AIR TRAFFIC CONTROLLER TRAINING: THE ROLE OF THE UNIVERSITIES

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ABSTRACT

In the wake of the air traffic controllers' strike of 1981, Transportation Secretary Drew Lewis called upon the nation's colleges and universities for help in rebuilding the ATC system. Five years later, the new role for the universities envisioned in that call for help has yet to be realized.

In this paper, the author examines the problems the FAA has encountered in trying to rebuild the ATC system and some factors inherent in the ATC occupation that contribute to many of those difficulties. He then proposes a more direct role in air traffic controller training for the colleges and universities through an Airway Science concentration in Air Traffic Control.

INTRODUCTION

The air traffic control system in the United States has absorbed a number of shocks during the past eight years. Deregulation of the airline industry has increased the amount of scheduled traffic while simultaneously imposing new patterns of demand on the system. In the midst of the deregulation process, the air traffic controllers' strike in 1981 reduced the staffing of the system literally overnight. Predictions of system recovery within three years have proven optimistic--some say fantastic. Nearly five years later staffing and workload continue to strain the ATC system's capacity.

Shortly after the strike, Transportation Secretary Drew Lewis suggested that the FAA would need the help of the colleges in rebuilding the system. The Airway Science curriculum was the result. [1] Airway Science has given the college programs a focus and some influence on FAA recruitment needs. But the results are slow to be seen. As of April, 1985, 102 FAA employees have been hired under the Airway Science announcement--and only three of those were "pure" Airway Science graduates, the others having met equivalent reuqirements. [2] Clearly the program has thus far fallen far short of its goals and its impact has been minimal.

What, then, can be done by the colleges and universities? What, exactly, should their role be--not just in rebuilding the system today, but in the rebuilt, advanced system of the next

century? The answer must be found in an examination of the problems besetting the ATC System, the particular characteristics of the work, and the strengths of the universities in aviation.

PROBLEMS - SYSTEM UNDER SEIGE

In recent years, there has been no shortage of investigations into the air traffic system. Both internal and external studies have produced consistent findings. The Jones Report of 1984, found traffic saturation exceeding the capabilities of an inadequately staffed, inexperienced workforce beset by declining morale. [3] The Government Accounting Office in March 1986 released the results of a year long study which claimed that controllers were overworked and not receiving adequate training, overtime use was excessive, and morale was declining. [4] The American Federation of Government Employees conducted a telephone survey of air traffic controllers and found the two most cited problems are inadequate staffing and inexperienced controllers. [5]

The consistency of these criticisms is unmistakable. The simultaneous growth in traffic since deregulation and loss of an experienced workforce in the PATCO strike have drastically upset the balance of the staffing to workload ratio. Perhaps to some extent, that upset has in turn contributed to the morale problems.

As consistent as the critics are, they do not seem to be overstating the case. Five years after the PATCO strike, the ATC workforce seems to be nearing recovery very slowly. In July 1981, 16,244 air traffic controllers were employed by the FAA. As of February 28, 1986, there were 13,958. [6] What is more critical is the shortage in fully qualified controllers. In 1981, 13,200 controllers, 80% of the total, were full performance level (FPL) controllers. Today there are only 8,673 FPL controllers (62%). The remainder are developmentals in training or Air Traffic Assistants (ATA's) who perform flight data functions. The FPL percentage varies from facility to facility. San Francisco International Tower, for example, has 100% FPL staffing, while Oakland Center has only 38%. In general, terminal facilities have a higher percentage of FPL's than en route centers, and the busiest facilities have the lowest percentages. [7] This of course exacerbates the staffing to workload problem and magnifies the effect on the entire system.

While staffing remains low, demand continues to grow. Nearly 38 million instrument operations were handled by FAA facilities in 1984--only 400,000 short of the prestrike high reached in 1980, and well ahead of the 32 million handled in 1982. This volume is further complicated by the growth of commercial operations. While general aviation operations are more than 3 million below the 1980 levels, air carrier and air taxi operations are up nearly 3 million. Thus, a significant portion of the IFR demand has switched categories from general to commercial. [8] The scheduling patterns of the commercial carriers have also undergone change since deregulation. While airlines

have long scheduled arrivals and departures in clusters during the most popular travel hours, the growing popularity of "hub and spoke" operations has intensified the peaks and valleys of traffic flow in and out of airports, [9] further straining the thin staffing.

