CRM Training for FAR Parts 91 and 135 Operators

Douglas Schwartz
Flight Safety International, Inc.

INTRODUCTION

In the next few minutes I would like to tell you about the why, what, and how of CRM at Flight Safety International (FSI)--that is, the philosophy behind our program, the content of our program, and some insight regarding how we deliver that to the pilot. I will touch on a few of the concepts that are part of our program. This will include a view of statistics we call the "Safety Window," the concept of situational awareness, and an approach to training that we call the Cockpit Management Concept (CMC).

For those not familiar with Flight Safety, it may be useful to know a little about us. Flight Safety is in the training business. It is the only thing we do. One distinguishing characteristic of the pilot training we do is that the pilots we train do not work for us-- we work for them.

FSI was founded in 1951 by A. L. Uettschi, a Pan Am pilot. We currently provide initial and recurrent training to over 20,000 professional pilots a year. There are over four hundred full-time, flight, ground, and simulator instructors employed by the company. We operate a fleet of seventy-five flight simulators which are dispersed among twenty-five Learning Centers in North America and two in Europe. Our growing fleet covers the entire gamut of corporate and airline equipment including MD-80, B-737, B-727, DC-10, and A-300 aircraft. Accordingly, each simulator represents the state-of-the-art at the time of manufacture. Levels of equipment include Phase II, Phase I, visual, non-visual, and training devices.

FSI has two divisions which provide support for pilot training operations. Communication Systems Division (CSD), located in Houston, Texas, which develops and produces training support materials, including manuals, slides, and video, as well as providing a focal point for course development. Our Simulation Systems Division (SSD) in Tulsa, Oklahoma designs and builds training equipment including flight simulators, cockpit system simulators, and part-task trainers.

The topic I have been asked to speak on relates to CRM training for 91, 135 and corporate operators. It is often assumed that there are major differences between these segments of aviation and airline and military operations. However, these differences are primarily organizational rather than operational. Hence, we do not distinguish in our CRM training between Part 135 operators, Part 91 operators, or Part 121 operators. That is, we believe when an airplane is being vectored to final approach in critical weather, or in any other condition, the needs of a flight crew don't vary according to the style of their operation or the kind of organization they fly for. Our CRM training also does not distinguish between training for captains, co-pilots, second officers, or any other crew members.

Flexibility is a key factor in CRM training at Flight Safety. We have a large operation that provides in-house training, sets standards, and develops programs on the basis of need. Training programs vary from one airline to another. At FSI we train crews for over 1800 corporations plus airlines, government agencies, and the military. Each has a different view of how to train, how to fly an airplane, and how to address CRM. CRM training at FSI is designed with a flexible delivery approach that allows it to be easily adapted to various needs.

The philosophy behind the cockpit resource management training we do at FSI begins with what we call the "Safety Window." The Safety Window represents a statistical view of accidents and accident causes over the past number of years. The Safety Window is defined as a block of airspace centered around a runway extending from the ground to 2,000 feet AGL. The window begins at or about a final approach fix and ends at the approximate conclusion of the final segment of take-off climb. It includes the approach, landing, taxi, take-off, and climb phases of flight.

An analysis of the Safety Window yields the following observations:

o   The window represents only 7 percent of total flight time (based on an average stage length of 75 minutes).

o   More than 80 percent of accidents and incidents involving professional pilots occur in the window.

o   Most of these events are generic. That is they are accidents that have as a root cause some sort of crew management error rather than a mechanical failure.

o   Crew workload intensity peaks within the window.

If this window of risk or exposure is so important, what can we learn from it? Should one leave the window if something goes wrong? Or, should you stay in the window? There is evidence to indicate that either choice might be appropriate, depending on conditions. What criteria should one use to make that choice?

This led us to the concept of "Situational Awareness." It is the heart of the cockpit resource management training that we do at Flight Safety. Situational awareness is an accurate perception of the factors and conditions that affect an aircraft and a flight crew during a specific period of time. In more simple terms, it is knowing what goes on around you.

