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Flight Service Specialist Initial Qualifications Course: Content Validation of FAA Academy Course 50232

Office of Aviation Medicine
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16. Abstract

This study evaluates the content validity of the Initial Qualifications Course provided to flight service specialists (FSS) by the FAA Academy. The purpose of FSS Initial Qualifications Course (FAA Academy course 50232) is to predict the student's probability of attaining certification as a full performance level controller in field facilities. First, results of analyses of the FSS position in automated flight service stations (AFSSs) are reviewed and summarized. Second, the linkage between job analysis and specifications of training content are described. Third, a content validation study, using a panel of 16 full performance level specialists from field facilities, is described. The panel reviewed the graded, multiple-choice written examinations and a sample of graded laboratory simulations against the available job function descriptions and identified knowledges and skills required to perform those functions. The panel indicated whether a knowledge or skill was represented or tested in the reviewed graded instrument. The proportion of knowledges or skills represented by an instrument was then calculated for each rater; the average of these proportions across raters provided an overall index of the degree to which the knowledges and skills were represented in the graded instruments. A criterion of 70% coverage was selected as the evaluative benchmark. (25)

Three job functions are taught in the FSS Initial Qualifications Course: (a) flight plan processing; (b) orienting lost aircraft; and (c) weather analysis. Overall, eight of the ten graded components of FAA Academy course 50232 appeared to adequately sample the knowledge and task domains associated with these three AFSS job functions. This content validation study and associated review of job analyses and course development indicate that FAA Academy course 50232 was constructed with reasonable competence and bears some reasonable, manifest relationship to the job of flight service specialist. The evidence provided by this study provides a basis for using the FSS Initial Qualifications Course on an interim basis for making personnel decisions about specialists.

17. Key Words

Air Traffic Control Systems,
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Flight Service Specialist Initial Qualifications Course: Content Validation of FAA Academy Course 50232

INTRODUCTION

Purpose of FAA Academy course 50232

The purpose of the FAA Academy course 50232, Flight Service Specialist Initial Qualifications Course, is to predict a student's probability to succeed to the full performance level as a flight service specialist (FAA Academy, 1989, p. iii). The proposed **Course Management Guide** asserts that

> "Students who fail to obtain a passing grade upon completion of the Flight Service Initial Training will be identified as a failure and withdrawn from training. ... Probationary students who fail the course will be terminated by the Aeronautical Center or may elect to resign..."

Legal requirements for validation

Federal Aviation Administration (FAA) policy requires compliance with all appropriate federal policies, guidelines, and procedures to assure equal opportunity in employment (FAA,1985). The appropriate federal guidelines in this case are the Equal Employment Opportunity Commission (1978) **Uniform Guidelines on Employee Selection Procedures.** The scope of the **Guidelines** are defined in section 1.B as follows:

> "**Employment decisions.** These guidelines apply to tests and other selection procedures which are used as a basis for any employment decision. Employment decisions include but are not limited to hiring, promotion, demotion, membership (for example, in a labor organization), referral, retention, and licensing and certification ..."

Purpose of this study

As is clear from the proposed **Course Management Guide**, employment decisions for flight service specialists will be made on the basis of their performance in FAA Academy course 50232. That initial training course is therefore a selection procedure, as defined by the **Guidelines**, and must be validated for use in making employment decisions. The purpose of this *post-hoc* evaluation of the content of course 50232, therefore, was to assess the validity of FAA Academy course 50232 for making personnel decisions in the flight service specialist occupation.

Technical standards

This report is the first of a series of studies that will be required to establish the validity of FAA Academy course 50232 in accordance with relevant legal, technical, and professional standards. These standards include the **Uniform Guidelines on Employee Selection Procedures** (Equal Employment Opportunity Commission, and others, 1978), the **Principles for the Validation and Use of Personnel Selection Procedures** (The Society for Industrial and Organizational Psychology, Inc., 1985), and the **Standards for Educational and Psychological Testing** (American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 1985).

Structure of the report

This report consists of six major sections. The first section provides a general background for the occupation, plus hiring and validation standards. The second section documents the job analyses conducted to support development of FAA Academy course 50232. The third section describes how the course was developed, based on available job information in consultation with subject matter experts and professional psychologists. Next, the course, as it evolved, is briefly described. The fifth section of the study evaluates the content validity of FAA Academy course 50232, as assessed by a panel of subject matter experts. Finally, the report concludes with brief recommendations on the use of the FSS Screen in personnel selection decisions.

BACKGROUND

Air traffic controllers

The Air Traffic Control Specialist (ATCS) occupation (federal job series "GS-2152") has three areas of specialization, or "options:" flight service specialists, terminal controllers, and en route controllers. Air traffic control specialists in the flight service option provide assistance to over 700,000 licensed pilots who fly civilian aircraft in the United States, Virgin Islands, and Puerto Rico. Flight service specialists provide information on their station's service area, including terrain, preflight and inflight weather; suggested routes and altitudes that appear to have few weather problems, indications of turbulence, icing; and any other information important to the safety of a flight. Specialists enter flight plan data into the computerized data base that is used to track aircraft throughout the national airspace. They also utilize the computer system to obtain current and forecast weather information from the National Weather Service (NWS) in order to assess weather conditions over intended routes of flight. Specialists also may be required to relay air traffic control instructions, assist pilots in emergency situations, provide airport advisory services, and initiate and participate in searches for missing or overdue aircraft. The flight service system is presently being modernized under the FAA's National Airspace System (NAS) plan. Facilities are being consolidated in most regions into automated flight service stations (AFSSs). An AFSS serves a large geographical area and utilizes state-of-the-art data processing and communications equipment. One important innovation, from the FSS perspective, is the greater use of long-distance telephone services and other automated and direct user devices.

Terminal option air traffic control specialists serve at FAA airport towers and associated terminal radar control (TRACON) facilities. They direct air traffic in and out of airports, issue taxi and takeoff instructions and air traffic clearances, and provide advice based on their own observations and information received from many sources: National Weather Service (NWS), air route traffic control centers (ARTCC), flight service stations (FSS), and others. Terminal controllers assure separation between landing and departing aircraft, transfer control of aircraft on instrument flight rules (IFR) to the en route controllers at the ARTCCs, and receive control of IFR aircraft coming into the terminal airspace from adjacent facilities.