In order to meet this demand, controllers are working longer hours, and spending more time on control positions. In fiscal year 1980, the FAA used 377,000 hours of overtime (approximately 23 hours per controller), at a cost of $8.1 million. In the 1985 fiscal year 908,000 hours were used (approximately 63.5 hours per controller) and cost $28 million. [10] As one supervisor has said, "There are just so many six-day work weeks in a person."[11]

Those days are growing longer, too. Supervisors and managers polled in the GAO study felt that only three hours of an eight hour shift should be spent on a radar position. The rest of the shift should be filled by time on non-radar positions, training, rest breaks, etc. [12] Before the strike, controllers were spending 4 to 4 1/2 hours on radar. In 1984, the time was up to 6 to 6 1/2 hours. [13] In addition, supervisors are spending an average of 35% of their time on positions, leaving their supervisory duties unfulfilled.[14]

Despite these pessimistic figures, the air traffic system remains safe and appears to be efficient. While average daily operations at centers increased 3.15% and 2.7% at towers in 1985, operational errors were down more than 25% and average daily delays were down 17.4%.[15] And since 1981, no accident involving

passenger planes has been attributed to controller error. [16] The critics acknowledge this, but add that the margin of safety is being stretched increasingly thin and recommend restrictions be placed on traffic growth until staffing goals are reached.[17]

Technological changes are coming which will alleviate much of the workload-staffing problem. Historically, technological improvements have allowed controllers to handle more aircraft and maintain narrower separation minima. This has held true for the introduction of radar in the 1950's, secondary radar in the 1960's, and automated radar displays in the 1970's. [18] The FAA's National Airspace System Plan (NAS Plan) proposes even higher levels of automation to increase safety, personnel productivity, and system capacity. While meeting the demands of increased traffic, advanced processing and display systems will reduce the required staffing by one-third by the year 2000.[19] Some data transmissions between the ground and aircraft will be made by Mode S transponder rather than voice, further reducing controller workload.[20]

But these advances are middle to long range solutions. In the meantime, the remaining alternatives are restricting traffic or increasing staffing; the former being the more distasteful choice from both economic and political perspectives. So the FAA prefers the latter and plans to hire 500 new controllers in fiscal years 1986 and 1987.[21] But the attempts to reach staffing goals are being complicated by higher than expected attrition rates in the ATC training program. New controllers must go through 12 to 15 weeks of training at the FAA Academy in Oklahoma

City followed by two to five years of on the job training (OJT) at their field facilities. The Academy training is designed to screen out those students who lack the requisite talents to become controllers and, thus, send only the most likely candidates to the field.[22] During the five yeras prior to the strike, the failure rate averaged 30%. Since 1981, Academy attrition has been nearly 50%. This is some 15% higher than expected, largely due to fewer students entering with prior military ATC experience.[23]

Attrition on the input end of the pipeline is compounded by attrition at the output end as well. Approximately 2,700 controllers--20% of the total--are eligible to retire.[24] Currently, new controllers entering the FAA are barely keeping up with those leaving. As of September, 30, 1985, the controller workforce numbered 13,998; as of February 28, 1986, the total was 13,958. The number of FPL's has grown from 8,315 to 8,673 over the same period--a very slow increase.[25] But this maintenance level could deteriorate rapidly. A proposal before Congress would change how federal retirement income is taxed. Should such a change come about, 80% of the controllers and 82% of the supervisors eligible to retire say they would do so. This would set the FAA recovery effort on its ear. But whether or not a flood of retirements hits the system, the present maintenance level inflow is inadequate to meet staffing goals. Several solutions are being discussed.

