Skills Development and Assessment in the AQP Environment

Maureen A. Pettitt, Ph.D.
Joseph H. Dunlap
Western Michigan University
Kalamazoo, MI 49008

Abstract

The Federal Aviation Administration (FAA) established the Advanced Qualification Program (AQP) to provide FAR Part 121 and FAR Part 135 air carriers with an alternative for training, qualifying and certificating flight crew members and other airline operations personnel. The purpose of the AQP is to increase safety through higher qualification standards while at the same time encouraging innovation and regulatory flexibility. This paper will describe the airline training environment under the AQP, methods for identifying, training, and evaluating CRM skills as required by AQP, the vital role task of instructor/evaluator training, and the implications of AQP for future pilot selection models.

Purpose and Scope of the AQP

While pilot training methodology has been modified over the decades to accommodate increasingly sophisticated simulators and the role of human factors in safe flight operations, the changes have been evolutionary rather than revolutionary. In 1991, however, the Federal Aviation Administration issued Advisory Circular 120-54, *Advanced Qualification Program* (AQP). This Advisory Circular (AC) provides guidance for obtaining AQP approval under Special Federal Aviation Regulation (SFAR) 58 for the qualification, training and certification of air carrier flight crew members. The FAA established the AQP to provide FAR Part 121 (air carrier) and FAR Part 135 (air taxi) certificate holders with an alternative for training, qualifying and certificating airline personnel in light of new aircraft, increasingly sophisticated technology, changing operational requirements, advanced simulation capabilities, and the evolution of instructional design. The principal objectives of the AQP are to:

1. improve safety through improved training and evaluation, and
2. encourage responsiveness to changes in industry in new aircraft technology, operations and training methodologies.

In their effort to meet these objectives, the FAA designed the AQP to encourage innovation in the methods and technology used during the training, evaluation and management of crew training. The AQP also permits a greater degree of regulatory flexibility for the approval of innovative pilot training programs so that training programs are tailored to an individual operator's needs and circumstances. In addition to innovation and flexibility, the AQP promotes the highest possible standards of individual and crew performance without undue increases in the cost to maintain training resources yet, at the same time, enhance professional qualifications to a level above the present standards.

The AQP consists of five phases: Application, Curriculum Development, Training System Implementation, Initial Operations, and Continuing Operations. From a practical standpoint, the air carriers have the ability to develop a set of instructional objectives that meet the needs and operational characteristics of the airline rather than training to arbitrary standards set forth in the federal regulations. However, each of the five phases involves considerable data collection, evaluation, documentation and FAA review.

An interesting outcome of the AQP has been a significant exchange of information among the air carriers. The Air Transport Association and the Federal Aviation Administration established an AQP Working Group in 1989 to assist carriers with the AQP approval process. The Working Group consists of representatives from carriers and other organizations interested in obtaining AQP approval. Focus groups meet several times between the annual meetings to wrestle with the difficult issues of instructional system design, data management, the integration of crew resource management, instructor/evaluator training, and the implementation of Line Oriented Evaluation. The purpose of the Working Group is to share information and, therefore, reduce the burden of AQP development.

