



CRM Principles and Practices for SPO:

CRM Interviews and Observations

Final Report

Kathleen L. Mosier

San Francisco State University

Ute M. Fischer

Georgia Institute of Technology

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CRM and DRM instructors and training managers as well as pilots and dispatchers are valuable sources of information on current CRM/TEM policies, priorities, and procedures. As complementary data to the literature review, we conducted 20 structured interviews with representatives from 10 airlines, Boeing Aircraft, and Rockwell Collins (ARINC). Most of the pilots we interviewed are members of ALPA's Training Council/Human Factors Working Group. Other interviewees included the Chief Pilot, ORD (AA), Director of Training (Boeing), or training managers for pilot or dispatchers.

In addition, we observed CRM training modules at American Airlines, United Airlines, and Alaska Airlines. Modules contained CRM/TEM for initial pilot training, pilot recurrent training, and captain upgrade training. We also visited the FOCUS lab (Flight Operations Center - Unified Simulation) at Mid-Tennessee State University.

Section 1 of this report, *Current CRM Training*, describes the current state of CRM/DRM training, drawn from the interviews and training observations. Section 2, *Major Issues for CRM in SPO*, outlines the major issues that concerned pilots and dispatchers with respect to the implementation of SPO.

Current CRM Training

CRM training for both pilots and dispatchers utilizes the Threat and Error Management (TEM) concept as the guide for behavior.¹ Situation Awareness (SA) and decision making are emphasized as the primary methods for threat and error identification and management. Training format includes lectures, scenarios, and role playing, as well as field trips to Airlines Operations Centers and maintenance facilities (for pilots), or observations of flight simulations (dispatchers). Case studies from ASRS or internal incident reports are used to illustrate good and poor CRM/TEM. CRM/TEM behaviors are practiced and evaluated during simulator sessions.

The evolution of CRM/TEM training has been largely positive in terms of identifying specific practices and behaviors that facilitate TEM and resource management; however two relatively recent changes are not so positive: 1) most airlines have eliminated joint training modules with flight attendants or dispatchers as a cost cutting measure, and 2) airlines are starting to put CRM training modules online for individual completion. Interviewees saw these changes as reflective of economic constraints. Interestingly, these changes were more likely to be reported by pilots in the major carriers than by those in regional airlines – possibly because hiring by the major airlines has slowed and current pilots have already had several rounds of CRM training and the assumption is that everyone knows CRM.

CRM/TEM is typically evaluated during LOEs (Line Operations Evaluations), LOFTs (Line Oriented Flight Training) or LOSAs (Line Operations Safety Audits).

¹ We did not interview Air Traffic Controllers, but a copy of their CRM training manual indicates that TEM as well as teamwork are major components of their training.

The method of CRM/TEM evaluation varied by airline in terms of standardization and rigor, with some airlines using a behavioral checklist and others rating aspects of CRM/TEM on a Likert-type scale.

Some curriculum differences were noted depending on whether training was geared toward newly hired pilots (Basic Indoctrination Training), line pilots doing an annual review (Recurrent Training), or First Officers upgrading to Captains (Captain Upgrade Training).

Basic Indoctrination and Recurrent Training

The concepts of CRM/TEM are integrated in training. The list of threats to be aware of include: memory items (i.e., forgetting or misremembering), systems malfunctions, terrain, weather, track procedures, performance, fatigue, illness, distraction, and ambiguity. Pilots are also trained to 'trap and mitigate' threats to customer satisfaction and flight dependability. Managing all of these threats may sometimes introduce conflicting goals (e.g., when safety requires that flight attendants remain in their seats but customer satisfaction is increased by flight attendant service). According to the training curriculum, managing threats and errors requires risk assessment, planning and decision making, situation awareness, communication, workload management, and automation management – the traditional components of CRM.

A large component of CRM training for new pilots (Basic Indoctrination course) addresses the specific tasks and responsibilities of each pilot role. The PF – Pilot Flying – and PM – Pilot Monitoring – each have assigned tasks and duties, and these are allocated based on the assumption that two pilots are required to handle the workload. Interviewees reported that the presence of the second pilot was most critical during preflight, taxi, takeoff/departure, and approach/landing phases of flight and that the most important tasks of the PM include:

- monitor and cross-check
 - o “Verbalize, Verify, Monitor” changes to automation
- communicate with ATC and ensure compliance with instructions
- provide second set of eyes
- provide right side of aircraft out-the-window view (especially important for taxi and landing)
- complete preparations for departure and arrival (e.g., prebrief, set up computer, get information about gates, etc.)
- communicate with cabin or company (AOC, dispatch)
- manage and verify checklists
- assist with high-workload tasks such as landing in unfamiliar places, or with complicated or non-standard tasks
- verbalize concerns when something appears unsafe or 'not right'
- provide social stimulation, motivation

Captain Upgrade Training

Captain upgrade training emphasizes the leadership role that Captains must assume, the importance of briefings, and managing interactions with other crewmembers and company representatives. Topics touch on standard areas of CRM/TEM – identifying threats and trapping errors, communication, situation awareness, decision making, conflict management, automation management, planning and prioritizing - and also included topics identified in the literature review, such as change blindness, tunnel vision, and use of pattern matching in decision making (NDM; see Literature Review)

Training implications for SPO.