En route option, or center air traffic control specialists at the ARTCCs give aircraft instructions, air traffic clearances, and advice regarding flight conditions during the en route portion of the flight. En route controllers assure separation between aircraft flying along the Federal airways system or operating into or out of airports not served by a terminal facility. Center controllers use radar or manual (non-radar) procedures to track all IFR aircraft in the assigned ARTCC airspace. They transfer control of aircraft to adjacent facilities when the aircraft enters that facility's airspace. However, only flight service station controllers will be discussed in this report.

Hiring

Persons typically enter the FSS occupation by one of two routes. On one hand, persons already employed by the FAA may transfer from other FAA occupational fields or programs into the FSS occupation. For example, controllers may "switch options," that is, leave the en route or terminal controller training program and enter into training as a flight service specialist. On the other hand, persons not already employed by the agency may apply for employment in the occupation via the competitive employment process administered by the Office of Personnel Management (OPM). Job applicants, in this case, must meet the standard OPM employment criteria in order to join the FAA as probationary employees and enter into training at the FAA Academy. These criteria include:

A. Pass the written ATCS aptitude test administered by OPM or the FAA with a score of 75.1 or better, AND have 3 years of general experience or 4 years of college, or any combination of education and experience equaling 3 years of general experience; OR

B. Pass the written ATCS aptitude test with a score of 70 or above AND 4 years of college AND have 1 year of graduate study or evidence of superior academic achievement; OR

C. Pass the written ATCS aptitude test with a score of 70 or above AND have previous air traffic controller or pilot experience as defined in the ATCS job announcements from OPM.

Initial training

New specialists report to the FAA Academy in Oklahoma City, Oklahoma, for initial FSS occupational training. The initial FSS training has been conducted on a pass/fail basis since the late 1970's in response to the 1976 Congressional recommendations (Pickrel, 1979). The training program was aimed at providing FSS candidates with a training and evaluation curriculum that would eliminate the few whose performance in training indicated a high probability of failure in field assignments (Convey, 1986; Pickrel, 1979). This older program, in place from 1978 through 1988 with some modifications, was organized around FSS operational positions. These positions were: weather observer, broadcast, teletype, flight data, preflight, inflight, and emergency services. The preflight, inflight, and emergency services positions included functions which, if not properly fulfilled, could have potentially catastrophic results. The program was used to make personnel decisions; its validation for that purpose is described by Pickrel.

Requirement for a new course

The flight service station system was slated for extensive automation under the NAS plan in the mid-1980's. The FSS job was expected to change, as a consequence, necessitating a redesign of the initial training program. On October 9, 1985, a training proposal for revision of the National Flight Service Station Air Traffic Training Program was approved by the then Technical Training Division (APT-300) of the FAA. The approved training proposal specified that AFSS Model 1 equipment (the new automation system for flight service) would be used in the training to accommodate field automation. The **Training Development Plan** (TDP) presented by the FAA Academy in January 1986, and approved March 9, 1986, authorized the development of course 50232 as the National Flight Service Initial Qualifications Course. FAA Academy course 50232 was developed to achieve three primary objectives (FAA Academy, 1989):

(1) To establish a foundation of knowledges and skills required for advanced on-the-job training;
(2) To test the ability of the student to learn and perform related job functions; and
(3) To predict a student's probability to succeed to the full performance level as a flight service specialist.

Legal Framework for job analysis, test development and validation

The legal framework for the development, validation, and implementation of a new selection procedure is provided by the **Guidelines** and relevant statutes and case law. Validity of a selection procedure becomes a litigable issue if, and only if, the complaining party can establish a proof of violation of the appropriate civil rights statute, most commonly Title VII of the **Civil Rights Act of 1964** [42 USC 2000e]. Violations may be established by showing (a) disparate treatment of an individual through the use of proscribed criteria (for example, the person was not hired because of his/her race) or (b) that "neutral rules" used in the personnel decisions have an adverse impact against a protected class, but are not justified by "business necessity." In the case of adverse impact, the employer may present an affirmative defense that the employment practice is job-related. In *Griggs v. Duke Power Co.* (1971) the Supreme Court wrote that ". .the touchstone is business necessity." More recently, the Court appeared to moderate its position in *Wards Cove Packing Co. v. Antonio* (1989, p. 2126), concluding that "...the employer carries the burden of producing evidence of a business justification for his employment practice." There are five important activities that serve as the basis for justifying a personnel selection procedure: (1) an analysis of the job (job analysis); (2) the construction of the test on the basis of the job analysis (test development); (3) the ongoing process of accumulating evidence about the validity of the test (validation); (4) the evaluation of test fairness, including proposed cutting scores; and (5) an assessment of alternative selection procedures that might produce less adverse impact or have greater validity or utility. This report, the first of two, reviews the job analysis and test development phases and begins the process of accumulating validity evidence. The second report will continue the assessment of validity and evaluate test fairness and alternatives.