Some in Congress, led by Representative Guy V. Molinari (Rep.-NY) believe "there is only one source (of)...trained,

experience controllers...,"--the fired PATCO controllers--and the FAA should tap that source. But this solution leads to its own set of problems. First, those ex-controllers have been "off the boards" for nearly five years, and would require a good deal of retraining. They are not, therefore, an immediate source. But more important is the effect their return would have on the controllers who stayed on in 1981.[26] In a survey taken after the strike, 89% of the controllers questioned were opposed to unconditional rehiring of the strikers. After the often bitter and abusive picketing at ATC facilities, many controllers would be uncomfortable at best working with rehired strikers, and morale could be expected to fall further.[27]

The FAA has implemented several programs of its own to help alleviate the problems. In February 1986, a cross-option program was instituted which provides incentive for controllers to transfer from terminal facilities to the more understaffed enroute centers, and some 500 controllers have already volunteered to participate. But this may become a case of "robbing Peter to pay Paul" if terminal staffing is sacrificed.[28]

A second innovation is currently underway. Training and automation functions at the en route centers are being contracted out to private industry in an effort to reduce non-control staff positions. This will return qualified personnel now holding staff positions to operational positions.[29]

But these are all short-term measures for what is a long-term problem. What is needed is a plan to build a larger, better trained workforce which will reduce workload and resultant stress and allow supervisors to return to supervisory duties. This in turn would help to improve some of the FAA's morale problems and improve efficiency.[30] And the only way to do that is to hire and train more controllers.

But if the solution is that apparent and that easy, why hasn't it been done? The answer lies in some problems inherent in training controllers and in some problems in the FAA's technical training program.

An air traffic controller is very much an information processor. The core skills involved are the acquisition and interpretation of information, the formation of a three-dimensional mental picture of the situation, the development of a decision, and the communication of that decision to the pilot. These skills have remained fairly stable despite technology and workload changes.[31] The difficult tasks for a controller are planning rather than performance tasks, and require cognitive more than psychomotor skills.[32] These skills must be overlearned to become automatic, which will lead to reduced reaction time, reduced effort and fatigue, increased smoothness, and increased resistance to stress.[33] This involves a type of processing which is automatic and requires extensive training to develop.[34] This training is expensive--approximately $175,000 in direct and indirect costs to provide a fully trained controller.[35]

Futhermore, air traffic control is a high performance skill. Besides requiring extensive training, many people fail to develop proficiency.[36] Not everyone is suited to the task. While the requisite talents are not necessarily rare, not everyone possesses them. This is the root of the attrition in ATC training. Given the high costs involved, the FAA has expended a great deal of effort to identify and eliminate candidates lacking those talents. In 1950, aptitude testing was initiated to screen out unlikely candidates. In 1960, the Civil Aeromedical Research Institute (Research was later dropped from the name) was established and it has since been the body responsible for collecting and analyzing data on training performance. CAMI continuously evaluates the effectiveness of and modifies as necessary the aptitude testing.[37] The test in use since October 1981, is fairly predictive of training success. Dr. Carol Manning, a CAMI personnel research psychologist says "there is a significant relationship" between the aptitude test score and success at the FAA Academy.[38]

CAMI has also conducted studies of biographical data collected on incoming students to further identify factors relating to success in the Academy. Age is the strongest factor identified--the older a person is when entering the Academy, the less likely he is to succeed. While prior ATC experience is a signficant factor, other non-ATC aviation experience is an unreliable indicator. Level of education does not relate to success, but academic achievement in high school appears to be related.[39] Based on this informtion the FAA has set limits on aptitude test scores and age (30 years) for newly hired

controllers, and does not require education beyond a high school diploma.

Once hired, the new controller enters a centralized training program at the FAA Academy that has a dual purpose--provide the trainee with the knowledge required for field training, and to again screen the trainees so that only those demonstrating aptitude are passed on the the field facilities.[40] Graduates then go to their facilities for one to two years of on the job training and return to the Academy for radar training after certifying in the tower cab at terminal facilities and on non-radar positions at en route centers. After 17 days of radar training, they return to their facilities for radar OJT, finally reaching FPL status after a total of two to five years of training.[41]

This is a long, difficult process made even more difficut by weaknesses in the training system. Some of these are long-standing problems, others are a result of the pressures to rebuild the system quickly. Many of them are recognized by the FAA and they are addressed in the Air Traffic Management Plan (the personnel equivalent of the NAS Plan).

