

THE COST EFFECTIVENESS OF SYSTEMATICALLY DESIGNED TRAINING: LESSONS FROM THE FAA'S AQP PROGRAM

J.S. Bresee and A.G. Whitley
Delex Systems, Inc.
Vienna, Virginia

ABSTRACT

Instructional designers have claimed for years that systematically designed, outcome-oriented training is not only better but is also cheaper. As the argument runs, properly designed training addresses specific needs that have been accurately identified by prior analysis; only the training needed is developed and administered, thus saving wasted time and motion in the training of irrelevant or already acquired skills and knowledge. This argument has always had strong appeal, but has seldom been supported by data. This is probably partly because much systematically designed training is implemented for emerging systems where no basis of comparison with past training practices exists. Moreover, when systematic training design practices are used to revise training practices for existing systems, the effort is typically coupled with a major revision in content so that the effect of new training practices cannot be clearly distinguished from the effect of new training content.

The Advanced Qualification Program (AQP) for the initial and continuing qualification of commercial airline pilots offers a good opportunity for assessing the effects of systematic training design without the intervening effect of new and different training content. As an initiative to allow airlines to replace current training practices with an approach driven by well-documented analysis of training needs and requirements, the AQP will allow training professionals to observe the effect of new design on existing content in a well-bounded and well-understood domain.

This paper provides an overview of the AQP development process, and shows how an AQP provides opportunities for assessing the cost effectiveness of the products of instructional systems development. A training cost model is introduced as a potential dependent measure for use in assessing cost effectiveness and in predicting the costs/benefits of specific training design options. Preliminary results of the application of the model show support for the positive economic impact of systematically designed training.

BIOGRAPHICAL SKETCHES

J.S. Bresee has worked as a training analyst and designer for the past 17 years, with experience in training requirements analysis, training system design, and training capability development. He is employed by Delex Systems, Inc., where he is presently program manager for Advanced Qualification Program development.

A.G. Whitley has held leadership and management positions in technology-based businesses for over 15 years. He is the Training Division Manager for Delex Systems, and oversees all of Delex's operations related to Advanced Qualification Program contracting and technical development.

INTRODUCTION: ISSUES IN COST EFFECTIVENESS MEASUREMENT FOR TRAINING SYSTEMS

Since its inception, practitioners of Instructional Systems Development (ISD) have almost uniformly claimed that systematically designed instruction ought not only to be more relevant and appropriate to a specific training requirement, but also, by virtue of these properties, ought to cost less in the long run. Unfortunately, this long-standing claim of "better and cheaper" has resisted verification with a tenacity that has often seemed surprising. In retrospect, it ought not to have been surprising. Differences in content, training goals, and political environment have each had a diminishing effect on the comparison of relative training effectiveness. In spite of the many years of history in applying systematic instructional design, acceptance of its cost-effectiveness is still tends to be more a matter of faith than fact.

Differences in training content present an obvious obstacle to measuring training efficiency. Improvements in training practices have often been implemented along with improvements in the systems which trainees will operate or maintain. When this happens, the content of the new training program is often sufficiently different that any performance improvement resulting from new training methods is overshadowed, or at least obscured, by the improvements in the basic technology which the students are being trained to use. When, for example, systematic training accompanies the introduction of a new aircraft, improvements in human factors engineering may have resulted in systems that are significantly harder to understand, yet significantly easier to operate or interpret than the corresponding systems on the aircraft being replaced. Introduction of the Attitude/Direction Indicator (ADI) responding to a central air data computer as a replacement for a gyro horizon and gyrocompass presented this sort of situation. In other cases, the systems of the new aircraft were both more capable and more difficult to learn. In aviation, this occurred when the flight management system (FMS) replaced the autopilot and VOR/TACAN for en-route aircraft control. In either case, the content addressed by systematically designed training is sufficiently different from the content addressed by more traditional training that direct comparison of relative training effectiveness

and associated cost is difficult.