This is a back-to-basics concept. At the start of primary training, pilots are taught the need to "think ahead of the aircraft"--situational awareness. We find that our flight instructors routinely have to remind highly-experienced professional pilots of this need to think ahead.

It is important to note that situational awareness has a very direct relationship to

safety. It is a simple one. The more a pilot knows about what is going on around him, the safer he will be, and the less he knows about what goes on around him, the less safe he will be.

The best illustration of this relationship is the safety record of drunk drivers. This is an area of growing national concern. Characteristics common to drunk drivers are--an unfounded sense of well-being, impaired hand-eye coordination, dulled senses, and slowed reaction time. Drunk drivers have more accidents because they have less control over their situation--they don't know what is going on around them. In other words, they have low situational awareness.

It is important to stress the contribution that situational awareness makes toward safety. Because safety is the operational goal and there is such a strong relationship between the two, we believe that the goal of any pilot training program should be to enable a crew to reach a higher level of situational awareness in operating their aircraft.

ESSENTIAL ELEMENTS OF SITUATIONAL AWARENESS

We have identified five elements that contribute to situational awareness: 1) experience and training; 2) physical flying skills; 3) spatial orientation; 4) cockpit management skills; and 5) health and attitude. Each is discussed below.

Experience and Training

We describe experience as a mental file or experience file that every pilot uses to assess conditions and make decisions throughout the progress of a flight. Study of human performance indicates that when an individual is put under a great deal of pressure, the tendency is for that individual to revert to a previously established pattern of behavior. Therefore, if you can instill within an individual's experience file the desired response to stimuli, there is more likelihood of a safe and desirable outcome.

Experience ties directly to training. They cannot be separated. Many situations have the potential to occur in flight, but are unlikely to do so. The training process is used to expand an experience file by creating those events. For example, a lifetime's worth of experience can be compressed into a very short period of time in a simulator. An excellent illustration of this relationship between training and experience is the loss of an engine on takeoff. Very few pilots have or will ever actually experience one. Yet most professional pilots have developed the control skills necessary to safely fly an airplane through a takeoff following an engine failure at or above V^1.

The transfer of skills developed in training to an individual's experience file works. The proof lies in crew response to an actual failure. It is not unusual for a crew reporting on the loss of an engine on take-off to say, "the airplane flew just like the simulator." The key here is not that the airplane flew like the simulator, although that is surely the case, but rather that the pilot flew the airplane just like he flew the simulator. The transition from training to the experience file works. This is why training and experience are an important contributor to situational awareness.

Physical Flying Skills

Physical flying skills contribute to situational awareness. The role of the pilot is changing from that of a control manipulator to that of an information processor. However, it must be remembered that pilots still have to fly airplanes. Control skills are essential and contribute to situational awareness.

Spatial Orientation

This is knowing where the aircraft is in space and where you want it to go in relation to navigational aids, other aircraft, altitude, terrain, attitude, airports, runways.

Cockpit Management Skills

Cockpit management skills are the thread that binds this model together. We have identified ten specific skill areas that play a role in cockpit management and their effect on situational awareness. They are the vehicle by which a pilot can attain, maintain, and re-achieve (if lost) situational awareness. These skill areas will be addressed in more detail later in this paper.

Health and Attitude

Both contribute to situational awareness. Physical and emotional health affect an individual's ability to clearly see conditions and events and to interpret their meaning. Personal attitude also has an effect on safety. Safety does not just happen. One must work to make it happen. This equates to a sense of professionalism. Together, health and attitude are important contributors to situational awareness.

DYNAMICS OF SITUATIONAL AWARENESS

With this overview of what situational awareness is in place, it's worthwhile to examine its dynamics. The heart of this is a model of individual versus group situational awareness. A captain and a copilot can each have their own view of what is happening, each with his or her level of situational awareness. However, the key to safety lies within the cumulative effect of what these pilots know--that is, the group's level of situational awareness. Contrary to what one might expect, group situational awareness does not appear to be the sum total of the levels of situational awareness of the crew members. Instead, group situational awareness is limited to the level of situational awareness of the pilot-in-command.