JOB ANALYSIS TO SUPPORT DEVELOPMENT OF FAA ACADEMY COURSE 50232

Job analysis

The first crucial step in test development and validation under the **Guidelines** is to conduct an appropriate job analysis. Indeed, the Supreme Court has rejected selection procedures that had adverse impact for lack of a job analysis (see Thompson & Thompson, 1982, for a review). It appears that the articulation of a "business related justification" for a challenged selection procedure will require evidence of some form of a job analysis. The broad job analysis requirements to support selection test development are reasonably well established in a series of legal decisions (see Hogan & Quigley, 1986; Sparks, 1988; and Thompson & Thompson, 1982, for substantive reviews). A job analysis is likely to be defensible if the following procedures are followed: First, critical incidents should be collected from a sample of incumbents and reviewed by a panel of subject matter experts (SME) to develop an initial task list (*Bridgeport Guardians v. Police Department*, 1977; *Davis v. Washington*, 1972). Job-related documents, such as position descriptions, training guides, and performance evaluation forms might also be reviewed to develop the initial task listing. Second, this initial task listing should then be reviewed and revised by a second, independent panel of SMEs (incumbents and supervisors, for example; see *Guardians Association of NYC Police Department v. Civil Service Commission of New York*, 1980). Third, a survey of a representative sample of incumbents should then be conducted to collect task-relevant information, such as frequency of task occurrence, task importance, and time spent (*Guardians Association*). In the fourth step, that empirical survey data can then be used to cluster tasks into related groups, which panels of incumbents can then analyze in terms of the knowledges, skills, abilities, and other characteristics (KSAO) required to perform those task clusters (*Contreras v. City of Los Angeles*, 1981; *Guardians Association*). The KSAOs should also be ranked in importance (*Craig v. County of Los Angeles*, 1980) and the level required for successful job performance specified (*Jones v. Human Resources Administration*, 1975).. Finally, the job analysis should be written (*Jones v. Human Resources Administration*).

Initial job analysis conducted by Gee (1986)

Identification of critical or important job behaviors

The FAA Manager of the Air Traffic Systems, Plans, and Programs Division (ATR-100; 1986) requested that a job/task analysis be conducted to support revision of the flight service specialist initial qualification training course. The Office of Aviation Medicine (OAM) procured the services of a private contractor to conduct the job/task analysis (FAA Contract DTFA01-86-P-0118, 1986). The resulting product (Gee, 1986) enumerated the job functions, tasks, and task elements performed by flight service specialists. Gee employed a "top-down" analytic strategy to identify the major activities performed on the job, the sub-activities involved, the tasks subordinate to or encompassed by those sub-activities, and, as appropriate, identification of the sub-tasks involved in the performance of the identified tasks. Three incumbent specialists from the Leesburg, Virginia, AFSS prepared an initial list of activities, sub-activities, and tasks using a consensus (Delphi) methodology as the starting point for the analysis in late 1986 (Gee, p. 10). Three incumbent specialists at the DeRidder, Louisiana, AFSS then revised and expanded that initial task list. Finally, a third panel of three full performance level (FPL) specialists at the Conroe, Texas, AFSS completed a final revision of the activity/sub-activity/task list. This final version was also reviewed by the DeRidder panel and by course developers at the FAA Academy (N unspecified). In sum, some nine FPL specialists from three field facilities derived a listing of the major functions or activities and subordinate tasks for the flight service occupation. However, the contractor did not collect frequency, criticality, or difficulty of learning ratings for the enumerated job functions or tasks from either the SME panels or by survey, as might be recommended on the basis of the 1980 *Guardians Association* decision.

Identification of required knowledges, skills, and abilities by Convey (1988)

In addition to describing the critical or important work behaviors, a job/task analysis must also identify the KSAOs required to successfully perform those tasks (see the *Guardians Association* (1980) and *Jones* (1975) decisions discussed previously). Gee did not identify the KSAOs required to perform the enumerated job functions at any defined level of acceptable performance. However, Dr. John Convey, an OAM contractor, did attempt in 1988 to ascribe the human attributes required to perform the functions enumerated by Gee. Those linkages appear not to have been submitted to systematic review by either subject matter experts panels for review or by a field survey of incumbents.

Myers and Manning (1988) job analysis

Identification of critical or important work behaviors

As previously discussed, the FAA Academy concluded that Gee analysis of the FSS job was not sufficient to support selection test development (Supervisor, FSS Revision and Development Unit, AAC-934A, December 1, 1987). Subsequently, two personnel research psychologists from the Civil Aeromedical Institute's (CAMI) Human Resources Research Division (HRRD) reviewed available FSS job information, training guides, handbooks, and relevant orders, and conferred with subject matter experts, as well as observed the job at the Bridgeport, CT, AFSS to develop an alternative listing of FSS tasks. This task listing was then translated into a survey form in order to collect field ratings of frequency of performance and criticality (Myers & Manning, 1988).

Frequency was defined using the following Likert-type scale: 1=*Once or less per year*; 2=*2-4 times a year*; 3=*1-3 times a month*; 4=*Once a week*;

Table 1
Results of FSS job/task analysis ratings (N=28)

Job function	F	C	S
	4.0	2.1	8.4
Processing new flight plans	4.0	1.5	6.0
Activating flight plans	3.4	2.1	7.1
Processing flight plan amendments/cancellations	4.0	1.2	4.8
Processing flight plan closures	3.8	2.2	8.4
Processing flight plan requests for clearance	4.0	2.2	8.8
Responding to pilot requests for weather data	3.6	1.9	6.8
Reporting significant aeronautical data	3.0	1.8	5.4
Responding to pilot requests for route planning	4.0	1.5	6.0
Requesting pilot weather reports	3.4	2.0	6.8
Processing pilot requests for airport information	4.0	2.2	8.8
Maintaining currency in weather data	1.2	3.4	4.1
Responding to emergency situations	2.7	2.2	5.9
Conducting search and rescue procedures	1.3	2.0	2.6
Processing emergency location transmitter signals	1.2	2.8	3.4
Orienting lost aircraft	2.5	1.9	4.8
Processing aeronautical data	3.3	1.6	5.3
Editing data base messages	3.5	1.8	6.3
Processing weather data	3.1	1.4	4.3
Briefing relieving specialist	3.1	1.8	5.6
Assuming position responsibility	3.1	1.8	5.6
Monitoring navigational and communications equipment			

Note: F=Average Frequency rating; C=Average Criticality rating; S=Average score, where score=F x C.

5=*Once a day*; 6=*2-4 times a day*; 7=*Once an hour*; 8=*2-4 times an hour*; 9=*More than 4 times an hour*.

Criticality of performance was defined in a similar manner: 1=*Very unlikely that incorrect performance will directly cause injury or death*; 2=*Moderate likelihood of injury or death*; 3=*High likelihood*; 4=*Will certainly result in injury or death*.

