Airline Safety:
Can We Break the Old CRM Paradigm?

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You are a passenger on a scheduled airline flight, and the weather is bad. Who would you like to be flying the airplane, the captain or the co-pilot?

This article will review the single greatest impediment to the airline industry's achievement of former Secretary of Transportation Frederico Pena's zero accident goal, followed by a short history of popular Crew Resource Management (CRM) and a commonly accepted look at what the next generation of popular CRM has to offer. This will be followed

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by an overview of a management system as an alternative to popular CRM, and a review of the above question.

I. TODAY'S CHALLENGE: THE HUMAN FACTOR

What is the greatest threat to air travelers today? Is it weather, the equipment, the airspace system, the pilots, the controllers, the airline management? While the emphasis often focuses on the pilots, they are not the lone threat. They are, however, the last link in the chain and are usually in a position to identify and correct errors that result in accidents and incidents. The numbers vary somewhat, yet mis-management by the flight crew is a causal factor in anywhere from 57% to 90% of all major airline accidents. This is, without a doubt, the single greatest threat to flight safety.

To keep this discussion manageable, the solutions proposed in this article are directed primarily towards the flight crew, yet remember they apply to most human endeavors and virtually all team operations. These endeavors include but are not limited to, airframe and equipment manufacturers, airline management, cabin crews, maintenance crews, dispatchers, even the National Transportation Safety Board (NTSB) and the Federal Aviation Administration (FAA).

In very basic, simple terms, the problem is one of decision making. Essentially three reasons explain why people make poor decisions: they have incomplete information, they use inaccurate information, or they process the information poorly. These are not mutually exclusive categories, nor are they limited to inexperienced pilots. Accidents occur all along the "competency curve." In fact a surprisingly high number of respected, proficient pilots, some of whom are check airmen and instructors, are involved in accidents. A highly respected pilot once said his biggest fear was that when he made a mistake, no one would tell him about it. On the other hand, if he had the reputation of being a marginal pilot, his crews would continually be on the alert for the inevitable error and would not hesitate to correct the situation. If crews consistently used a process that would assist in better decision making, while simultaneously providing a constant level of monitor and backup, then there would be fewer errors.

In April, 1994, the Flight Safety Foundation published a report titled "Review of Flightcrew-induced, Major Accidents of U.S. Air Carriers, 1978–1990". This report contained ten findings. Four particularly significant findings are the following:

• "In more that 80 percent of the 37 accidents reviewed . . . the captain was the flying pilot. . . The [National Transportation] Safety Board was unable to determine any particular significance to, or draw any conclusions from, this finding."
• "Procedural, tactical decision, and monitoring/challenging errors were the most common types of errors . . . and of the primary errors identified, errors of omission were more frequent than errors of commission."
• "Monitoring/challenging failures were identified in 31 of the 37 accidents reviewed in this study."
• "A pattern common to 17 of the 37 accidents was a tactical decision error by the captain (with more than half constituting a failure to initiate required action), followed by the first officer's failure to challenge the captain's decision."[1]

These are all indicative of crew management failures, what many in the industry call Crew Resource Management (CRM) or Human Factors. Many names for this exist and the terms change periodically as airlines discover that last year's attempts failed to achieve the anticipated results. So they change the training course a little and give it a new name so both management and flight crews will view it as something quite different without prejudice.

Missing is a management system or process that provides a standardized structure for the decision making process. This process should be self-monitoring and provide backup or redundancy that will immediately identify and correct any management failures.

II. A BRIEF HISTORY

In 1979, following a number of major airline accidents caused primarily by crew mis-management (i.e. poor decisions, ineffective communications, interpersonal conflicts, lack of situational awareness, task saturation, etc), NASA hosted a symposium focusing upon the need to train crews in cockpit resource management. In 1981, United Airlines and Scientific Methods jointly produced a course called Command/Leadership Resource Management, which became the prototype for the rest of the industry. The consultants, primarily psychologists and business management consultants, were then hired by other airlines to produce airline-specific variations of the course.