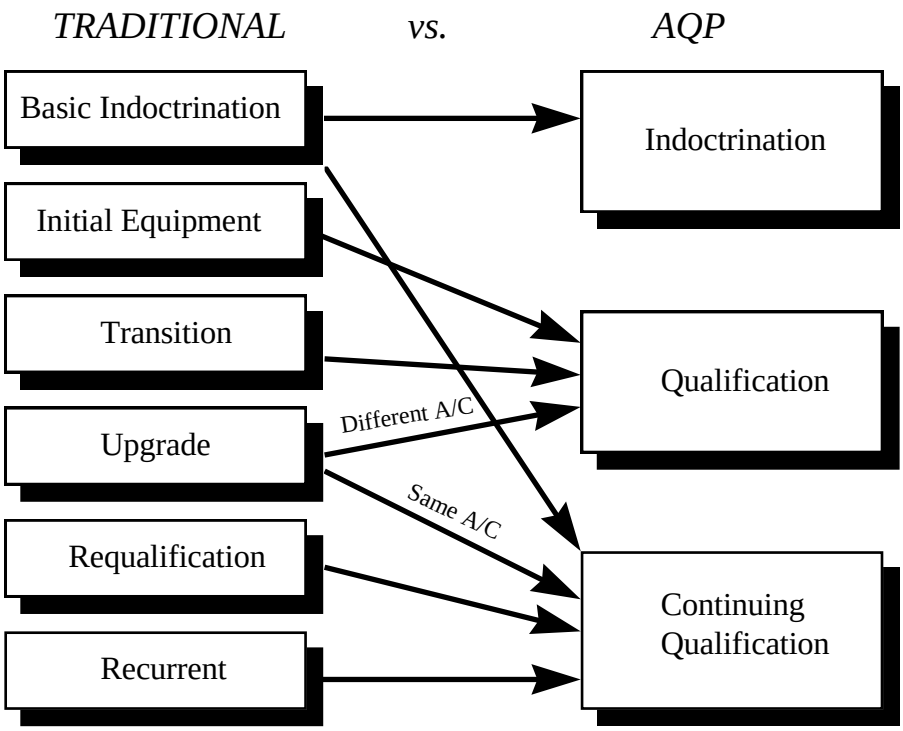
Although participation is voluntary, AQP approval is being sought by all major air carriers, some regional airlines, cargo airlines, Boeing, Airbus, and others. There is a consensus among these organizations that that improved safety and substantial savings will result from implementing an AQP (Pettitt & Dunlap 1995). The economic benefits of AQP are related to increased safety, the flexibility to train non-critical tasks less often, more effective evaluation of pilot performance, the use of systematic analyses to assure that curricula include no more -- or no less -- than is needed, an increased flexibility to utilize less expensive training equipment (i.e., part task trainers and flight training devices) in order to reduce the footprint requirements for a full flight simulator, and the ability to extend the evaluation period based on pilot performance data. Consequently, the AQP is becoming the standard for pilot training at most U. S. airlines.

The AQP Training Environment

The AQP model employs proficiency-based training and evaluation derived from the Instructional Systems Design (ISD) process described below. Consequently, the FAA is very involved with the development of the program as well as the evaluation of program outcomes. The FAA further requires that airlines provide de-identified pilot performance data. This allows the FAA to assess the airlines training program and to track trends within and across airlines. There are three training programs under AQP:

1. Indoctrination -- aircraft generic training
2. Qualification -- initial equipment, transition and upgrade
3. Continuing Qualification -- recurrent, requalification, and upgrade

Figure 1 is an example from Delta Air Lines (slightly modified) graphically presenting the differences between the traditional pilot training program and the AQP training environment.