Another obstacle to direct comparison has been changing training goals. When the goal of an existing training course is described as the "understanding" of a system, while the goal of a systematically designed replacement training course is stated as the detection and correction of system malfunctions, the increased specificity of the desired outcome is probably sufficient to yield a very different set of training and testing strategies. When students are asked to "gain an understanding" of a system, not only is the learning goal non-specific, the model of instruction that is in place is generally that of the public school classroom. This sort of goal might be appropriate when a broad subject area (say, for example, English Literature) is under consideration, the availability of teachers is limited, and testing can only occur by means of sampling the domain.

Generally in these cases, the teacher "surveys" the content, students do extensive additional reading, and tests which sample a domain of knowledge are administered periodically. This sort of approach requires to some extent that tests remain a mystery. When the complete domain of content is so large that it can only be surveyed, and when tests can only sample this domain, prior knowledge of the test would allow a student to learn only the tested sample of the domain, and invalidate the instructional intent of the course.

Of course, just the opposite is true in most technical training. Here, specific tasks comprise the training content. The typical "survey" objective borrowed from academia is not as appropriate under these conditions. Still, this sort of objective shows up in some aviation training systems, especially as part of aircraft system overview training. Here, the stated learning goal (as distinguished from a behavioral training objective) is often something unobservable and unmeasurable like "gain an understanding of the function of the hydraulic system." Goals of this sort are found especially in older or smaller commercial aviation training curricula, and instruction developed to support such a goal will differ significantly from training designed to enable the performance of more specific objectives.

Finally, in some cases, much time and effort has

been spent in justifying and implementing what was then a new and very different training development process, often requiring much persuasion to pave the way. In this situation, it would not be surprising if a program manager elected not to emphasize formal summative evaluation of the program; the career consequences of ambiguous or negative results could be severe.

In summary, then, the evaluation of the effectiveness of systematic training has suffered from significant differences in the basic technical content, significant differences in the specific goals of the training curricula being compared, and lack of incentive to take the measurements. What is needed to make the case for cost effectiveness is an environment where newly designed training can replace an earlier training system addressing the same content and oriented toward the same student evaluation criteria.

This situation can presently be found in commercial aviation where airlines are re-designing crew training systems under the FAA's Advanced Qualification Program (AQP). This initiative allows those airlines who undertake a complete analysis of their operational tasks to replace current training and evaluation practices with new events which are tailored to each airline's own operational requirements. This initiative provides a nearly perfect laboratory for the demonstration of the cost effectiveness of systematically designed instruction. Most importantly, the core content both before and after the implementation of new training is exactly the same. The aircraft to be operated has not changed, nor have the manufacturer's published procedures, the airline's operating practices, or the route structure in which the crew must fly.

Under an AQP, an airline establishes a new set of qualification standards that take on the force of regulation for its crew members. Based on systematic job analysis, these qualification standards reflect airline-specific training and evaluation needs for the equipment, route structure and crew population of the airline. The governing special federal aviation regulation (SFAR 58) and accompanying advisory circular (AC 120-54) require that the new training and evaluation system and standards be at least as stringent as current practices, with the objec-

tive of improving levels of crew qualification above the present standards as provided in FAR parts 121 and 135. In practice, this has meant that aircraft handling standards have remained as presently published in existing practical test guides, but an increased emphasis on crew resource management and line-oriented settings for training and evaluation has been added. These additions have caused some changes in training and testing strategy, but it can be argued that they are the result of systematic instructional development, and are therefore part of the instructional treatment. In summary, methods and techniques of training and evaluation have changed, but every significant aspect of the job itself, including standards of performance, has remained the same. Clearly, the AQP application represents a nearly ideal ISD laboratory.

The political or programmatic reasons for avoiding comparative evaluation of training effectiveness is eliminated by FAA direction. AQP participants are required under the governing SFAR to submit evaluation performance data with student identification removed on a periodic basis to the FAA branch overseeing AQP development and implementation. This requirement acts to ensure a valid basis of performance comparison between training approaches.