The training was quite different from the technical training that pilots typically receive. There were no standard operating procedures, no checklists, and nothing they could touch or see. In fact, there was little in the way of specific actions they were to take as a result of this training. They were taught to be more empathetic, to listen better, to be more

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1. FLIGHT SAFETY FOUNDATION, Review of Flightcrew-induced, Major Accidents of U.S. Air Carriers, 1978–1990 (1994).

assertive and diplomatic, and to be "better". While these are all good things, they are hard to pin down. Much of the training and early CRM evaluation revolved around attitudes. It was thought (and still is by many people) that by measuring an individual's attitudes via a paper and pencil test, an organization could predict a pilot's managerial performance on the flight deck.

Due to the subjective nature of this "first generation CRM", everyone had their own interpretation of what constituted "good CRM". Many pilots, especially those who have had successful careers with no accidents and violations or those who have risen perhaps through the ranks, considered this training quite valuable—for the other guy. Most of these pilots felt they were already managing quite well and therefore, the training did not apply to them.

This is not to say that this early attempt at CRM was a futile exercise. It was a step in the right direction. It recognized the importance of the team and the role of pilots as team managers and team members. This awareness training, however, did little in the way of actually improving behavior and producing better decisions.

CRM, as practiced in some airlines, has actually been a negative influence on flight safety. Following a major accident, one manager said of his airline's approach to CRM, "I think CRM started out as one of those feel-good things. I think you could also statistically prove that more accidents have occurred because the captain was not a strong enough person."[2] Most popular CRM programs fail because, while they try to encourage teamwork, communications and situational awareness (SA), they do not provide a CRM structure or specific procedures that will make this happen routinely on all flights.

III. Today's Popular CRM

In the late 1980's, we saw the emergence of "behavioral markers." These markers are an attempt to define management actions. Most of today's CRM programs incorporate these markers. While this is certainly an improvement over first generation CRM, it has its share of disadvantages as well. Behavioral markers, as used in this context, are a fairly large set of independent behavioral descriptors. Some are operational, lacking a management perspective, while some are quite vague, and still subject to interpretation. From the pilot's perspective, as well as that of

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2. J. Lynn Lunsford and Terry Maxon, *Computer Cited in Cali Crash: Mix-up Over Codes for Columbia Cities Blamed*, THE DALLAS MORNING NEWS, August 23, 1996, at 1A. In the article, Captain C.D. Ewell, chief pilot and vice president of flight operations, American Airlines, was quoted in reference to American Airlines Flight 965, a Boeing 757 which crashed on approach to Allfonso Bonilla Aragon International Airport, Cali, Columbia on December 26, 1995, killing all but four of the 163 persons aboard.

those tasked with evaluating CRM performance, the behavioral markers are not organized in a manner that is easily taught, used or observed.

Popular CRM, now fortified with these behavioral markers, is often viewed as a "toolbox." When a crew is presented with a particular situation considered to require CRM skills, they select the proper tool (or technique), use it, and then return it to the toolbox. This approach treats CRM as a specialized, reactive technique to extract a crew from a negative situation or at least minimize the adverse affects of a particular event. We call this *event-driven* CRM because the programs require designers and administrators to develop CRM-specific simulator scenarios for training and evaluation. These scenarios are developed around a set of CRM triggers which prompt the crew to use a specific CRM tool to satisfactorily resolve a particular event.

CRM that is used "only when needed" is rarely used at all in reality. First, if crews only practice this in CRM-specific training and evaluation sessions, they will not gain sufficient familiarity to become confident, proficient, and comfortable with these techniques. It follows that in some situations in which the crew is under high stress and workload (those times when CRM is particularly critical) they may not have the excess mental capacity to apply these seldom used techniques. Instead, they will revert back to the skills that are more comfortable, their "natural behavior". They will act just as they would have prior to CRM training. Psychologists call this the law of primacy.