Consider this illustration: a twin-engine jet with a two-pilot crew is in flight, straight and level at 250 knots. The aircraft is in the clouds, 500 feet below the peak of a mountain which is 2 miles ahead. The captain is flying the airplane. The aircraft and its crew and passengers are in a dangerous position.

The captain and copilot each have a sense of the situation--that is, a level of situational awareness. For the sake of this illustration, let us assume that the captain

does not know the mountain is dead-ahead. By the equation relating safety and situational awareness, the captain has low situational awareness. He is not safe.

In this example, the copilot knows exactly where the aircraft is in relation to the mountain. He can be said to have high situational awareness. By the equation, he should be safe.

What is going to happen to the aircraft? Clearly if the copilot cannot raise the captain's situational awareness, he will fly into the mountain. Despite the copilot's high situational awareness, the crew is unsafe.

This example illustrates how the captain can limit group situational awareness. A look at accident history provides a case in point. Just a few short years ago, a DC-8 ran out of fuel during a visual approach to Portland International Airport. The flight had experienced a gear problem. Concerned about the possibility of a post-crash fire, the captain elected to delay landing in order to burn-off as much fuel as possible. Too much fuel was burned. The aircraft lost power and crashed in a residential neighborhood short of the runway. Weather was not a factor.

During the events leading up to the accident, both the first officer and the flight engineer repeatedly expressed concern about the fuel-state of the aircraft to the captain. He did not heed their advice. The captain had low situational awareness. The other crewmembers had high situational awareness, and tried to raise the situational awareness of the captain. They were unable to do so. The aircraft crashed.

The B-737 that crashed on take-off from Washington National Airport in 1983 provides another example where a captain's low situational awareness could not be raised by other crewmembers, and the aircraft crashed.

Some of the cockpit management skills that come into play include communicating skills and managing people. These illustrations also draw attention to the concepts of command and leadership.

So far, this paper has examined situational awareness from several perspectives. The concept has been defined. The definition was expanded upon by identifying the five elements that contribute to situational awareness. Finally, the dynamics of situational awareness are described in the model of individual versus group situational awareness. The next step in this process is to put the idea of situational awareness into a practical format that a pilot can use.

THE ERROR CHAIN

The dynamics of situational awareness are embraced by the concept of the "error chain." It is rarely the case that accidents result from one clearly-defined catastrophic error. Instead, accidents tend to result from a series of errors or events. This so-called chain-of-events is called an error-chain. The cliche that "no chain is any stronger than its weakest link" might hold here. That is, if a pilot or a crew could be taught to break

one or more of the links in an error-chain, then in theory, the accident might not happen. This may appear to be too simplistic, however, after applying the concept to selected accidents, there is reason to believe that it works. In fact, by breaking only one of the links in an error-chain, it is possible to stop the progress of a flight towards an accident.

How then, may a pilot identify links in an error-chain so that the accident that might happen, is avoided? We have identified ten clues to the loss of situational awareness. They are the keys to finding the links in an error-chain.

1) *Ambiguity:* when two or more independent sources of information do not agree.

2) *Fixation or Preoccupation:* when attention of the crew is focused on one item, event or condition to the exclusion of all other activity in the cockpit.

3) *Empty Feeling or Confusion:* when a pilot or crew is unsure of the state of the aircraft or its condition.

4) *Violating Minimums:* when minimums are intentionally violated or consideration is given to doing so.

5) *Undocumented Procedures:* when consideration is given to using an undocumented procedure or when an undocumented procedure is, in fact, used.

6) *Nobody Flying the Aircraft*

7) *Nobody Looking Out the Window*

8) *Failure to Meet Targets:* when parameters or expectations of events are not met.