The researchers collected data at 2 locations: the McAlester, Oklahoma, and Wichita, Kansas, AFSSs from among the 24 AFSSs that had been fully commissioned and had at least 1 full year of operational experience at that time. Myers and Manning collected data from 26 incumbent specialists and 2 training managers at the 2 facilities. The frequency and criticality ratings were combined to derive an average score for each job function. The results of this analysis are presented in Table 1. Four tasks had higher overall scores than any other tasks, indicating both frequent occurrence and the criticality of correct task performance. These tasks were: (1) processing new flight plans; (2) processing pilot requests for clearance; (3) responding to pilot requests for weather data; and (4) maintaining currency in weather data. These tasks are briefly described as follows.

Processing new flight plans. Pilots, including general aviation and military, are required to file a flight plan indicating the planned route of flight, departure time, and estimated arrival time. Pilots file flight plans by phone, in person at the station, or via voice recording. The specialist then processes the new flight plan, querying the pilot as needed to clarify or complete the plan, either in person or by calling the pilot if the plan was filed via voice recording. The plan is reviewed by the specialist for completeness and errors, verified with the pilot, and then stored in the automated data base.

Processing pilot requests for clearance. A pilot may request changes or modifications. For example, the pilot may request an Instrument Flight Rule (IFR) or Special Visual Flight Rule (SVFR) clearance in order to obtain air traffic control services. The specialist must receive that pilot request and determine the appropriate air traffic control facility to contact. The specialist then contacts the facility, requests the clearance, and receives either approval or denial. The specialist then must relay that clearance verbatim to the requesting pilot, receive the pilot's acknowledgement or rejection of the clearance, and make the appropriate log entries.

Responding to pilot requests for weather data. Before filing a flight plan, a pilot may request weather information from the specialist. The specialist must request background information from the pilot in order to choose an appropriate type of weather briefing. The specialist then formulates a plan of action to generate the weather data from the automated system, evaluates the information, integrates the data into a briefing, and informs the pilot of weather data in a specified format. The specialist then logs the pilot briefing contact.

Maintaining weather data currency. The specialist is responsible for maintaining an on-going understanding of current and forecast weather conditions order to assess implications of changing meteorological conditions on flights within the assigned flight plan area. The specialist does this by observing the weather display queue for new or changed weather data, reviewing appropriate weather maps and graphics generated by the automated system, as well as pilot reports. From this review of available data, the specialist determines weather trends and assesses probable impacts on the routes of flight through the assigned flight plan area generally, and on any VFR flights, specifically.

Identification of required knowledges, skills and abilities

Manning then identified skills and knowledges required to perform the studied job functions on the basis of available job documentation. An unspecified number of subject matter experts from the FAA Academy Flight Service Revision and Development Unit (AAC-934A) reviewed those skills and knowledges and linkages between job functions and clusters of skills and/or knowledges developed. These linkages will be reviewed through proposed re-analysis of the automated FSS job as consolidation of facilities proceeds under the NAS plan.

Summary

Two job/task analyses of the position of flight service specialist in an AFSS were conducted. The first, a product delivered by Gee was considered an incomplete foundation for the development of a selection (that is, screening) program. A subsequent analysis, conducted by Myers and Manning, resulted in a list of important work behaviors and specification of required KSAOs. That analysis served as an important input to the next step in the development of FAA Academy course 50232, specification of test content and program structure in the process of test development.

TEST DEVELOPMENT

Legal framework for test development

The second crucial step is to develop the selection procedure on the basis of the job analysis with careful attention to professional and technical test construction. A selection test must be predicated upon a suitable job analysis and have been constructed with "reasonable competence" (*Guardians Association*, 1980). For example, in *Guardians Association* (p. 96), the selection test was criticized for haphazard process of writing test items by "amateurs in the art of test construction" that did not have access to the job analysis materials during test construction. In contrast, the employer in *Cuesta v. New York Office of Court Administration* (1987) adhered to a careful test construction process, and was guided by the results of the job analysis under the supervision of a professional test development firm. The employer and contractor were careful to assess the important aspects of the job for which measurement was appropriate and feasible, rather than measuring all components of the job in their exact proportion regardless of significance (*Cuesta v. New York Office of Court Administration*, 1987, p. 46,603). The central lesson of the *Guardians Association* and *Cuesta* cases is that the selection test must be competently constructed and its content solidly anchored in the job analysis in order to survive the rigors of legal scrutiny if adverse impact is established.

This framework suggests two central issues that should be addressed in order to establish the linkage between the job analyses, as conducted for the flight service specialist occupation and FAA Academy course 50232. The first issue is, "Were the results of the job analysis used to specify the content of the FSS Screen?" This section of the report will examine the available documentation linking job analysis to program specifications. The second issue is, "Were the selected tasks appropriately operationalized in the graded instruments from which scores will be computed as the basis of future selection decisions?" The second issue will be addressed in another section of this report.

Specification of test (screen) content from the job analysis

The next question is: Were the results of the Myers and Manning analysis used to frame the content of FAA Academy course 50232? The products of the Myers and Manning job analysis were reviewed by subject matter experts at the FAA Academy in the process of designing course 50232. Initial decisions about course content made in January 1988, reflect the results of the Myers and Manning analysis, according to notes taken and distributed by the Supervisor of the Flight Service Revision and Development Unit (AAC-934A):

"The following decisions were made and agreed upon by the participants:

> "The screen will consist of four primary areas: weather analysis; flight plan processing, which will incorporate Model 1 usage; emergency services; and the last item is what we called prioritizing requests.
>
> "The weather analysis will consist of a group of charts and alpha/numeric data that the student will have to match together. This will test his/her ability to analyze weather patterns. It will also contain a pilot briefing that will demonstrate the student's ability to present the weather in a summarized form.
>
> "The flight plan processing will demonstrate the student's ability [to] utilize the Model 1 equipment.
>
> "The emergency services will be the VOR [Variable Omni-directional Range] and ADF [Automatic Direction Finding] orientations from the present course.
>
> "The last item, prioritizing requests, will involve multiple simultaneous radio contacts where the student must identify the highest priority requests and provide the service in the proper order."

On one hand, the weather analysis and flight plan processing components clearly flow directly from the results of the job/task analysis. On the other hand, the inclusion of emergency services, in the form of orienting lost aircraft, in the proposed Screen is the product of SME review of the job/task analysis. The fourth component, prioritizing requests, appears not to have been operationalized in the FSS Screen.