Training personnel confront a confusing proliferation of directives with often seemingly contradictory requirements. The OJT program suffers from a lack of standardization. The content of some courses is outdated. Equipment deficiencies limit realistic training--the military spends three weeks training in tower cab simulators, while the FAA uses table top airport

models.[42, 43] Solutions to these problems are subject to budget constraints, but attempts are being made to address them. Recent changes to the Academy program are designed to perform more training at the Academy and thereby relieve field facilities of some of the OJT burden. Also, more emphasis is being given to placing new trainees in facilities based on their performance at the Academy, thus improving their chances of success and reducing "wasted" training in the field.[44]

Hiring and training more controllers, then, is not quite as easy as it sounds--nothing ever is. Since hiring is based on placement on the Office of Personnel Management register, and placement on the register is based largely on aptitude test scores, hiring more trainees means hiring candidates with lower scores. Experience indicates that this will increase the attrition rate so that proportionately even more trainees must be hired to increase the output of trained controllers; and this runs up against the wall of budget cuts.

Since trainees with prior ATC experience generally fare better in the Academy, the next alternative is to hire more of them--and that is, in fact, what the FAA has done in the past. But that pool of former military controllers has diminished over the past fifteen years.[45] Furthermore, not all ATC experience is equal. Former military controllers with ratings only but no operational experience and those with only VFR operational experience tend to do no better than trainees with no experience,[46, 47] further reducing the size of the pool.

Therefore, this source is simply not adequate to the increased staffing needs.

The problem, then, appears to be two-fold: first, how to increase the capacity of the training pipeline and second, how to reduce attrition so that more candidates entering the pipeline come out as FPL controllers.

Increasing capacity within the FAA's training program will be extremely difficult in the age of Gramm-Rudman-Hollings. All federal agencies are being forced to cut programs and reduce personnel. Since ATC operational functions must take precedence, and administrative functions can only be cut so far, training programs will surely suffer some cut backs. Thus, the FAA may need to consider increasing training capacity externally and finally turn to the colleges and universities for more direct support in training controllers.

THE ROLE OF AIRWAY SCIENCE

One of the "larger purposes" of the Airway Science Program was to develop a common recruiting source for federal, state, and private aviation employers,[48] and the FAA has stated an intention to evaluate the program to determine its ability to satisfy air traffic requirements.[49] But education in itself does not improve the success rate in ATC training. In fact, college graduates have a higher attrition rate than any other group based on level

of eduction (30.9%). This applies equally to those who listed aviation related courses of study.[50]

This seems to bode ill for the prospects of assistance from the Airway Science Program. Experience would seem to indicate that a college degree, even one in aviation, is of little help to the controller trainee. However, most aviation degree programs have typically concentrated on either professional pilot training or aviation management. Few programs have included air traffic control as more than a course or two within other concentrations. Those schools which have included ATC as a concentration have been limited to VFR tower training due to the non-availability of radar simulators. The Airway Science curriculum echoes this tendency, offering only a three credit course in ATC.

For The Airway Science program to contribute appreciably to improving ATC staffing, the curriculum will need revision. The single ATC course must be expanded into a separate concentration in air traffic control which would include several courses in advanced ATC theory and procedures. The curriculum could be designed to include the academics now taught at the FAA Academy. Program graduates would need to attend the Academy only for a comprehensive examination to ensure a base of requisite knowledge, followed by the screening portion of the present Academy program. These trainees would thereby spend four to six weeks at the Academy as opposed to the current twelve to fifteen weeks. Furthermore, the advanced ATC courses should be designed to include practice in the control procedures used in the

screening laboratory. Evidence suggests that such practice helps.

Since the late 1960's, the FAA has offered a Predevelopmental Program as part of its "Upward Mobility" effort. This program provides a year of training to help women and minorities "acquire the necessary training and experience to enter the ATCS developmental training program." During Phase II of the Predevelopmental Program, students are taught basic aviation and air traffic--very much the same material covered in the present Airway Science curriculum. Further training, including 11 weeks of practice for the non-radar control lab used in the Academy screening, occurs at selected field facilities.[51]

Data collected by CAMI indicate that Predevelopmental graduates have a 5 to 10 percent better than average pass rate in the non-radar lab.[52] This would seem to indicate that if a student is prepared with specific training in ATC he is more likely to succeed in the Academy training. Such preparation is likely to be nearly as useful to the student as ATC experience. It would seem to follow that a well-designed curriculum which included laboratory courses in air traffic control skills would provide excellent preparation for the FAA Academy program and appreciably improve the student's chance of success. In addition, such courses would serve as a screening process themselves, as some students discover they are unsuited to or simply dislike ATC.