AQP PROGRAM DESCRIPTION

An airline develops an Advanced Qualification Program by following an explicit Instructional Systems Development (ISD) process with analysis and documentation requirements that fully meet the intent of MIL-STD-1379D. While many of this standard's internal documentation requirements of questionable usefulness are eliminated, the overall program requirements will be familiar to any ISD practitioner. The airline must explicitly identify the behavioral components of the job to be performed, and establish qualification standards based on specific observable behaviors. A supporting curriculum outline must be developed which provides proficiency-based training in support of the approved qualification standards. Evaluation of each qualification standard based on a terminal proficiency objective takes place in a line-oriented (mission-oriented) environment, either during a line check or an annual line-oriented

evaluation (LOE) session in an advanced flight simulator. The result is a replacement of "one-size-fits-all" airline training with specific training solutions for individual airline requirements.

An AQP is typically developed according to the advisory circular in a five-phase process. These phases are:

- Phase I: Initial Application
- Phase II: General Curriculum Development
- Phase III: Training System Implementation and Courseware Development and Implementation
- Phase IV: Initial Operations
- Phase V: Continuing Operations

Beginning with the formal application, an airline carries out explicit, documented analysis, design, implementation and ongoing evaluation of the resulting training system. Supporting documentation requirements can be met conventionally, or through more innovative approaches that are individually approved. For example, when airline operating documents are concise and readily accessible, a comprehensive set of references to these documents serves very well to document supporting skills and knowledge. In such cases, analysis requirements can be met with a comprehensive task listing, a complete set of qualification standards, and references to specific pages of operational documents.

Once training and evaluation requirements are established through analysis, a curriculum is designed that allows for proficiency-based assessment of student performance throughout training. This design process is followed by courseware and training media development and procurement where necessary. Initial implementation takes place in Phase IV, with ongoing program operation and evaluation carried out in Phase V. The process builds in the flexibility to reduce training costs through innovative media choices, tailored curriculum outlines, and other specific modifications that allow adjustments to each airline's individual needs.

MEASURING THE RESULTS: A MODELED APPROACH

There is no question that airlines have a unique opportunity to improve the quality of their training programs and significantly reduce training costs under the AQP initiative. From the very outset, it was apparent that there was a need to develop a clear understanding of the changes in training curricula, media, and training costs for airlines considering a transition to AQP. There are three primary analytical challenges that drive this need. First, a detailed understanding is essential for evaluating the impact of specific changes to existing training programs as well as comparing the cost-effectiveness of alternative training solutions. Therefore, it is necessary to identify, measure, and relate the utility and costs associated with new training approaches in a systematic fashion. Second, evaluation of AQP alternatives requires consideration of a number of variables and cost factors that must be addressed for each airline as a separate entity. Each airline develops and maintains its own training program with unique characteristics that will dictate training scope and associated cost magnitude. Third, implementation of AQP must be monitored over time to track the actual versus estimated costs of training programs that are developed.

In order to meet the analytical challenges of AQP development, specific tools were required to assist with analysis during implementation as well as for subsequent tracking of AQP results. The approach taken was to develop an AQP cost model to be used for three primary purposes: (1) to calculate initial estimates of cost savings resulting from implementation of an AQP; (2) to conduct comparative cost analyses of alternative AQP implementation plans; and (3) to document initial estimates of cost savings for subsequent verification and validation by actual costs savings once an AQP was implemented. A tailored AQP implementation and tracking system to document airline cost savings from systematically designed instructional programs under AQP as well as the expenses associated with AQP implementation was also developed. The data captured in this latter system form the basis for subsequent verification and validation efforts of initial AQP model predictions.

The two applications comprising this cost forecasting and tracking system provide highly accurate data on net airline savings from transitioning to AQP. In effect, the cost model and accompanying cost tracking software provide a closed-loop system for predicting, assessing, and verifying cost savings resulting from systematically directed changes to airline training programs. The AQP model and tracking system were developed using Borland's Paradox relational data base management system, providing a relatively straightforward, economical and portable set of tools for analyzing training applications.

The AQP cost model is the essential tool for estimating the cost of training operations. It is logically structured through a data base architecture which partitions the input data for the airline and cost parameters into five fundamental modules:

An Airline Equipment Module for basic airline data inputs including aircraft fleet size, number of aircraft by type, and aircrew ratios for each aircraft type over a five-year projection period. This module is required to structure basic elements of the AQP analysis.