Discussions with the CAMI researcher present at the January 11, 1988, meeting suggest that the discussants believed that the overall rating for the "orienting lost aircraft" task did not truly reflect its importance to the occupation because, while the frequency of the task was low, its criticality was very high. Discussants at this meeting included six subject matter experts (full performance level specialists) serving at the FAA Academy as course developers. They concluded that this task (orienting aircraft) is an emergency situation in which it is "very likely that incorrect performance will directly cause injury or death." This assessment reflected the criticality ratings provided by incumbents in the Myers and Manning job analysis.

Participants at the January 11, 1988, meeting justified dropping the "processing flight plan requests for clearance" task from the proposed FSS Screen because specialists simply relay, verbatim, clearances received from terminal or en route controllers. Moreover, discussants concluded that the relevant skills and knowledges were taught and tested in the flight plan processing component of the proposed FSS Screen. Therefore, although the "processing flight plan requests" task was rated in the job analysis as "frequent" and "somewhat critical," it was perceived by the Academy SME panel as being easy to train and as not requiring any skills and knowledges not already assessed in the proposed course.

Finally, another subject matter expert meeting was conducted on February 11, 1988, to discuss the weather analysis portion of the proposed course. Again, from notes taken and distributed by the Supervisor of the FSS Revision and Development Unit (AAC-934A) for that meeting, participants determined that two primary weather-related skills were implied by the job/task analysis:

> "The first skill is to maintain currency on weather producing patterns and the second is the ability to respond to a pilot's request for weather data."

The participants agreed at this meeting that these two tasks, identified in the Myers and Manning job analysis, would be operationalized in two separate laboratory simulations. Maintaining currency was operationalized as a laboratory exercise requiring the specialist to observe to determine weather trends from review of appropriate weather maps and graphics. Responding to pilot requests for weather data was operationalized as a separate laboratory exercise to evaluate current information in light of trends and to inform the pilot of that assessment using appropriate phraseology.

Development of the course

Development of FAA Academy course 50232 is more fully described in the formal course report prepared by the FAA Academy Instructional Systems staff (FSS Instructional Systems Unit, AAC-934A, December 1990). The NWS unit assigned to the FAA Academy developed the weather analysis tests and laboratory simulations based on the FAA specifications. The remainder of the course was developed by FPL specialists assigned to the FAA Academy during 1988. A doctorate-level Instructional Systems Developer joined the development staff mid-year 1989 to provide professional guidance and oversight to the development of instructional, testing, and laboratory materials for course 50232. In addition, personnel research psychologists from CAMI provided consultative services throughout the development of course materials for the FSS Initial Qualifications Course. FAA Academy course 50232 represents an evolution of previous FSS training programs, rather than a radical departure, in the same way that field automation and consolidation of FSSs represents an evolution, rather than revolution, of the air traffic system.

Summary

It appears that the Myers and Manning (1988) analysis of the FSS job in AFSSs was used to specify the content of the proposed FAA Academy course 50232. On one hand, the flight plan processing and weather analysis elements of FAA Academy course 50232 can be traced directly to the Myers and Manning analysis. On the other hand, the inclusion of emergency services in the form of "orienting lost aircraft" as part of course 50232 is the direct result of decisions made by a panel of subject matter experts upon review of the job/task analysis results. The development of course 50232 was accomplished through the collaboration of SMEs and professional psychologists and an instructional systems designer. FAA Academy course 50232 was developed with reasonable competence and care in accordance with existing professional and technical guidelines, standards, and practices.

DESCRIPTION OF FAA ACADEMY COURSE 50232

The overall course specifications for FAA Academy course 50232 resulted from this series of meetings between Academy subject matter experts/course developers and CAMI researchers. The development of actual course materials is documented in the final course report from the FSS Revision and Development Unit to the Air Traffic Branch of the FAA Academy (Flight Service Instructional Systems Unit, AAC-934A, November 1990). The general outlines of the final course are presented below.

Four major occupational topics are covered by the course in both classroom and applied laboratory settings: (a) general academics; (b) flight plan processing using Model 1 AFSS equipment; (c) weather analysis; and (d) aircraft orientation. The general academics instructional block is designed to provide basic aviation information needed for job performance and knowledgeable communication with pilots. Students also memorize the relevant characteristics of the FAA Academy local flight plan area, the geographical region for which the specialist is responsible in the laboratory simulations later in the course. Knowledge gained in this block of instruction is tested in the General Academics Block Test.

The flight plan processing components of course 50232 introduce the student to the Flight Service Automation System (FSAS), Model 1 equipment, procedures, terminology and briefing functions. FSAS briefing functions enable the specialist to call up various pieces of information from the computer data base of flight plans and weather data. Knowledges gained in this block of instruction are tested in the General Academics Block Test; both knowledges and skills are tested in the flight plan processing laboratory exercises.

The Weather Analysis instructional block, developed and administered by the NWS in cooperation with the FAA Academy, provides the basic meteorological information required to effectively evaluate the probable impact of changing weather conditions on intended routes of flight. Students, in the course of this instructional block, learn to recognize the causes and effects of specified weather patterns. They also learn to extract relevant information from the weather data base, using the FSAS Model 1 equipment in order to determine whether weather conditions could pose a potential danger to proposed flight plans. The Weather Analysis Block Test is oriented towards testing of knowledges gained through academic instruction; the Weather Analysis Controller Skills Test (CST), on the other hand, is intended to be an integrated test of knowledges and skills. The applied laboratory exercises allow the students' knowledges and skills to be systematically evaluated in a "hands-on" simulation of gathering information, integrating it, and assessing potential impact on air traffic.

Finally, the Aircraft Orientation component of the FSS Screen teaches the student two distinct methods for providing aircraft orientation services. The student then applies those knowledges in laboratory simulations of lost aircraft situations and also in a final CST. Both the laboratory exercises and the CST allow the students' knowledges and skills to be systematically evaluated.