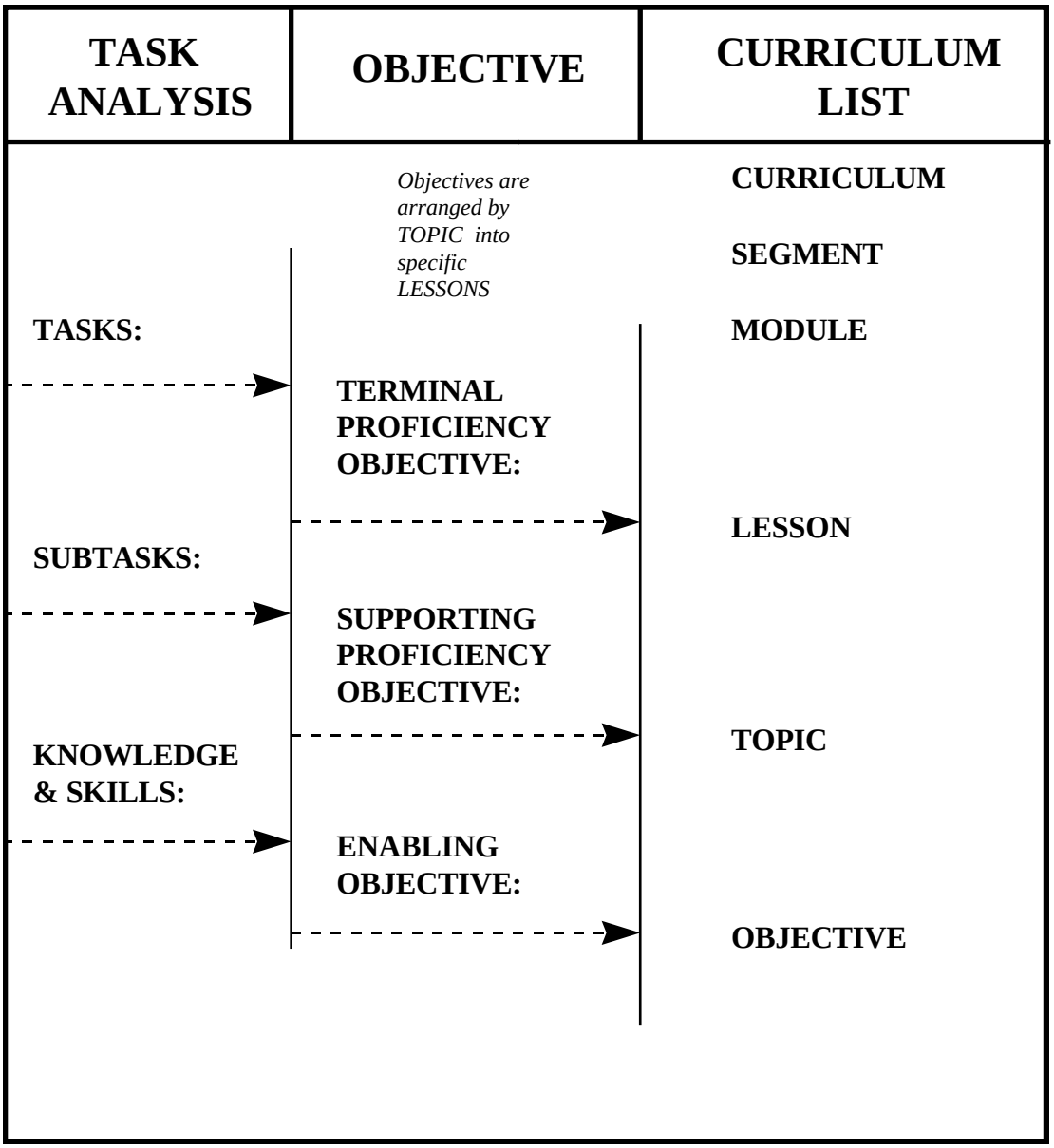


Training Curricula
Figure 1

While the AQP is a multi-phase process, for the purposes of this paper, our discussion will be limited to Phase II, the development of the training curriculum. The FAA has adopted the use of a systematic curriculum design methodology known as Instructional Systems Design (ISD). Adapted from the field of systems engineering, ISD was first applied in training and education in the late 1950s. In brief, the ISD process consists of a) establishing precise instructional objectives, b) developing viable approaches to meet those objectives, and c) assessing how well the objectives have been met. The FAA requires that AQP applicants use some contemporary variant of the ISD approach in developing their training curricula.

During Phase II, the airline conducts a comprehensive task analysis, normally by phase of flight (including ground operations, takeoff, climb, cruise, descent, approach, landing, after landing) and for emergencies and systems operations. The task analysis requires the identification of tasks and subtasks as well as the knowledge, cognitive skills and/or motor skills, and attitudes required for each task. The tasks are then consolidated into proficiency objectives, which include the criteria for effective performance of subtasks (supporting proficiency objectives) and tasks (terminal proficiency objectives). Enabling objectives (sometimes referred to as elements) are also identified and provide the foundation of the ground school portion of the training. The hierarchical organization of the task data and the resulting curriculum are

presented in Table 1.



Task Analyis to Curriculum Development
Table 1

After the proficiency objectives have been developed, the airline may conduct a criticality analysis. The criticality analysis is derived from the supporting task analysis and identifies certain terminal proficiency objectives (TPOs) as critical or non-critical. Critical TPOs must be assessed every evaluation period (i.e., each year) while non-critical TPOs need only be evaluated within the continuing qualification period (i.e., two years). This provides the airline with much greater flexibility. The second step in Phase II is the development of a syllabus cross referenced to the supporting task analysis. Step three requires that the airline establish training requirements, an implementation plan and provide the FAA with the policies, procedures and data collection forms related to the training. During Phase II the airline develops a Program Audit Database which is subsequently used to validate program development, implementation and maintenance. The ISD approach provides a documented and systematic basis for an audit between the front end (analysis) and back end (performance data).

