in developing spatial abilities measures that are of higher overall validity for task performance, especially when the task is followed over skill acquisition trials. (For more details, see Ackerman & Lohman, 1990.) Ultimately the focus comes back to the classic though somewhat controversial issue of aptitude/ability/achievement measurement. What is it that the FAA is after when it goes about selecting applicants for ATCS positions? Is it some stable ability, or is it a level of performance obtained from drill and practice, or from mere exposure to similar test items? When examinees differ greatly in background or experience with novel spatial figures, it may be beneficial from both validity and public policy perspectives (vis-a-vis sex and race differences in test scores) to provide opportunities for attenuating these spurious influences on test performance via provision of test practice -- if, as in the case of our research, tests can be designed that *increase* in validity with practice.

6. What about "tracking" the training program, in order to take advantage of aptitude-treatment interactions (ATI's)? It seems as if the *outcome* (i.e., ATCS knowledge and skills) should be the criterion for ATCS selection, not equal treatment. Several possibilities exist for capitalizing on aptitude-treatment interactions. If the FAA is willing to consider the possibility of tailored training (e.g., via intelligent computer-aided instruction), it may be useful to develop measures that select for asymptotic FPL performance, rather than measures that are more highly oriented to selection for training performance (Screen). This is especially important in light of the recent ability-skill acquisition literature (e.g., Ackerman, 1987, 1988, 1989)with regard to the abilities that determine OTJ performance. In brief, this research has reaffirmed the importance of general and broad content (spatial, verbal, numerical) abilities in early task performance (e.g., during training), but also includes a framework that identifies other (e.g., psychomotor) abilities as valid predictors of asymptotic, skilled performance. In this sense, one can look for talent (for FPL performance) that is not captured by standard measures of spatial abilities and reasoning. This sort of framework delineates that one should no more select a clerk-typist or a football player on the basis of general reasoning or spatial abilities, if psychomotor abilities are better predictors of skilled performance. The same general framework may apply to many aspects of the ATCS job.

7. One final item. One last issue seems pertinent to today's symposium. That is, it appears to be especially worthwhile for the FAA to consider alternatives to *experimentation* in the operational environment. Given the limited amount of time and the general restrictions to creating control and experimental groups of ATCS developmentals, the FAA might consider funding applied-research in the Academy and in industry that can focus on the fundamental issues related to selection and training of ATCSs, *without the concomitant worries related to detrimental impact of non-optimal procedures that could operate in the on-line selection/training environment*. By separating these specific real-world concerns of the Screen from the research domain, it should be possible to develop and test (in isolation or in combination with other interventions) new selection and training procedures. Once fully tested in the laboratory, it would be possible to move directly into the operational environment with such improved measures or procedures, without causing disruptions of the flow of ATCS training.

Within the context of research possibilities, several constructs appear especially worthy of attention. One set of constructs includes many abilities that can be optimally taped using dynamic displays (such as dynamic spatial reasoning), for example, see the work by Gibson and his colleagues (1947), and by Pellegrino, Hunt, and their colleagues (e.g., Pellegrino, Hunt, & Yee, 1989). Another set of constructs involve non-cognitive determinants of skilled performance (such as self-regulatory skills), such as are discussed by Kanfer (1990). Many other constructs are potentially important in providing incremental validity for predicting individual differences in both ATCS Screen and FPL performance levels. A discussion of these issues is beyond the scope of this discussion, but interested persons might consult compendiums of recent research, such as the edited volumes by Ackerman, Sternberg, & Glaser (1989); and by Kanfer, Ackerman, & Cudeck (1989).

Acknowledgement. Preparation of this paper was made possible through the support of the Office of Naval Research, Cognitive Science Program -- Contract N00014-89-J-1974, Phillip L. Ackerman, principal investigator.

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☆U.S. GOVERNMENT PRINTING OFFICE: 1991 - 561-020/21103