The first class entered course 50232 in March 1989, on a non-pass/fail (that is, all pass) basis. The program has continued on a non-pass/fail basis pending stabilization of course content and standardization of course administration (Broach, 1989). In June 1990, the Manager of the Air Traffic Branch (AAC-930) determined that course 50232 was sufficiently stabilized in content and standardized in administration to warrant validation for use in making personnel decisions.

TEST VALIDATION

Legal framework for test validation

The third important step is to accumulate evidence concerning the validity of the newly-developed selection test using an appropriate data collection strategy. Validity refers to "the appropriateness, meaningfulness, and usefulness of the specific inferences made from test scores" (American Educational Research Association, and others, 1985, p. 9). Traditionally, the data collection strategies employed to accumulate validity evidence have been grouped into three categories: (a) content-related; (b) criterion-related; and (c) construct-oriented. Content-related evidence for the validity of a selection procedure demonstrates the degree to which the sample of items, tasks, or questions on a test are representative of some defined universe or domain of content. For example, systematic observations of job behavior may be combined with expert judgment to construct a sample of critical or important job behaviors that can be administered under standardized conditions.

The first task for developers is the adequate specification of the domain that the proposed test is intended to represent, given the probable use of the test. In other words, a job analysis must be conducted and used to derive the specifications for the test, as discussed above. Another important task for developers is the determination of the degree to which item or work sample formats and response properties are representative of the job domain to be sampled. That is, an appropriate testing strategy must be employed. Criterion-related evidence, on the other hand, demonstrates that the test scores are systematically related to one or more job performance criteria or outcomes. The intrinsic value of a criterion-related study as evidence for the validity of a selection procedure depends on the relevance of the job performance criterion or organizational outcome that is used (American Educational Research Association, et. al., 1985, p. 11). Finally, construct-oriented validation focuses primarily on the test score as a measure of a psychological characteristic thought to underlie successful performance of critical or important work behaviors. The choice of a validation strategy (content-, criterion-or construct-related) is a function of professional judgment in light of the intended inferences from test scores.

Strategy[2]

Choice of validation strategy

The choice of validation strategy, in this case, was dictated by two constraints. First, a predictive or concurrent criterion-related validation strategy was not technically feasible as defined by the **Uniform Guidelines** (section 14.B.[1]). Specifically, reliable measures of field job performance with appropriate statistical properties are not currently available for the flight service occupation. Moreover, there is little attrition from field training among the students who passed through the program since March 1989. Second, the **Uniform Guidelines** (section 14.C.[7]) provides that

> "Where a measure of success in a training program is used as a selection procedure ... the use should be justified on the relationship between the content of the training program and the content of the job."

Success — or lack of — in course 50232 will be used as the basis for retention or separation from the flight service occupation as described previously. Therefore, a content-oriented validation strategy was selected for this study.

Technical standards

To establish content validity under the **Uniform Guidelines** (Section 14.C.[4]),

> "For any selection procedure measuring a knowledge, skill, or ability the user should show that (a) the selection procedure measures and is a representative sample of that knowledge, skill, or ability; and (b) that knowledge, skill, or ability is used in and is a necessary pre-requisite to performance of critical or important work behavior(s)."

In this case, what is required is a showing that the components of the selection procedure; e.g., the graded tests and laboratory exercises, sample the knowledges and skills required to perform the important job functions identified in the various job/task analyses. The linkage between knowledges and skills and the selection procedure is most easily established when the results of the job analysis clearly served as the blueprint for the test and when the process of test development is well documented (*Chance v. Board of Examiners*, 1971; *Commonwealth of Pennsylvania v. O'Neill*, 1979; *Cuesta v. New York Office of Court Administration*, 1987). The instructional systems design process used by the FAA Academy and consultative services provided by personnel research psychologists from the HRRD provided some assurance that instructional and test content would be anchored in the available job information and management-defined course objectives. However, a review of the graded components by subject matter experts from the field was chosen as a final quality control check on course content, as represented by the graded instruments, vis-a-vis the available knowledge and task information for the job functions that are tested in course 50232.

Method

Subject matter expert (SME) panel

A panel of 16 full performance level automated flight service specialists was assembled in Oklahoma City for the week of September 10-14, 1990. Six of the specialists were currently assigned as Assistant Managers for Training in the home facilities; the other 10 specialists were non-supervisory, active duty personnel performing the day-to-day job of a specialist. The mean age for the group was 42, and ranged from 29 to 53. Overall, the group had been at the full performance level (FPL) for an average of 12 years. The least-experienced specialist had 1 year as an FPL controller; the most experienced had 28 years in service as an FPL specialist. There were three women in the panel. However, it must be noted that none had more than three years of experience in AFSSs, in view of the recency of consolidation and automation. Moreover, the panel size was limited by practical constraints of the availability of personnel and funds for travel. The majority of the panel declined to provide race/ethnic data (13 of 16). Five of the controllers had a 4-year college degree; 10 reported at least some college education, while 1 reported a high school degree as the highest degree of education completed.

Procedure

Raters were provided with a rating sheet for each graded component of the FSS Screen. The rating sheets listed the knowledges and tasks associated with each major instructional block, as identified in the Myers and Manning job analysis, and particularly, Manning's analysis of knowledges required to perform AFSS job functions[3]. The rating sheet provided for making a "yes" or "no" judgment as to whether the knowledge was represented by at least one item of the relevant block test. Raters evaluated whether tasks and knowledges were represented by laboratory exercises and CST on the premise that these instruments represented integrations of knowledge and behavior. Raters read through the academic, multiple-choice type examinations (the Block Tests and CST) or worked through the problem scenarios in the AFSS laboratory. Due to time constraints, only the final graded problem for each block was examined. The results of this study are therefore based on a sample of the laboratory problems; the adequacy of the laboratory simulations can only be inferred from this sample, rather than unequivocally demonstrated.