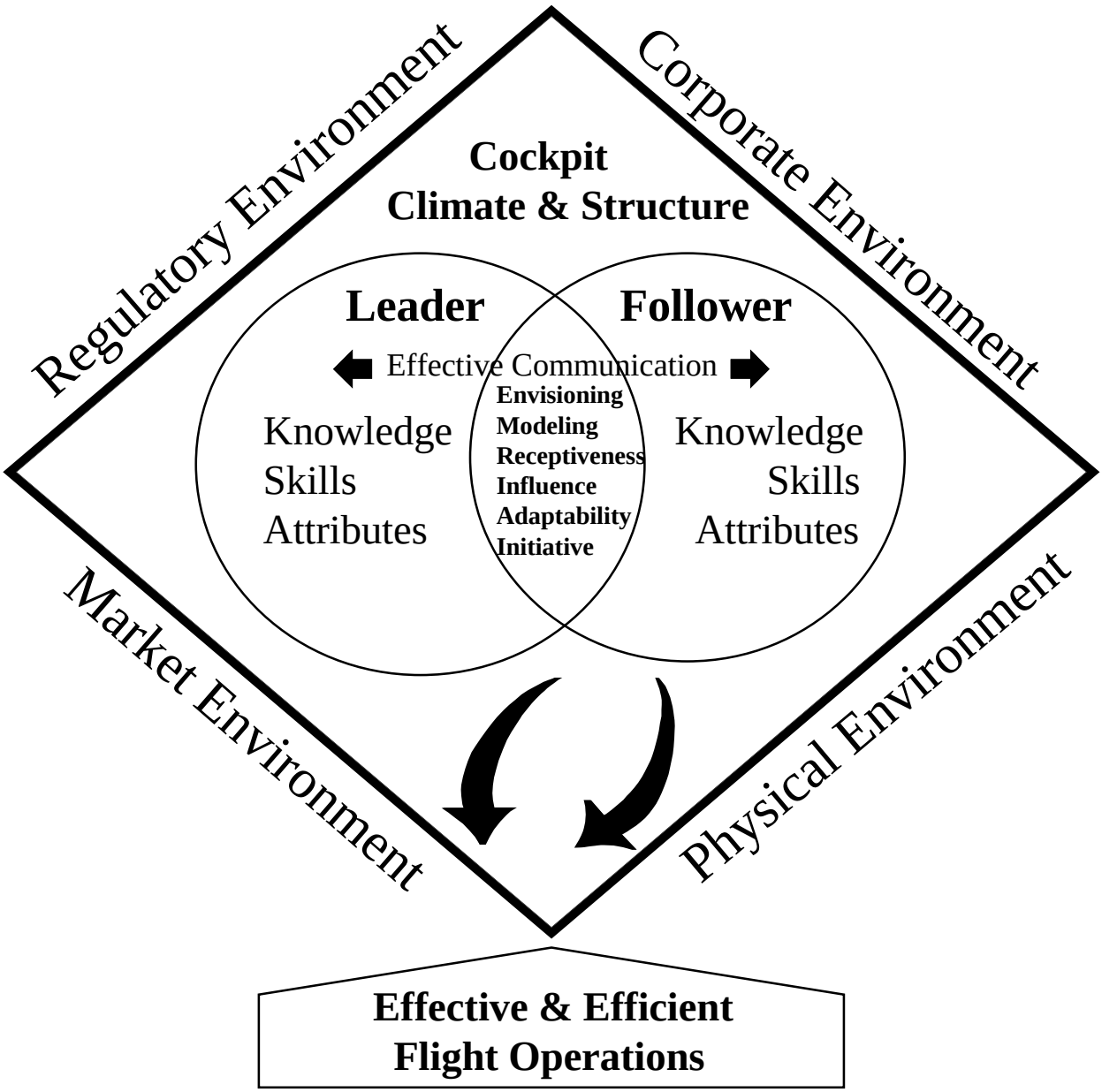
CRM Skills Identification, Training and Evaluation in AQP

Crew Resource Management (CRM) refers to the effective use of all resources available to the crew: human, hardware and information. The aviation industry views CRM as one way of addressing the challenge of optimizing the human/machine interface and associated interpersonal activities. These activities include team building and maintenance, information transfer, problem solving, decision making, maintaining situational awareness, and dealing with automated systems (Federal Aviation Administration 1993). The AQP has no formal requirement to develop "team" proficiency objectives. However, proficiency objectives are specific to duty position and PF/PNF and will, consequently, include the skills required of the individual pilot to perform effectively as a team member. While many U. S. carriers are not rating team performance, some have developed the training and evaluation tools to do so.

Identifying CRM Skills. A number of analytical tools can be used independently or in combination to identify CRM knowledges and skills.

1. The description of the tasks and subtasks included in the task analysis,
2. The literature and research relevant to CRM skills,
3. A protocol to elicit CRM knowledge and skills from experienced pilots, and
4. Theory-based experiments to explore specific variables of interest.