Flights conducted using event-driven CRM are essentially unmanaged until someone recognizes a problem that requires these very specialized management skills or techniques. It is absolutely critical that flights are managed from start to finish. Management begins with a thorough, relevant, strategically oriented, pre-flight briefing, before the crew even steps on the airplane and continues through the post flight debrief that analyzes the positive and negative aspects of the flight, resulting in specific actions on the part of the crew. One of the primary purposes of CRM is to identify and avoid potential problems, or at least mitigate the negative impact of events that may be unavoidable. Crews cannot rely on an "event" to initiate the management process. Such a reactionary approach is ineffective at best. CRM must be active on all flights, including the simple, routine, fair-weather flights when traffic volume is low, ATC is providing assistance, and the runways are long, wide, and dry. If crews do not manage when conditions are favorable and easy, it is highly improbable that they will do so when they are experiencing and effective management becomes critical. This is analogous to only using your seatbelt when you are certain you are going to crash your car. When you need it most, you neither have the time, presence of mind, nor the ability to locate and securely fasten it.

There is also a growing trend in the industry to integrate some CRM procedures into operational checklists, primarily emergency and abnormal checklists. There is some merit to this, as it provides a bridge from certain operational situations into the management function. The problem arises in the attempt to transform an operationally based checklist into a comprehensive guide to flight deck management. Such a composite checklist can seduce pilots into thinking that this takes care of CRM. A pilot may simply wait for the checklist to remind them of what to do and they will believe they are managing well. Nothing could be further from the truth. Effective, proactive management starts long before the checklist is taken out, and continues well after the flight is completed.

Both airlines and pilots often complain that, captains lose much of their authority under CRM, and it becomes management by consensus. Captains feel that CRM forces them to surrender some of their command to their copilots. A spokesman for American Airlines, after the December 20, 1995 accident in Cali, Columbia, stated that "we are doing some things, getting away from CRM, putting the captain more in charge."[3] Perhaps the spokesperson's response is based on the fact that popular CRM is unstructured and subjective. Even the airlines' program developers and instructors never really understood how to effectively manage the team operation. They saw it as a "win-lose" proposition—if the copilot were to be more assertive and speak up when he saw things differently, then this must come at the expense of the captain's authority and his ability to make unilateral decisions. It is a debit-credit approach. Popular CRM creates a great deal of confusion because of its highly subjective nature. Every crew and every pilot will interpret it to mean something different. At what point does a copilot cross the line from merely assertively expressing his concerns and opinions, and becomes aggressive, perceived by the captain as a threat to his or her command?

A CRM *system*, however, is synergistic. It is a "win-win." The captain who manages well, is not only the manager and leader of the crew in a physical sense, but is also responsible for managing the flight's intellectual assets. The captain's scope of authority does not diminish, but actually expands. At the same time, the crew has very specific management responsibilities for which they are trained. They participate at all levels of the flight (intellectually and physically) under the captain's command. It is a cooperative and focused team operation with one leader and an active and involved participating team.

It is critical that the captain exercise his or her authority as a strong leader. Either extreme is dangerous, be it the captain who lets the copilot make all the decisions, or the captain who issues orders that must not be

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3. *Id.* (quoting American Airline spokesperson John Hotard).

questioned. An effective leader and manager leads the crew through the decision making process. He or she solicits relevant information from the team and leads an objective evaluation of the data. The captain is always in command and has final responsibility and authority for the flight. This should never be in doubt. But it does not mean that he or she does so in a vacuum without benefitting from the crew's knowledge, skills, and experience.

IV. The Popular "Vision" for Tomorrow's CRM

So what is next for mainstream CRM? What is the popular vision for "Fifth Generation CRM?" In 1996, Dr. Robert Helmreich defined Fifth Generation CRM in "The Evolution of Crew Resource Management."[4] He states that the next advancement in CRM must "focus on managing human error"; must provide "training in limitations of human performance"; and embrace a "continuation of earlier generation training topics under error management framework." Unfortunately, this new generation of CRM is merely a fresh coat of paint on an old approach that has seen limited practical value in the real world.

Another recent study conducted by researchers at the University of Texas at Austin, concluded that one of the reasons earlier attempts at CRM had failed is that the pilots never quite understood what this training was supposed to accomplish. So Fifth Generation CRM will need to clearly state its objectives—"to reduce the incidence of error, to trap errors before they become consequential, and to mitigate the consequences of those that occur . . . the [behavioral markers] taught in CRM should be recognized as countermeasures against error."[5]

Fifth Generation CRM offers no new advances to help the industry achieve these goals. Merely stating the purpose will not make it happen. In Dr. Helmreich's own words, Fifth Generation CRM will continue to teach behavioral markers—not exactly an advance in the technology. While it now has some direction, it is still as vague and subjective as ever. It appears to be more marketing hype than substance. There are still no procedures, nor is there any sort of a structured process. It is still reactive.