Analyses

First, the overall proportion of raters assigning a "yes" to each task or knowledge element for a graded instrument was computed. For example, 16 of 16, or 100% of the raters indicated the "principles of aerodynamics" were tested in the General Academics Block Test (Table 2). Second, the proportion of tasks or knowledge elements assigned a "yes"

Table 2
Proportion of raters (N=16) indicating that the General Knowledge elements were represented in the General Academics Block Test

General Knowledge element	BT
Principles of aerodynamics	100.0%
Aircraft types	37.5
Aircraft performance characteristics	100.0
Navigational aids (Radio beacons, VORs, etc.)	50.0
Aeronautical Charts and symbology	93.8
Federal airway system	100.0
Regulations governing VFR/IFR operations (FAR, etc.)	100.0
Phonetic alphabet/numbers in communications	87.5
Aircraft identifiers and call signs	6.3
Facility identifiers	87.5
Phraseology	93.8
Priority of duties	68.8
Local flight plan area topographic features/landmarks	87.5
Local flight plan area navigation aids	87.5
Local flight plan area airways, airports, and mileages	87.5
Local flight plan area restricted areas/airspaces	87.5
Local flight plan area communication frequencies	81.3
Overall % general knowledge elements represented	**80.9**

Note: BT=Block Test

across elements was computed for each rater. For example, rater 1 may have indicated that 14 of the 17, or 88%, of the "general knowledge elements" identified in the job/task analysis were covered by the General Academics Block Test. Rater 2 may have indicated, in contrast, that all (100%) of these elements were tested in general academics, and so on for each of the 16 raters. These percentages were then averaged across raters (percent "yes" across elements and raters) to provide an indication of how well the test sampled from the task and knowledge domain associated with each job function. For example, on the average, the rating panel indicated that about 81%, or 14 of the 17, of the "general knowledge elements" were represented or tested in the General Academics Block Test (Table 2). A criterion of 70% coverage was selected as the minimally acceptable sampling. This somewhat arbitrary criterion was selected because it was consistent with the common standard used by the FAA Academy in assessing student competency and it assured that the task domain was reasonably well sampled. Panel members did not evaluate the appropriateness of a testing format for a particular knowledge or skill; nor were panel members free to add or delete knowledges or skills.

Results[4]

General Academics

Overall, raters indicated that about 80% of the listed general knowledge elements from the job/task analysis were represented in the General Academics Block Test (Table 2). Three specific topics, however, were not well covered in the test: (1) aircraft types; (2) navigational aids; and (3) aircraft identifiers and call signs. The general knowledges appear to be adequately sampled for the purpose of establishing the content validity of the test.

Flight Plan Processing

Overall, the SME panel indicated that about 69% of the knowledges associated with flight plan processing in the available job/task analyses were

Table 3
Proportion of raters (N=16) indicating that the Flight Plan Processing elements were represented in the Flight Plan Processing block test and/or laboratory problem

Flight Plan Processing element	BT	Lab
Knowledges		
FSAS/FSDPS configuration	93.8	6.3
CRT display operation	62.5	93.8
Main keyboard layout and operation	81.3	87.5
Keyboard function keys	100.0	100.0
Screen editing procedures	93.8	75.0
Flight plan mask display procedures	43.8	93.8
Data entry procedures	93.8	100.0
Flight plan data elements	100.0	100.0
Keywords for filing plans	25.0	100.0
Flight plan display procedure	100.0	43.8
Overall % Flight Plan Processing knowledges represented	**69.4**	**80.0**
Tasks		
Receive request to file flight plan via phone or walk-in		100.0
File flight plan		100.0
Query pilot about flight plan		100.0
Review flight plan for completeness and/or errors		100.0
Verify flight plan with pilot		62.5
Store flight plan in data base		100.0
Overall % Flight Plan Processing tasks represented		**93.8**

Note: BT=Block Test; Lab=Graded laboratory exercise

represented by the flight plan processing portion of the General Academics Block Test (Table 3). Three elements were perceived as not well covered by the panel: (1) CRT display operation; (2) flight plan display procedures; and (3) keywords for filing flight plans. The flight plan processing portion of the General Academics Block Test appears to be only marginally acceptable for the purpose of establishing the content validity of the test. However, the identified weaknesses can be easily ameliorated by expeditious item writing, try-out, and incorporation into the block test. The flight plan processing laboratory problem, in contrast, appears to sample the relevant knowledge and task domain adequately, with 80% of the identified knowledge and 94% of the listed task elements represented. Overall, it appears that the flight plan processing laboratory problem adequately sampled the knowledge and task domains.

Aircraft orientation

Overall, the SME panel indicated that 99% of the knowledges associated with aircraft orientation in the presented job/task information were represented in the CST (Table 4). About 74% of the delineated tasks were also represented in the CST.

Table 4
Proportion of raters (N=16) indicating that the Aircraft Orientation elements were represented in the Aircraft Orientation written test and/or laboratory problem

Aircraft Orientation element	CST	ADF	VOR
Knowledges			
VOR navigation terminology	100.0	0	100.0
Plotting procedures	100.0	100.0	100.0
Coordination procedures	100.0	100.0	100.0
ADF navigation terminology	100.0	100.0	0
Airborne receiver component functions	100.0	93.8	93.8
Use of orientation aids	100.0	87.5	100.0
Radio procedures and phraseology	100.0	100.0	100.0
Information needed from pilot to orient aircraft	100.0	100.0	100.0
Procedures for determining heading and altitude	93.8	93.8	100.0
Procedures for establishing aircraft on inbound heading	100.0	100.0	100.0
Overall % Aircraft Orientation knowledges covered	**99.4**	**97.2**	**89.4**
Tasks			
Choose method of aircraft orientation (VOR or ADF)	100.0	93.8	100.0
Conduct aircraft orientation services	100.0	100.0	100.0
Determine if pilot knows how to operate equipment	25.0	31.3	31.3
Instruct pilot on aircraft equipment operation if needed	100.0	87.5	93.8
Perform required mathematical calculations	37.5	25.0	0
Enlist assistance of any other aircraft in area	0	0	0
Receive pilot request for guidance to airport	100.0	100.0	100.0
Issue course instructions and advisories to pilot	100.0	100.0	93.8
Terminate aircraft orientation	100.0	100.0	100.0
Complete orientation record	75.0	93.8	100.0
Overall % Aircraft Orientation tasks covered	**73.8**	**73.1**	**71.9**