For example, we used a combination approach to identifying skill for our FAA-funded research to identify trainable cockpit leadership and followership skills. In order to identify these skills we first conducted an extensive search of the literature. Then we convened a research focus group with subject matter experts from U. S. major and national air carriers. We drew from this wide array of experience available to develop a contextualized model of cockpit leadership and followership. This model is presented in Figure 2. We identified six skills common to both good leadership and good followership, listed in the center of the model. We are currently in the process of developing guidelines and a prototype instructional module for training leadership and followership skills.



Leadership Followership Model
Figure 2

Training CRM Skills. There remains within the U. S. air transportation industry a variety of philosophies and applications of CRM. The FAA advocates an approach which includes the following: awareness, practice and feedback, and continuing reinforcement (Federal Aviation Administration 1993). There are issues, however, yet to be resolved. To what extent should CRM training be integrated? What are the most effective instructional technologies for training CRM? What is the most effective way of assessing CRM skills across curricula and instructional delivery systems?

The systematic ISD approach to developing training curricula under AQP resolves many

of these questions for the air carrier. The AQP has been structured specifically to include both phase-specific and phase-independent (i.e., "global") CRM skills in training and evaluation. The FAA's Model AQP developed by Battelle, for example, is completely event-based – even in the earliest portions of a qualification curriculum – but includes both task-specific and global CRM skills.

In an effort to resolve some of the training and evaluation issues surrounding CRM skills, the FAAs Office of the Chief Scientist and Technical Advisor for Human Factors has funded a wide range of research project. Conducted by a number of organizations and universities in conjunction with the air carrier community, these research programs have contributed a wealth of information to airlines, agencies and training organizations concerned with improving CRM training.

Evaluating CRM Skills in Line Oriented Flight Training (LOFT) and Line Oriented Evaluations (LOE). Today, the airlines make extensive use of simulation in flight crew training. Simulators range from low-fidelity, non-motion flight training devices (FTD) to advanced full flight simulators (FFS) that employ sophisticated motion, visual, control loading and aerodynamic programming. A Line Operational Simulation (LOS) is a training or evaluation scenario that simulates an operational flight and accurately replicates interaction among a flight crew and between a flight crewmember and others (i.e., dispatch, air traffic control, ground operations). When LOS scenarios are used as a training tool, they are referred to as Line Oriented Flight Training (LOFT). When the LOS is used as a means of evaluating individual or crew performance, it is referred to as a Line Operational Evaluation (LOE).

The FAA requires the use of LOS for both the training and evaluation of flight crews in an AQP. This aspect of the AQP has been the focus of much attention in the years since the AQP was first introduced. A recent development has been the application of the event set methodology to "build" LOFT and LOE scenarios. An event is defined as a combination of a task or subtask (from the task hierarchy) and one or more conditions. It is a flight situation that challenges students to use CRM knowledges and skills as well as technical ones. The FAA suggests that event sets address specific CRM training needs derived from pilot performance data. This data may be from an external source (i.e., NASAs Aviation Safety Reporting System [ASRS]data) or internal sources (i.e., incident reports filed by the airline's own pilots).

The event set includes a) the event trigger, the condition under which the event is fully activated, b) distractors designed to divert the crews attention, and c) supporting events designed to further both the CRM and technical training objectives. The instructor is provided with a list of the knowledges and skills critical to the effective performance of the event and the expected observable behaviors derived from the airlines CRM model and expectations for technical response to the event.

Event sets can be used to present specific skills individually before students are expected to integrate them into complex events and to prepare students for more difficult and complex events. Using a variety of simple event sets focused on one or two skills discourages boredom or frustration. The event sets can, of course, be clustered together to build scenarios. It is essential that the events sets and/or scenarios are validated in some manner to ensure that the training

objectives are being met and that there is agreement and consistency among raters. An event set methodology presently used by United Airlines and Atlantic Coast Airlines is presented in Table 2.

Table 2
Event Set Methodology

1. Identify primary CRM and technical training objectives.	1.1 Identify primary CRM categories and integrate with primary technical training objectives. 1.2 Identify the related observable behaviors for the CRM categories identified in 1.1.
2. Identify incidents that will produce the training objectives.	2.1 Identify potential incidents through in-house records, ASRS data-base, or other information sources. 2.2 Develop a preliminary list of relevant incidents and events. 2.3 Refine listing of incidents and events and correlate with phase of flight, CRM categories, and observable behaviors.
3. Specification and development of scenario event sets.	3.1 Specify LOFT/LOE scenario objectives, related TPOs, CRM categories, and observable crew behaviors for each scenario event set. 3.2 Translate incidents and situations into scenario event sets by identifying the event trigger, distracters, and supporting events, and specify the phase of flight. 3.3 Integrate the individual scenario event sets into an overall scenario. 3.4 Specify event set success criteria.
4. LOFT/LOE event set pretest and validation.	4.1 Conduct pretest to ensure event set objectives and evaluation criteria are realistic. 4.2 Conduct validation to ensure event sets are consistent with training objectives.