9) *Unresolved Discrepancies:* when confusion, questions, or statements of concern are not resolved.

10) *Departure from Standard Operating Procedure:* when standard operating procedure fails to be used at the appropriate time.

Any one of these can be a clue to finding a link in an error-chain.

This is not a black and white situation. Pilot judgement and experience is needed to put this to use. For example, while the clues are intended to identify lost situational

awareness, there are instances when they could result from high situational awareness. For example, it may be appropriate to use an undocumented procedure in the event of a failure for which no procedure has been developed.

The goal of training programs taught by FSI is to allow a crew to reach a higher level of situational awareness in the aircraft. Four of the five elements that contribute to situational awareness--experience/training, physical flying skills, spatial orientation, health and attitude--have traditionally been a part of professional aviation training programs.

The fifth element, cockpit management, has not been an integral part of training programs. It has been taught by exception, by instructors who orient briefings and training programs toward CRM type skills. Discussion of cockpit management skills has frequently been a part of "hangar flying."

In order to allow a crew to train to the highest level of situational awareness possible, it is necessary to have in place a training program that will allow them to focus attention on those areas that will contribute to that goal. The addition of cockpit management courseware allows this to happen.

COCKPIT MANAGEMENT TRAINING ELEMENTS

The cockpit management courseware used by Flight Safety addresses ten specific skill areas. Before reviewing them, it is first necessary to provide a reference point by establishing a definition of cockpit management. We define it as "the use and coordination of all resources available to the crew to achieve the established goal of safety, efficiency, and comfort of flight." The skills used to help achieve this goal are:

1) Checklist Use and Function
2) Management of Resources
3) Communication Skills
4) Recognition and Management of Distractions
5) Flight Planning and Progress Monitoring
6) Judgement and Decision-Making
7) Managing People (includes personality awareness, leadership and command)
8) Pattern Recognition
9) Stress Management
10) Workload Assessment and Time Management

This training is provided as part of a *Cockpit Management Concept* of training (CMC). There are four elements that make up the Cockpit Management Concept of training. The first is courseware for cockpit management training.

The second is Line-Oriented Flight Training (LOFT). The key to LOFT is the development of simulator scenarios that allow the crew to build experience identifying links of an error-chain. Teaching crews to find the links of an error-chain without the use of simulators and carefully designed LOFT scenarios is not likely to succeed. It has to be

trained into the experience file so that in the real world it can be turned into practice.

The third is crew self-critique. This involves the use of video cameras to record simulator sessions for use in debriefing. Our application is to permit crews to view portions of their own performance and to critique themselves. The learning potential is extraordinary.

The last element is instructor critique. Nothing works, in our view, without the instructor tying it together.

Each of these elements of CMC have been designed in a stand-alone or component format. That is, a student need not do all four in sequence to make the program work. Each section is designed so that it can be done independently of the other. They can be used in whole or in part. CMC training can be included in any training program. It can also be used as the format for a stand-alone course. This allows flexibility to meet various organizational needs. It also permits a course to be tailored to the specific needs of the student.

Flexibility is particularly important to us at Flight Safety because of the nature of our relationship with the crews we train. The pilots that we train do not work for Flight Safety. We work for them. This is different from the situation at most airlines and military training organizations.

Our cockpit management courseware is delivered by an instructor who then uses a specially-designed computer-interactive learning system to permit students to role-play, using the skills discussed by the instructor. As an option to instructor-led training or as a self-study vehicle, the interactive system can be used very effectively by itself.

We have chosen to include CRM training in four sections. One section of material will be taught at each subsequent training interval. The purpose of this sectional approach is to introduce this new material in a fashion that will allow it to be absorbed into a pilot's experience file, ready to be used effectively when needed.

For those who wish to address CRM training at one sitting, we will establish a three-day seminar late this year. Seminar training will be supported by LOFT training and crew self-critique during normal simulator training sessions.