Note: CST=Controller Skills Test; ADF=Automatic Direction Finding graded laboratory exercise; VOR=Variable Omni Range graded laboratory exercise

However, in the view of the panel, there were three areas that were not well sampled, as indicated by element proportions of less than 70%: (1) determining if the pilot (of the lost aircraft) knew how to operate the equipment; (2) performing required mathematical calculations to obtain time and distance; and (3) enlisting the assistance of other aircraft. The first and third areas may be corrected by future revisions and development. The low rating of mathematical calculations was considered to be suspect because of the wording of the task statement; time and distance computations are not performed in the course of ADF or VOR aircraft orientations. The aircraft orientation laboratory problems for both methods (ADF and VOR) presented the same pattern of general and specific results. There-

Table 5
Proportion of raters (N=16) indicating that the Weather Analysis elements were represented in the weather written tests and/or laboratory problems

Weather Analysis element	BT	CST	BIG	RTE
Knowledges				
Weather equipment parameter selection/entry	6.3	0	50.0	50.0
Detailed weather data display procedure	12.5	5.9	25.0	68.8
Weather message order	87.5	41.2	0	50.0
Weather reports/displays	100.0	94.1	75.0	100.0
Types of forecasts/advisories	100.0	94.1	100.0	100.0
Types and characteristics of weather systems	100.0	94.1	100.0	100.0
Weather charts and symbols	100.0	94.1	100.0	100.0
Overall % Weather Analysis knowledges represented	**72.3**	**60.7**	**50.8**	**71.1**
Tasks				
Observe display queue for new/changed weather data		0	0	37.5
Detect updates in weather		17.6	12.5	100.0
Review weather maps and/or color weather graphics		94.1	100.0	100.0
Review continuously all weather updates and reports		25.0	6.3	81.3
Determine weather trends		50.0	87.5	100.0
Determine impact of weather on routes		88.2	100.0	100.0
Determine impact of weather on VFR flight		17.6	100.0	100.0
Convey descriptive summary of current en route weather		0	87.5	62.5
Assist pilot in selecting alternate routes or destinations		5.9	0	100.0
Overall % Weather Analysis tasks represented		**34.7**	**54.9**	**86.6**

Note: BT=Block Test; CST=Controller Skills Test; BIG="Big Picture" Weather Analysis graded laboratory exercise; RTE="Route Weather" Weather Analysis graded laboratory exercise

fore, the aircraft orientation components of the FSS Screen adequately sampled the relevant knowledge and skill domains.

Weather analysis

Overall, the weather analysis graded components of the FSS Screen are the weakest (Table 5). The Block Test appears to adequately sample the associated knowledge domain (72% coverage overall). However, the Weather Analysis CST did not adequately represent either knowledges (61% overall) or task elements (35% overall). Three knowledges were not adequately sampled in the rating panel's view: (1) weather message order; (2) detailed weather data display procedures; and (3) equipment parameter selection/entry. Just two of nine task elements were perceived by the panel as being adequately represented in the CST (review maps/graphics and determine impact on routes). A substantive review of the Weather Analysis CST is indicated. The test does not appear to represent an adequate sampling of the relevant task and knowledge domains as defined by the available job/task information for purposes of content validation. The overall ratings for the "Big Picture" weather analysis problems, in which the students review the continental U.S.

weather picture, sample approximately 50% of the relevant weather knowledges and tasks. A substantive review of these laboratory problems is also indicated. On the other hand, the "Route" weather problems, in which students assess the impact of continental weather on specific routes of flight, and attempt to convey that assessment to pilots, sampled 71% of the defined knowledges and 87% of the delineated tasks. The "Route" weather analysis problems appear to adequately sample the relevant domains.

Summary

Overall, 8 out of 10 graded components in the FSS Screen appear to adequately sample the knowledge and task domains associated with particular job functions. Therefore, FAA Academy course 50232 may be said to bear some reasonable, manifest relationship to the job of a flight service specialist. However, the review by the field SME panel also indicated specific areas of inadequate sampling of knowledges and tasks, particularly in the Weather Analysis CST and "Big Picture" laboratory problem.

RECOMMENDATIONS

Interim use of the FSS Screen

The **Uniform Guidelines** (section 5.J) provides that a selection procedure that is not fully supported by required validity evidence may be used on an interim basis for making pass/fail determinations provided

> "(1) The user has available substantial evidence of validity, and (2) the user has in progress, when technically feasible, a study which is designed to produce the additional evidence required by these guidelines within a reasonable time."

The evidence developed in this report provides substantial support for the validity of the program as currently implemented. However, that same evidence points to specific weaknesses that must be rectified. Course 50232 might be used as the interim FSS screening tool, while revision of identified weaknesses are completed and criterion-related validation and fairness studies conducted. Active efforts must be made to collect additional evidence, with special attention to the representation of minorities and women, about the fairness, validity, and utility of the program as well as to clearly document revisions and to gauge their probable effect during any interim use. However, as noted recently by Cronbach (1988, p. 5), validation is never finished; revision and validation are intermeshed and proceed jointly. Validation, as is revision and development, is an ongoing process of accumulating evidence, testing explicit and implicit hypotheses about people and jobs, and making appropriate adjustments to both theory and practice on the basis of available information. This study represents but one more step in that long accumulation of evidence.

Notes

[1] This work was performed under task AM-90-C-HRR-123. The opinions and interpretations expressed are those of the author alone and are not necessarily those of the FAA.

[2] Further information with regard to this study can be obtained from:

Supervisor, Selection and Validation
Research Section (AAM-523)
Civil Aeromedical Institute
P. O. Box 25082
Oklahoma City, OK 73125
(405) 680-4839; (FTS)747-4839

[3] Rating materials are available from the Supervisor, Selection and Validation Research Section (AAM-523), CAMI.

[4] The source data for this study are maintained in the archives of the Selection and Validation Research Section (AAM-523). An electronic data base of student scores in FAA Academy course 50232 is under development. The data base is maintained for research purposes only and is confidential. No data on an individual student may be released.

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