According to interviewees, CRM /TEM training and materials for SPO will need to reflect the distributed team as well as new roles and responsibilities. For example, new procedures must specify communication protocols and task allocation between air and ground. Training for communication should emphasize the use of standard terms to define flight and system status, abnormal situations, and internal and external threats.

Training for team building and maintenance will be important and should be inclusive of all remote crewmembers. One training manager suggested using a well-defined team-building training concept – similar to a boot camp. Training should provide each crewmember with knowledge of the other jobs in the crew, and of likely pinchpoints or other team constraints. Everyone in the remote team should have high degree of knowledge of all parts of the single pilot operation.

Simulator training and practice must involve members of the remote team. Currently, interactions with extended team members (e.g., between pilots and dispatchers, flight attendants, and maintenance personnel) are relatively brief during training (although some airlines provide jumpseat rides for dispatchers), and although the concept of the larger team is emphasized it is not always reinforced through joint training or practice.

Major Issues for CRM in SPO

Interview and observation data suggest two common themes related to CRM/TEM in SPO. One theme concerns the concept of the distributed crew – what changes when your co-pilot is replaced by a set of remote crewmembers on the ground? The other theme has to do with automation – what changes in automation and automation monitoring/interaction will need to occur to make SPO viable?

Crew/Team Issues

Communication.

Most pilots agreed that communication between air and ground would have to be frequent and much more precise and detailed than current intra-cockpit

interactions in order to compensate for loss of visual information and non-verbal cues.

Several people suggested a 'think-aloud' strategy to let ground know about current and planned activities. Communication technology would have to be fast and flawless, with a hot mike (no keying required). One training manager suggested a communication protocol that supports the TEM philosophy – keywords, phrases, etc., and that would be triggered by threats and evoke a trained response from the remote crewmember.

Configuration and characteristics of ground personnel.

One-on-one, with one pilot in the air and one on the ground was definitely the preferred configuration for normal operations. In other cases, pilots wanted the appropriate person for ground support – for flying tasks, they wanted a pilot; for maintenance issues, a mechanic; for weather and diversion issues, a dispatcher. Pilots worried that ground support people might become distracted if supporting several aircraft at once and therefore not give the pilot in cockpit full attention. They noted that ground personnel may not share the same sense of urgency as the pilot in non-normal situations. On the other hand, some mentioned that a person on the ground might provide helpful calmness in the event of an emergency.

The one-to-one configuration most acceptable to pilots is of course not feasible for SPO. The most important factor in their preferences, however, was the availability of the specific type of assistance needed for any situation. Some pilots brought up the issue that if lower-level personnel (i.e., in terms of status and pay) comprise the ground crewmembers, economic disparity in salaries as well as perceived differences in education or training may interfere with team building and camaraderie between air and ground. This suggests that status and position issues must also be considered in the creation of the remote team as well as in training and procedures for SPO.

Roles and Responsibilities.

Current SOPs for flight operations delineate the roles and responsibilities of each pilot as well as flight attendants, dispatchers and other operations personnel, and maintenance. Procedures on the flight deck are prescribed down to the level of gestures (e.g., pointing to an indicator). Doubtless, roles, responsibilities, and procedures will undergo significant revision in SPO.

Many of the interviewees wanted the ground person to function as a remote First Officer and to perform tasks such as programming the FMS, changing frequencies, making PA announcements, checking weather, controlling flaps or landing gear, and dealing with ATC and company communications. Others expected help from the ground person only when workload was high or during non-normal situations. Overall, pilots were worried about the potential increase of PF workload when tasks are not shared between two people.

Dispatch trainers also expressed concern about the workload and extra tasks associated with SPO. They would not be able to handle the same number of flights that they do currently, and would need extra personnel to manage increased responsibilities and communication. Right now, in-flight consultations between pilots and dispatch primarily concern weather or flight planning/replanning, and the focus is on information management as it applies to the regulatory environment. Limited consultations with dispatch, mechanics or physicians are the norm.

Perhaps the most significant change in SPO roles and responsibilities will be the potential delegation of the flying task to ground personnel. Interviewees responses to the question of when this should occur varied. Some pilot interviewees were put off by the notion of letting the aircraft be flown from the ground at all ('can't imagine delegating the flying task'), but others suggested doing this not only in drastic situations such as incapacitation of the pilot, but also on a regular basis ('every other leg'), during low workload phases or bathroom breaks, and in emergencies or when the PF is handling other issues (e.g., non-normal situations or problems).