Evaluating Leadership/Followership Skills in an Event Set Scenario

An example at this point may help to bring some clarity to a fairly muddy process. Assume the qualification standard is for climb after takeoff. The terminal proficiency objective (TPO) might be to "Perform climb" and the supporting proficiency objectives (SPO) would be "Perform climb to initial altitude." Among the enabling objectives might be: "Observe all engine indications (K)," "Comply with sterile cockpit (A)," and "Makes adjustments to departure procedures in accordance with surrounding environment (C)." These are examples of knowledge (K), attitudes (A), and cognitive skills (C). There would be, of course, psychomotor skills (normally designated as M) as well as additional knowledges, cognitive skills, and attitudes listed in this qualification standard. Additional enabling objectives required for successful task accomplishment would include CRM-related knowledges and skills not stated as TPOs or SPOs.

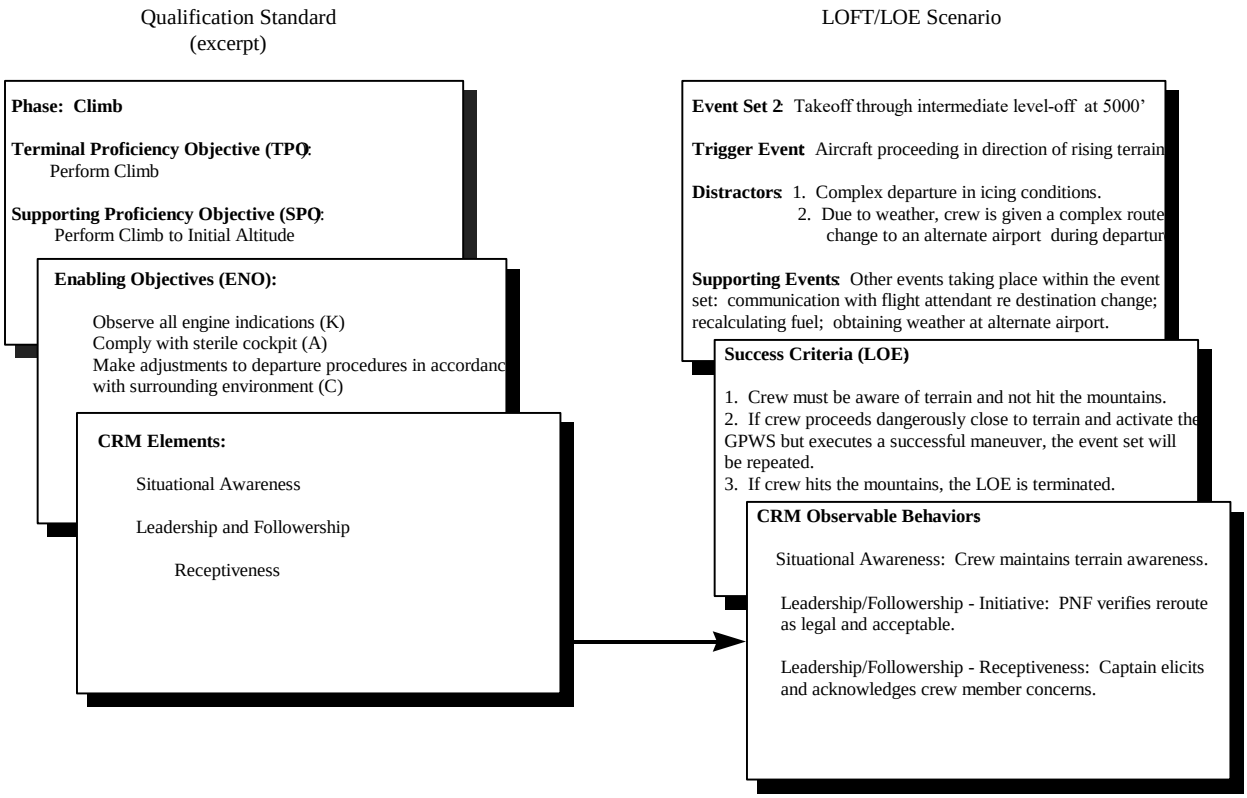
If we want to evaluate this qualification standard in a LOFT or LOE scenario, we might organize the scenario with Event Set One as the "Predeparture to takeoff in winter conditions" followed by Scenario Event Set Two: "Take off through the intermediate level off at 5000 feet." The event set would be designed with a trigger event (the 5000 foot level-off with the aircraft proceeding in the direction of rising terrain) and event distractors (a complex departure in icing conditions and a complex route change to an alternate airport given during departure due to weather).