Non-radar laboratories are relatively inexpensive and simple to set-up. They require, at the minimum, flight progress strips and holders to record traffic information, a simulation area airspace chart, a clock, and a board to hold the strip-holders. The instructor can respond to the student's "transmissions" or other students can act in the role of pilot.

Radar laboratories are also no longer out of the reach of university budgets. Radar simulators with a high degree of realism are increasingly available at reasonable cost. These systems are not realistic equipment trainers--they typically run on standard microprocessor terminals. But the simulated radar presentation and operational characteristics are very realistic, enabling the student to learn and practice the cognitive and planning skills required. The psychomotor skills of setting-up and using a particular type of radar console is appropriately learned on the job.

With such equipment available at reasonable cost, a university can develop a lab for advanced ATC courses which would be capable of teaching all the skills now taught in the FAA Academy. Standardization could be ensured by periodic on-site program evaluations by FAA personnel and by evaluations of graduates' performance. In addition, a radar laboratory would be a valuable addition to the basic ATC course presently in the curriculum, providing those students going on to other aviation career fields more insight into and understanding of the ATC system. Thus they will be better able to see the implications of

their decisions and policies for the ATC system and of system changes for their operations.

The exact content of an air traffic control curriculum can be developed only after an in depth evaluation of the existing ATC training program curriculum and an analysis of its strengths and weaknesses. But some starting points can be suggested. The core Airway Science curriculum would, of course, be retained.

The forty semester hours in the area of concentration might include:

History of ATC	3 hours;
Control Tower Operations	3 hours;
Non Radar Lab	4 hours;
Radar Lab	5 hours;
Meteorology	3 hours; and
Weather Reporting and Analysis	3 hours.

The remaining twenty nine hours would consist of courses in sociology, psychology, communications theory, and management.

Also, it is imperative that students be evaluated early in the program to ensure that they are medically qualified for ATC positions, and that they be required to take the OPM aptitude test before committing themselves to the concentration. Those students not meeting medical standards or scoring low on the aptitude test would be counselled by their faculty advisors to enter one of the other areas of concentration.

In effect, the development of the concentration would serve to decentralize training. The program would act as a supplement to the FAA Academy, producing graduates with [illegible]

background equivalent to that of Academy graduates, and prepared to step into the field portion of the training program after a brief orientation and evaluation.

Expanding the role of the universities in this way offers several advantages. First, it would incrase the capacity to train air traffic controllers by opening a new avenue for that training. The Universities can become an external resource for the FAA, supplementing the number of controller trainees passing through the Academy and compensating for the diminishing pool of ex-military controllers. This could provide a consequential assist to the FAA's attempts to reach and maintain its staffing goals.

The decentralization of ATC training implicit in this proposal carries with it some advantages as well. As the technological advances in ATC, and aviation in general, proceed apace, innovative ways of employing that technology will be needed. Such innovation is fostered by decentralization since more minds are at work on similar problems. Innovation can also be expected in the training approaches, techniques, materials, and equipment used. Application of the expertise and resources of the universities to the field of ATC can be expected to generate new ideas and new methods.

Certainly such decentralization and innovation carry the seeds of a new problem--loss of standardization. But a quality assurance program can be developed which would ensure standardization and review of new approaches and techniques.

The improved training techniques and the strong academic basis in the Airway Science curriculum could also be expected to improve the quality of the employees entering the FAA. With their background in management and a wider understanding of the aviation industry, they would have the potential of being more effective staff specialists and managers as they progress in their careers. They would be better equipped to implement the technological changes to come and better able to relate to and work with professionals in other aviation fields.

Finally, a partnership with the universities is in line with the trend toward increased government use of privatization. Privatization can be a cost effective means of accomplishing support functions, such as training, by relying on contracts with the private sector. Such a partnership with the universities can help the FAA meet its personnel needs in the face of increasingly restrictive budgetary contraints.

This proposal amounts to a significant change in FAA training policy. The agency has been reluctant to relinquish responsibility for ATC training to outsiders--and understandably so, given the nature of the job and the need to ensure quality. The safety and efficiency of the ATC system depends on a quality product--well trained, professional controllers. But that reluctance is giving way before the forces of budget cuts and the dilemma of seemingly perpetual staffing shortages. The system cannot remain both safe and efficient without some new source of personnel to man the positions in the system. The universities,

through the Airway Science program, can become that source. The time for a marriage of interests and efforts seems at hand.

FOOTNOTES

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