Both pilots and dispatchers expressed concern about appropriate flight training for any ground person who might be called upon to take over the aircraft. Pilots also expressed concern about issues of responsibility for the flight. Roles as well as responsibilities for each party will have to be very clear. For example, if ground personnel will be expected to make decisions concerning the flight, they will need to have not only the same training as the pilot-in-command, but also the same legal responsibility.

Trust.

Trust was predicted to be a much bigger issue in SPO than in current operations. Usually, trust between pilots develops as a function of working together in the cockpit and sharing common training. Pilots in SPO will need to have trust in all of their remote crewmembers – people they may not know, cannot see, and with whom they may not have trained or worked.

Interviewees suggested that joint training would be critical for CRM in SPO and would promote trust among remote crewmembers. One airline has conducted remote joint training with dispatchers and pilots in the past, using technology links. This may be an appropriate avenue for CRM training in SPO, as it reflects the reality of the remote team environment.

Psycho-social concerns.

Several pilots mentioned psycho-social aspects of flying that would change in SPO. For example, the second pilot is someone who talk to you, keeps you awake and alert, makes the flights more 'fun.' They worried they would not perform as well without a second person to keep them on their toes, and wondered whether they would be as quick to ask for needed help from a ground person as they would from a PM sitting next to them. One Chief Pilot interviewee mentioned that SPO would eliminate the mentoring and on-the-job training that First Officers receive when they fly in the two-person cockpit. Pilot interviews also worried about the prospect of long flights by themselves in the cockpit, and cited the dangers of

fatigue. Of these psycho-social issues, the risks associated with fatigue may be the most significant for SPO, and fatigue awareness and management will need to be emphasized in SRM curricula.

Automation Issues

Displays.

Interviewees offered several insights as to what remote crewmembers would need in terms of new technology for SPO and how they would use it. Pilots and dispatchers suggested that pilots and ground personnel should have the same systems displays and overall view, and should be able to see input to computer and MCP. In particular, if a course of action is being selected based on information on a display, the same information has to be available to all crewmembers in addition to whoever is the decision maker. Status messages should be visible to all players.

Several interviewees suggested live video cameras in both places so that each person would have an awareness of the other's activities, and could ensure that he/she was healthy, engaged, etc. (One pilot suggested a holographic person in the second seat – his technological version of Leslie Nielson's blow-up autopilot...)

Technology.

Pilots agreed that distributed operations would require a high level of automation as well as data link and a dedicated communications line to the ground crewmember. Automation would have to be perfectly reliable, especially during high workload. Automation management training currently emphasizes the use of the highest level of automation that is appropriate for a given situation, but the classification of 'appropriate' may shift to a higher level in SPO if automation is treated as an electronic crewmember. Some pilots expressed the concern that SA and automation awareness would be negatively impacted by the loss of a second pilot in the cockpit.

Although some pilots suggested that ground personnel should have access to aircraft displays and systems, they were also adamant that the ground person should not have the capability to do anything that would impact the aircraft without the Captain knowing about it. This issue was also noted in the SPO I and II studies (ref), as flightdeck and ground pilots expressed the need to know 'who is doing what.'

Other tools for managing workload and facilitating remote collaboration included automatic data downlinks of maintenance and systems data and uploads of information and clearances, touch-screen displays, camera feed from outside the aircraft to convey indications of problems (e.g., engine fire) to the pilot and ground; a method to convey sensory cues (eg., smell, vibration)

Loss of basic airman skills.

One training manager noted that new pilots see automation as given, and that reliance on automation has exceeded the ability of the crew to turn it off. Many pilots today have never flown an aircraft that doesn't have sophisticated

automation, and as a result have minimal flying skills. Because of this, a current training issue (at least for US airlines) involves teaching pilots when to downgrade or turn off automation and use basic airman skills. It will be even less likely that pilots will fly manually in SPO than in present operations, and the deterioration or lack of basic flying skills will continue to be an issue.

Final notes.

Interviewees agreed that the technology to manage SPO exists, and most were resistant but resigned to the notion that the cockpit crew will probably decrease from two pilots to one. Workload was a major concern for both pilots and dispatchers, even when they considered technology enhancements. The workload issue will need to be addressed for SPO, particularly in non-normal flight situations.

Pilot and dispatch interviewees also predicted that building a smoothly functioning and cohesive distributed team would require special training, very specific procedures in terms of communication and tasks, and automation and displays to facilitate remote collaboration.

Interviewees predicted that acceptance of the SPO concept may increase over time. Several pilots suggested that the Millennial Generation of pilots (born after 1980) may be more accepting of the idea of SPO than they are. People of this generation have become used to remote collaboration in video games as well as working with partners they cannot see.