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4. Robert L. Helmreich, Department of Psychology Aerospace Crew Research Project, The University of Texas at Austin. *"The Evolution of Crew Resource Management."* IATA Human Factors Seminar, Warsaw, Poland, (October 31, 1996). In this paper, Dr. Helmreich discusses the five generations of CRM.

5. Robert L. Helmreich and William E. Hines, *Crew Performance in the Approach/Landing Phase: Observations in 2,600 Flights;* University of Texas Aerospace Crew Research Project, *"Approach and Landing Accident Reduction Working Group, Cartagena, Colombia,* (February, 1997). Technical Report 97-1.

V.   A MANAGEMENT SYSTEM, A NEW PARADIGM

So what is the answer? How do we significantly reduce, if not totally eradicate, the single greatest threat to aviation safety—mis-management? The solution is a management *system* in which not only the flight crews are trained, but everyone in the airline from senior management all the way down. Everyone must then be required to use the system. That's right, we must require it, just as we do with all other important procedures. We would not for a moment consider allowing a pilot to continue flying if he or she could not demonstrate proficiency in all the required operational procedures. Yet the industry continues to allow flights to go unmanaged. A familiar refrain among pilots, unions, trainers, and managers is that CRM must be "non-jeopardy." That is because popular CRM can not be objectively evaluated. A management system, on the other hand, has specific procedures that can be quite easily evaluated.

This discussion will use particular system, the *QUANTUM* Management System, as a model with the acknowledgment that other developers may find alternative ways to accomplish its goals. Simply put, the purpose of a management system is to help teams make the best possible decisions all the time, in a consistent, reliable, and repeatable manner. This must produce observable improvements on all flights, including training, evaluation, and line flights. In addition, these new behaviors must be permanent and self-reinforcing, actually continuing the improvement process years after the initial training effort.

A management system is error-tolerant. People will always make errors. So while we must do everything we can to prevent errors, some will still occur. An error-tolerant system is designed to quickly identify and correct errors in their infancy.

A management system has five basic attributes:

1. It **guides** the crew to the best decision.
2. It identifies and corrects errors in the early stages of development.
3. It provides timely and action-oriented **feedback** to identify the root causes of effective and ineffective performance to continuously improve future operations—increasing the probability of repeating the successes and eliminating the failures.
4. It provides a mechanism for continuous **monitoring** of the status of the flight's management.
5. It provides a **backup** that is ready and able to replace any missing management functions detected by the monitoring process.

Most CRM programs endorse the debrief process as a method of learning from flight experiences. However, they only address operational failures. These are generally, symptoms of management failures. The feedback referred to here goes far beyond that. The various components

of the management system enable crews, with some practice, to identify the basic underlying managerial causes which manifest into hundreds or thousands of seemingly independent, unrelated operational errors or successes. Every debrief should end with a specific action the crew will take to either reinforce the positive behaviors or eliminate the negative ones. It is not unusual to see fleet or organizational operating procedures change in this manner, thereby improving the performance of all crews in the future.

This is accomplished through Professional Responsibilities and Standard Management Procedures. All management procedures are derived from hundreds of specific behavioral objectives, specific attitudinal objectives, and specific informational objectives, which are the end product of extensive task analysis. The purpose of the task analysis is to identify exactly what an individual must know and do in order to manage well. The Professional Responsibilities and Standard Management Procedures are organized into a logical structure, the management system, designed to achieve specific goals.

The training system itself, is tasked with changing long-standing behavior (habits) that an individual has developed over a lifetime. While the industry standard two-to-three day workshop will develop an awareness of the relevant issues, it is largely ineffective in producing meaningful improvements.