A Labor Cost Module for the cost data for training instructors and aircrews (Captain, First Officer, Flight Engineer) for each aircraft type. The module factors wages, taxes and fringe benefits and includes inputs for travel and per diem costs for aircrews associated with training sessions. It establishes crucial cost parameters for the AQP analysis.

A Training Resource Module documents current and projected training costs for simulator time, flight training devices (FTDs), ground school instruction and any specialized training that is required for each aircraft type.

A Curriculum Module for data on utilization rates for each of the training resources required under existing programs or projected with a new curriculum after AQP implementation. This data is also unique for each aircraft type in the fleet.

An AQP Implementation Module documents alternative costs associated with analysis and curriculum design tasks, procurement of training media, and the costs of sustaining training following AQP implementation. This module is essential for establishing all costs associated with implementation of AQP for each airline.

Based upon the parameters established within each of these data base modules, cost-benefit calculations reflecting alternative training approaches and resulting cost savings are provided by the model.

The primary value of the AQP model is in assessing the feasibility of new training approaches by calculating potential cost savings resulting from their application. The AQP cost model is specifically tailored to address current commercial airline aircrew training requirements including initial, transition and upgrade training, and the corresponding training courses developed as part of an AQP. Costs associated with existing training programs are compared with forecasted training costs following implementation of AQP. Forecasted costs include initial costs for establishing and implementing an AQP program within an airline, and the ongoing costs required to maintain the program. In a typical application, a five-year projection of costs based on existing training programs will be compared with training costs forecasted following implementation of AQP training. The five-year projection period provides a useful context for incorporating consideration of future changes the airline plans to make, such as changes in fleet size or aircraft types, and assessing the cumulative benefits from AQP training over time.

The model is capable of addressing a variety of training options and reflecting cost implications in great detail. It is structured to include all important variables associated with existing and future airlines training options, and is therefore capable of being rapidly reconfigured to conduct sensitivity analysis and update cost estimates.

RESULTS AND CONCLUSIONS

The airline training cost model has proven to be a valuable tool in supporting the selection among the training design alternatives that AQP

development presents. In developing and verifying the model, training analysts obtained cost information for existing training programs from several major and regional airlines, and found that the model's predicted costs were in generally close agreement. In most cases, this agreement was rapidly achieved, with only small adjustments of variable values required to achieve accurate cost predictions. In those cases where significant errors in prediction were found, further research led to a modification of the model to account for the specific circumstances that were operating in these special cases. Accurate predictions of current costs suggest that the forecast of savings under AQP are based on a solid foundation.

The AQP cost model has been applied to more than 15 airlines for purposes of predicting costs savings resulting from AQP training. At the present time, tracking data have only been collected over a significant period of time for one regional airline during the early stages of AQP implementation. While this sample size is certainly not adequate to draw strong conclusions, the results to date provide solid support for the predictive value of the model. In this example, actual net savings (AQP savings less costs of implementation) have been realized to within 2% of model predictions over seven months of operations.

The close correspondence between forecast and actual cost savings observed to date tends to lead to two specific conclusions about the model itself. Firstly, the current model does in fact capture the important cost variables associated with airline training operations. Secondly, the accurate prediction of cost savings lends support for the structure of the model with respect to the relationship of these variables. It seems reasonable, therefore, to conclude that a cost model of this basic design is a useful tool in management assessment of training cost savings due to changes in training operations. When combined with performance data on qualification standard behaviors, the basic data is available for an assessment of training cost efficiency.

Use of the cost model has led to a more general conclusion that airlines pursuing AQP conversion of their training systems are demonstrating real cost reductions as a result of systematically designed training. By moving training and

checking closer toward actual line operations and away from contrived training maneuvers is an clear application of the military aphorism that "you fight like you train." In all cases studied thus far, this has led to more cost efficient training as well, with savings in the first year which are often sufficient to fund AQP program development efforts.

Modeling current practices serves as the basis for prediction. Developing a cost model that can accurately predict current costs from observably-changing readily obtainable facts is reasonable insurance that such a model will accurately predict the effects of changes in training practices that affect the component variables of the model. This approach would seem to be applicable to any training system and its associated costs as both a program planning tool, and as a dependent measure of its overall effectiveness.