

# COCKPIT/CREW RESOURCE MANAGEMENT FOR SINGLE-SEAT FIGHTER PILOTS

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## INTRODUCTION

The goals of U.S. Air Force Cockpit/Crew Resource Management (CRM) training are to maximize operational effectiveness and combat capability and preserve personnel and material resources through a focus on aviation human factors. CRM training provides crewmembers with performance-enhancing knowledge and skills tailored to fit the unique characteristics of each primary mission and covers six core behaviors: Situational awareness, crew coordination/flight integrity, communication, risk management/decision making, task management, and mission planning/debrief. While CRM training appears to be readily accepted by Air Force aviators who fly multi-crew aircraft, including two-seat fighter aircraft, there are differences among single-seat fighter pilots in the perception of the applicability of CRM training in their environment. These perceptual variances are highlighted by the fact that single-seat fighter aircraft do not have "crews," but rather operate in "flights" of individual aircraft, each with a single pilot, to accomplish their mission through a mutually supporting effort. This research was undertaken to examine how F-16 fighter pilots viewed the Air Force's emphasis on CRM; the breadth and depth of CRM skills and behaviors; CRM's applicability to the "single-seat fighter community;" potential changes to CRM training; and the pilots' dominant learning styles. The purpose of this study was to determine the pilots' *attitudes*, prior to later examining their behaviors.

## BACKGROUND

Cockpit/Crew Resource Management for single-seat fighter aircraft is a relatively new approach to solving an old problem: How can aviators make the most effective use of all available resources -- physical assets and personnel. CRM training involves a focus on aviation human factors. Inadequate training in aviation human factors, that is, incomplete situational awareness; fixation and distraction; weak inter- and intra-flight communication; poor crew coordination and flight integrity/discipline; and inadequate mission planning/debriefing, risk management/decision making, and task management, has caused numerous lost lives and accidents which could have been prevented.

In the early 1980s, Cockpit Resource Management was introduced into the aviation arena, at first mostly in the airlines. Commercial aviation CRM started out centering on personality variables, attitudes, and management styles. Noted aviation human factors researcher Robert Helmreich characterizes the development of CRM as occurring over five generations to date (Helmreich, Merritt, & Wilhelm, 1999). Prior to 1980, crew coordination was traditionally focused on the individual pilot and reviewing accident reports for ways to improve flight operations. In the early 1980s, first-generation "Cockpit Resource Management" started a shift toward measuring the pilot's attitudes against an ideal standard, as an improvement vehicle. By the mid-1980s, second-generation CRM brought the entire flight deck into the process with an emphasis on cockpit group dynamics, along with a name change to "Crew Resource Management." During the early 1990s, third-generation CRM incorporated all of the organizational personnel into the process (flight crews and maintenance, etc.), while stressing team-building skills to enhance performance. By the mid-1990s, fourth-generation CRM widened the focus to bring the entire team under the CRM umbrella (pilots, support, maintenance, air traffic controllers, etc.) and to emphasize procedural integration by adding specific "behaviors" to their checklists. The goal of fourth generation CRM was to assure that decisions made and actions taken, even in nonstandard situations, were the results of making human factors and CRM an integral part of all flight training (Personal communication with Helmreich, in Spiker, Tourville, Silverman, & Nullmeyer, 1996). The breadth of CRM training has since continually grown to include communication, situation awareness, decision-making, and other human factors. A recent aim of CRM training has been to examine error chains and explore strategies to manage error. The fifth generation of CRM unfolded in the late 1990s for the new millennium with the perspective that since "human error" is inevitable; it is therefore a valuable source of information. Accordingly, CRM can be viewed as exercising a set of error management countermeasures: First, to avoid the error; second, to trap an error before it can be committed; and third, to mitigate the consequences of an error that does occur

and was not trapped (Helmreich, et al, 1999). Current research also accentuates that learning must be a continuous process over time to be effective and stresses the importance of incorporating cognitive psychology models in team building training programs (Ilgen, 1999).

In the U.S. military, the scope of CRM evolved from an emphasis on the aircraft pilot or aircraft commander, to training that is applicable to the active inclusion of all flight and crewmembers. The Air Force has embraced CRM and in 1994 issued Air Force Instruction 36-2243, Cockpit/Crew Resource Management Program, which established the requirement for developing and managing tailored, mission-specific CRM training. In 1998, Air Force Instruction (AFI) 11-290 replaced AFI 36-2243 as the Air Force's instruction on CRM for flying operations. Each Air Force major command is responsible for supplementing the Air Force instruction by creating its own specific training for its individual aircraft and missions. This situation creates the potential for variances in the CRM training received in the different major commands.