In addition to a management system, airlines need a training and implementation system that: 1) provides bridges from the classroom to the work environment; 2) guides, reinforces and requires the new behavior; 3) teaches in a manner in which each individual participant can easily understand and assimilate the new material; 4) provides a means for an individual to "catch up" later if he/she should fall behind at any point; and 5) allows the pilots time to think about the new requirements, the logic behind them, and test them in various situations. We cannot ask a professional in any field to blindly accept new procedures without giving him or her the opportunity to thoroughly evaluate them and then build confidence and proficiency in utilizing them.

It is important that the training successfully reaches each pilot within the airline. While this seems to be stating the obvious, a quick look at current CRM training methods used in most airlines suggests that this is a very real concern. Each pilot who is not satisfactorily trained and is allowed to fly on the line represents an unnecessary risk—a potential accident. It is important to adopt a comprehensive management, training, and implementation system incorporating specific Standard Management Procedures that can be taught, required, and evaluated as objectively as any Standard Operating Procedure.

VI. Introducing a Management System to the Airline Industry

Such a management system has been in existence for many years and is in fact successfully used by smaller flight organizations that have recognized the value in going beyond the mere lip service offered by popular CRM training organizations. These are flight organizations that want and expect to see significant, measurable, day-to-day improvements in all aspects of their flight operations as a result of their training investment. They demand a tangible return on their investment and can not afford to throw money away just to simply check off the "CRM box" to meet minimum training requirements.

While implementing the complete management system in a large airline may seem daunting, this does not have to be the case. Once airline management commits to adopting a management system, the actual implementation process can be as aggressive as company management desires. It can be spread out over a number of years, implementing one procedure at a time, or it can be taught and implemented in a single process. This should not be construed as a quick fix. It requires a commitment and an investment in time, effort, and money. If it is done in small increments, it is important that each training phase brings the airline closer to its ultimate goal.

So why hasn't this systems approach been embraced by the flying community? There are numerous reasons, none of them particularly compelling when considered objectively.

CRM training and consulting has developed into a specialized field, complete with its share of self-proclaimed experts. On top of that, the government has awarded numerous research grants to study various aspects of CRM. A number of individuals have gained international recognition as a result of their advocacy of certain popular CRM methodologies. What would happen if they were to be proven wrong?

From the perspective of the airline training or operations managers who must make the decision or recommendation, new approaches are understandably viewed as too risky. They can't really be faulted for following the industry leaders even if the results are marginal, at best. There are a lot of people in the airline industry who admit that popular CRM produces limited benefits in daily operations (as well as emergency and abnormal situations), but the safe bet is still on the mainstream solutions. There used to be a saying in the computer industry that "no one ever got fired for buying IBM." It may not have been the best system for the particular company's needs, but the risk was perceived as being much more acceptable than going with Brand "X" which may have been a better choice based strictly upon system performance and the requirements

of the job. Nothing is 100% guaranteed. In the event of a problem, the manager would rather be in the position of defending the IBM selection than the Brand "X", even if a cost/benefit analysis clearly favored the Brand "X". This is human nature. Unfortunately, we find that larger airlines (or the CRM decision makers within the airlines) are more susceptible to such perceived peer and organizational pressure than are the smaller flight organizations that make their decisions purely on the basis of return on investment analyses.

How about a research grant to objectively evaluate the feasibility of new concepts and ideas that have the potential to positively impact flight safety? While in theory, this sounds like a fair route to take, it too has its share of potholes. Once the grant money has been awarded, it is perfectly legal to change the purpose of the research project. This is exactly what happened to one such research grant. The research team applied for FAA funding to evaluate the feasibility of a management system (titled "Analysis of Cockpit Management System Training in a Regional Carrier Environment"). Soon after the grant was awarded, the project was changed to "Developing and Evaluating CRM Procedures for a Regional Air Carrier." It is all perfectly legal, but did the FAA, taxpayers, and flying public get what they thought they were buying?

Why this change in direction? Airlines, training organizations, and researchers find that it is easier to slightly modify currently held philosophies and CRM programs in which an individual or organization has invested a great deal of resources (effort, time, people, money) and in which reputations may be at stake, than to abandon them for a new approach. But why would the airline, the immediate beneficiary of this research, choose to accept only minor modifications in something that has produced only limited benefits, rather than evaluate something that has the potential to make dramatic improvements in safety, flight efficiency, and passenger service?