Since the LOFT scenario is a non-graded, learning experience, success criteria will probably not be stated, but the instructor would discuss the learning objectives of the LOFT prior to the LOFT debriefing session. In a Line Oriented Evaluation (LOE), however, the success criteria will be stated. In our example of event set two, the success criteria might be stated as:

1. The crew must be aware of the terrain and not hit the mountains.
2. If crew proceeds dangerously close to terrain and activate the GPWS, but executes a successful escape maneuver, it will require a repeat.
3. If crew hits the mountains, the LOE is terminated.

The LOFT/LOE evaluation worksheet would include a listing of the technical skills associated with task accomplishment. In addition, a listing of the relevant CRM skills, indicated by observable behaviors, would also be included. A graphic representation of this process of translating qualifications standards (including terminal, supporting, and enabling objectives) into scenario event sets is provided in Figure 3. Note that that the enabling objectives listed under the qualification standard represent only a partial list. The CRM elements include some, but certainly not all, of the CRM-related knowledges and skills required for successful task accomplishment not previously stated as TPOs or SPOs.

This approach gives instructors and evaluators a structured and systematic means of assessing sometimes difficult to measure CRM skills. In our example in Figure 3, the initiative and receptiveness associated with leadership and followership skills are described as observable behaviors: “PNF verified reroute is legal and acceptable” (initiative) and “Captain elicits and acknowledges crew member concerns “ (receptiveness). Relatively vague concepts are translated into behaviors that can, with appropriate training, be assessed accurately.



Event Set Scenario
Figure 3

Instructor and Evaluator Training and Evaluation

Under AQP, instructors and evaluators themselves must be trained, standardized, and evaluated. This may be, after the curriculum development phase, the most significant contribution to effective AQP implementation. While this training has not received the serious attention it deserves at some airlines, the level of the instructor/evaluator skills in training and debriefing will significantly impact the quality of the training program. The assumed ability of a pilot to develop the required technical and interpersonal skills in other pilots is too often based on criteria unrelated to teaching abilities. It becomes incumbent on the airline under the AQP guidelines to not only train instructors and evaluators, but to evaluate their performance as well.

One excellent example of instructor/evaluator (I/E) training is provided by Atlantic Coast Airlines, a regional carrier located on the East Coast of the United States. As part of an FAA-sponsored research project, this carrier developed a comprehensive approach to I/E training, standardization, and evaluation. While the focus of this research was on Line Oriented Evaluations and Line Checks, we have modified the approach slightly to include LOFT sessions as well. A summary is presented in Table 3.

Table 3 Instructor/Evaluator Training and Evaluation	
Develop I/E Tools	*LOFT/LOE Guide* Event Set Methodology Simulator Setup Role of the Facilitator Facilitator Tasks Explicit Scenario Success Criteria *Evaluation Worksheet* Use of observable behaviors Ratings based on observable behaviors Provides structure for evaluation of performance
Introductory Training	Development of LOFT/LOE scenarios and event sets Familiarization with guides and evaluation worksheets Definitions of CRM skills and rating scales Develop skills for effective use of evaluation worksheet Use example videos of crews flying LOFT/LOE Briefing, administering, and debriefing LOFT/LOE Practice and feedback
Standardization Training	Use videotaped segments Initial evaluation ratings done separately Immediate calculation and feedback of rater agreement Same-day feedback of rater consistency I/E group discussion of results
Continuous Monitoring	Continuous de-identified data collection and analysis Recurrent training Re-testing for rater agreement and consistency

Implications for Pilot Selection

The AQP training model suggests some interesting questions about pilot selection as it is currently conducted at many carriers. Do current pilot selection models adequately assess the CRM-related skills of pilot candidates? In many cases the answer may be No. We have advocated elsewhere (Pettitt & Dunlap 1996) the development of a contextualized assessment for selection, a process that enables the airline to ✌select-in✍ pilots with the CRM skills necessary for effective crew performance. It seems logical to assume that the costs of CRM training can be reduced if the selection process gives greater attention to the CRM skills of pilot applicants. It may be advantageous for airlines to examine this approach closely at this juncture. The downsizing of the military, coupled with projected pilot retirements, suggests that U. S. airlines face a shrinking pool of available, qualified pilots. This could represent an economic, pragmatic -- as well as operational -- mandate to create selection instruments that reflect the emphasis on

CRM skills.