### **SPECIFIC RESEARCH OBJECTIVES**

The primary purpose of this research was to gain an understanding of single-seat fighter pilots' attitudes toward CRM training, with a long-term objective of using the data to enhance CRM training for the fighter community.

The overarching research question in this inquiry was "What enhancements to single-seat fighter pilot Cockpit/Crew Resource Management training programs could improve the pilots' understanding and acceptance of CRM training, with the goal of improving their long-term retention and application of CRM training?"

Additionally, a component of the inquiry was to examine the learning styles of the F-16 pilots in an attempt to determine the most reinforcing format for CRM training. Also, a composite, integrated CRM training model would be developed to enhance training retention and application.

### **METHODS**

#### **Participants**

Extensive interviews were conducted with 36 F-16 pilots from three different squadrons at the 56<sup>th</sup> Fighter Wing, Luke AFB, AZ. These pilots represented three groups: F-16 instructor pilots (n = 14), F-16 student pilots (n = 11), and squadron and wing leaders (n = 11).

### **Interview Content and Structure**

Interviews were conducted in an open-ended format. Interview questions were used to initiate and facilitate the interview process. The research employed qualitative research techniques using grounded theory, where the common respondent topics and links, foundational theory, and hypotheses were allowed to evolve during the on-going data collection and analysis without preconceived hypotheses (Creswell, 1994). This qualitative study on F-16 pilots' *attitudes* was "hypothesis-generating," rather than hypothesis-testing as in quantitative research.

### **Data Collection and Analysis**

Each interview lasted approximately one hour and involved two researchers. Interviews were conducted in the fall and winter of 1998 and the spring of 1999. Interview sessions were continued to the point where there was a saturation of information, meaning that no new information was emerging (Merriam, 1988). Data analysis was conducted simultaneously with the data collection. This included sorting the responses into categories, interpreting the data, and formatting the data into a reflective picture. As the data were collected, coding was accomplished to reduce the information into themes or categories for interpretation.

### **FINDINGS AND INTERPRETATIONS**

The interviews provided a rich narrative with which to examine and understand single-seat fighter pilots' attitudes toward CRM. The interviews examined CRM formal training in undergraduate pilot training, F-16 formal course training, F-16 instructor training, F-16 continuation training, and other formal CRM training. The interviews also investigated the respondents' attitudes toward the USAF emphasis on CRM, integration of CRM in everyday operations, instructors' attitudes of students' understanding of use of CRM, students' attitudes of instructors' and evaluators' use of CRM, suggestions by respondents to improve CRM training, and respondents' learning styles.

The research interpretations, conclusions, and implications were determined primarily by the principal researcher, a former F-16 pilot and fighter wing commander, based on the researcher's 25 years of interaction with, and an appreciation for, single-seat fighter pilots and their unique flight environment. In qualitative research, the success of interviews rests on the skill and experience of the investigators (Merriam, 1988). Development of these research interpretations, conclusions, and implications was derived from not only exactly "what" each respondent said and "how"

they said it, but also from the researchers' assessments of the pilots' underlying "attitudes" toward the research questions.

**Interpretations (from data)**

**Undergraduate Pilot Training (UPT) CRM Training.** Only seven of the 35 respondents recalled that they were given CRM training during UPT. A high correlation between rank (an approximation of time in the Air Force) and the respondents who stated that they had not received specific CRM training in UPT, reflecting the recent introduction of CRM training over the few years (see Table 1).

Table 1. UPT Training

Response	Number	Percent
Recalled CRM Specific Training in UPT	7	20
Did <u>not</u> recall CRM Specific Training in UPT	28	80
No response	1	

Potential correlation between demographic variables and common response variables were examined. Only one significant relationship was found: the relationship of rank with completion of a CRM training course during Undergraduate Pilot Training ( $r = .632, p < .01$ ). With relatively new pilots being given training in UPT, which the older pilots have not been exposed to, a common framework of CRM-related terms and expectations between those groups appears to be still evolving. This variance in foundational CRM formal training in UPT could contribute to some differences in attitudes toward CRM concepts and principles between the older pilots and the younger pilots. The data also revealed that formal CRM training in UPT was not consistent between the respondents with respect to either syllabus structure or content. However, newly published Air Education and Training Command (AETC) instructor and student CRM lesson plans underscored a move by AETC for standardized baseline CRM training in UPT.