The answer becomes evident in light of the airline's purpose for participating in the research project. The FAA is encouraging airlines to develop new cost effective training programs under the Advanced Qualification Program (AQP), which is geared towards training to proficiency versus the completion of a pre-defined number of training hours. CRM is one of the requirements of AQP. This research project represented an opportunity for the development of the airline's AQP training curriculum to be subsidized by the government. In addition, the airline training personnel, as well as the principle investigators were only knowledgeable in the popular approaches to CRM. This represented their comfort zone and there was little incentive to venture into the unknown.

By staying with what they already knew, they could concentrate their efforts on areas in which they were primarily interested. As the grant's

name change indicates, some of the key researchers were primarily inter-ested in the development of evaluation techniques, not in the CRM issues (the development of CRM procedures consisted of adding a few some-what vague "procedures" to the airline's operational checklists). The problem here is that while there is a need for a reliable means of deter-mining whether the CRM training is effective, the measurement tool itself does not directly contribute to flight safety. Evaluation techniques are of secondary importance.

One of the advantages of a true management system is that, by defi-nition, it has a built-in evaluation mechanism. The procedures are easily observable. Either they are performed correctly or they are not. Since all flights must be managed, there is no need to expend precious re-sources and further delay the implementation process by designing CRM-specific simulator scenarios to evaluate a crew's performance. Any sce-narios the airline currently uses will work quite well for use in training and evaluating crews in a management system. If the management pro-cess is in place, the crew will be able to effectively manage any event they are likely to encounter. Unfortunately, this is bad news for the evalua-tion experts. It leaves them little to do.

The simulator is, without a doubt, a powerful and economical train-ing and evaluation devise. However, the best way to evaluate the effec-tiveness of the management, training, and implementation systems is to observe and evaluate crew performance on line flights. This is where the performance counts. Simulator crashes are of no real concern since no one gets hurt. It's a learning experience. Modern simulators are capable of producing realistic flight experiences and do a fine job of approximat-ing the real world environment. No matter how realistic the experience, it is not the real thing. When crews fly simulators they know they will encounter emergencies and are prepared for them. This is not the case on the line, when flying highly reliable equipment in an environment in which they may never have experienced a traumatic event. Crews that demonstrate acceptable CRM performance in the simulator may actually do very little managing on the line flying multi-million dollar airplanes carrying hundreds of passengers.

The result, in this case, is that the FAA will not get what it originally contracted. Taxpayer money has been spent on unnecessary "research." The flying public is no closer to increased safety. Airlines will not have the opportunity to see an objective evaluation of a completely new ap-proach to the single greatest threat to aviation safety, passenger service and flight efficiency.

VII. CONCLUSION

Adopting a management system involves a radical change in the direction of CRM for the airline industry. It means moving from the event-driven CRM "toolbox" to a process-driven CRM *system*. It means abandoning the subjective approach (and yes, even the behavioral markers) in favor of a task analysis based, objective management system that defines specific procedures that can be monitored and backed up. It means no longer relying solely upon tactical thinking, but on a combination of tactical and strategic thinking. It means CRM is no longer merely recommended or encouraged, but *required*.

Which brings us back to our questions at the beginning of this article. Who would you rather fly the airplane under adverse or demanding conditions? Most people would initially opt for the captain, most likely an experienced pilot who has probably seen it all. Now consider that the NTSB found that 80% of the accidents occurred when the captain was the pilot flying (generally, pilots swap legs, so that about 50% of the flights are actually flown by the captain). Consider also, that in most accidents, there was a failure in the monitoring and backup functions. What does this say? The captain is generally an effective monitor and backup. He or she will not hesitate to take decisive action when necessary. The copilot, on the other hand, may not be as quick and confident in correcting the captain. This suggests that with today's popular CRM practices, we would be better off with the copilot flying and the captain monitoring. This would produce a full crew complement.

However, if both crewmembers have demonstrated their knowledge and proficiency in the management system (which is a requirement to fly for the airline), it is not so critical who is actually manipulating the flight controls. The copilot has the necessary skills and responsibility (as well as the full support of the airline's management) to effectively monitor and backup the captain, supporting the captain's strong leadership and command. It is a true team operation.