The contextualized assessment model of interpersonal skills, utilizing the resources currently available to the airlines. Contextualized *training* has been the touchstone of airline training for decades. The advent of full-motion simulators made this possible. This notion has been taken a step further under the AQP paradigm -- contextualized *assessment* is referred to as Line Oriented Evaluation (LOE). However, contextualized assessment in the selection process has been overlooked by most airlines.

There are several advantages of utilizing a contextualized selection model:

1. Specific skills related to job performance are evaluated.
2. The capture of performance-based data which can be used as a baseline to measure gains in training and job performance.
3. "Selecting in" individuals with desirable skills represents an approach that should be, compared to "training in" the right stuff, more cost effective.

Ideally, the proposed model would help the airline to identify attitudes and skills that are associated with effective performance in air transport flight operations, taking into account the unique characteristics of the organization and operational environment, and enable the development of appropriate contextualized assessments to "select in" applicants with the right (CRM) stuff.

Conclusion

The Advanced Qualification Program offers air carriers an unprecedented opportunity to design innovative crew training programs that better meet the unique needs of individual carriers. Although the AQP development process is both lengthy and complex, the benefits of AQP are increased safety through improved training and evaluation, as well as reduced training costs. In addition, AQP allows the air carriers to be more responsive to changes in aircraft technology, operations, and training methodologies. The heart of the AQP is the development of the air carriers training and evaluation methodologies. While the focus of the AQP has been on qualifying experienced pilots, we believe the AQP paradigm – based on the ISD approach to include systematic front end analysis and back end performance date --can be applied with equal success to ab initio training programs.

The primary purpose of this paper has been to present current approaches to identifying, training, and evaluating CRM skills within the AQP training program. We have also suggested that the AQP approach to pilot training and evaluation could also be used as a model for more innovative pilot selection process. We have suggested that a contextualized selection model -- a multi-measure approach using existing airline resources. This model encourages better assessment of an applicants CRM-related skills as well as more complex cognitive skills (i.e., judgment, innovation, and adaptability).

As the relationships between U. S. carriers and their counterparts in Europe and other parts of the world increase, it is logical that the non-U. S. partners might wish to strengthen ties

and reduce costs through joint crew training. The AQP could provide the foundation for standardized training. While such an approach would require harmonization of the regulations (i.e., FARs and JARs), the effort would be worthwhile if significant training effectiveness and economic efficiency were realized.

Acknowledgments

The authors gratefully acknowledge the contribution and efforts of the following individuals and organizations: Dr. Tom Longridge (FAA Advanced Qualification Program Office AFS-230), Dr. Eleana Edens (FAA Office of the Chief Scientist and Technical Advisor for Human Factors AAR-100), Dr. Tom Seamster (Cognitive and Human Factors), Capt. William Hamman (United Airlines), Capt. Kim Schultz (Atlantic Coast Airlines), Dr. Robert Helmreich and John Wilhelm (University of Texas-Austin), Dr. Robert Holt (George Mason University), Susan Mangold and David Nuemeister (Battelle), Capt. Fred Kirijan (Delta Airlines), the airline pilots and flight training managers who served as our subject matter experts and provided such keen insight for our cockpit leadership and followership research, and the members of the Air Transportation Association/AQP Working Group.

References

Pettitt, M. A., & Dunlap, J. H. (1995). "The Economic Impact of the Advanced Qualification Program on Airline Operations and Economics." In D. Jenkins (Ed.), *Handbook of Airline Economics*. New York: McGraw-Hill.

------ (July, 1996). Training vs. Selection: The Right (CRM) Stuff." T*he CRM Advocate.* Charlotte, NC: Resource Options.

U. S. Federal Aviation Administration (August, 1991). *Advanced Qualification Program* (Advisory Circular 120-54). Washington, D. C.: Federal Aviation Administration.

U. S. Federal Aviation Administration (February, 1993). *Crew Resource Management Training* (Advisory Circular 120-51A). Washington, D. C.: Federal Aviation Administration.