**F-16 Formal CRM Training.** AETC's F-16 Formal Training (FT) CRM program also reflects the gradual CRM knowledge evolution experienced by UPT pilots, with the youngest pilots having received the most CRM exposure (see Tables 2 & 3).

Table 2. F-16 Formal Training

Response	Number	Percent
Recalled some training	18	85.7
Did not recall training	3	14.3

Table 3. F-16 Formal Training Experience

Response	Number	Percent
Neutral or mixed experience	10	47.6
Strongly positive experience	0	0.0
Less than positive experience	8	38.1
No Training	3	14.3

Until recently, expanded AETC CRM lesson plans did not exist in a format that completely aligned with the Air Force Instruction on CRM training programs, the latest being AFI 11-290, 14 August 1998. Consequently, without standardized direction, the FT training programs appeared to be oriented toward aviation physiology subjects, such as G-LOC and stress management, as well as some CRM subjects like problem solving, situational awareness, and aircraft incident and accident reviews. Using the new AETC Instructor and Student Guides, P-V4A-A-C-CR-IG, March 1998, as a baseline upon which to build, FT CRM training can be expanded.

**F-16 Instructor CRM Training.** While instructor CRM training must cover a broad spectrum of academic and flying skills, it does not appear to have a consistent component which focuses on teaching instructors to recognize or correct shortfalls in the students' understanding of, and implementation of, CRM behaviors and skills (see Table 4).

Table 4. F-16 Instructor Course

Response	Number	Percent
Recalled some training	3	30
Did not recall training	7	70
No response	3	

If the instructors are to carry the responsibility of assuring that CRM skills and behaviors are a part of every flight and simulator, then the instructors should have continual CRM refresher training to highlight recent innovations and developments in CRM and aviation human factors.

**F-16 Continuation Training.** CRM Continuation Training (CT) programs are administered individually by the using major commands. AETC and the Pacific Air Forces (PACAF) currently support CT with

in-house resources, while Air Combat Command (ACC) and United States Air Forces Europe (USAFE) provide this training through a support contractor. F-16 pilots' experience with the commands' training has been varied (see Table 5).

Table 5. Continuation Training

Experience	AETC (n)	AETC (%)
Neutral or mixed	12	92.3
Strongly positive	0	0
Less than positive	1	7.7

Experience	ACC/ USAFE (n)	ACC/ USAFE (%)
Neutral or mixed	6	33.3
Strongly positive	6	33.3
Less than positive	6	33.3

Experience	Total (n)	Total (%)
Neutral or mixed	18	58.1
Strongly positive	6	19.3
Less than positive	7	22.6

Many F-16 pilots who have attended the ACC and USAFE CRM programs liked the case studies with interactive computer-based training, but did not like the PC-based situational trainer. The tactical relevance of

the training and applicable scenarios was very high on the respondents priorities. The experience and credibility of the CRM instructors were also very important.

**Overall Attitudes Toward F-16 CRM Training Program.** The pilots' "perceptions" about CRM appeared in some cases to be an obstacle to the adoption of CRM principles in the broadest context (see Table 6). The F-16 pilots interviewed displayed a high enthusiasm for their mission and an in-depth knowledge of fighter operations. However, many pilots did not indicate a full understanding of the breadth of the Air Force CRM program, or the value of CRM training to enhanced combat readiness and effectiveness. Many experienced, single-seat F-16 fighter pilots felt that they had "always done CRM." They generally did not like the term "CRM" because of the multi-crew airplane connotations. Many pilots thought that CRM focused on multi-crew aircraft. Some pilots indicated that they wanted the USAF to show that it was serious about CRM training by funding it adequately and assuring that the CRM training was specialized for single-seat fighter aircraft.

**Suggestions to Improve CRM Training.** The three highest frequencies of F-16 pilots' suggestions to improve CRM training (see table 7) were: to assure that the concept of training (format, duration, frequency, etc.) enhances the learning process, to assure course delivery is applicable to the audience, and to consider

Table 6. Pilots' Attitudes Toward F-16 CRM Training.

Attitude Coding Area	Interview Topics						Total
	USAF emphasis	Integration top down guidance	Integration flight operations	Integration simulator operations	IP attitudes	Student attitudes	
<b>"CRM" not desired term</b>	9	16	19	7	10	5	<b>66</b>
<b>Already doing CRM</b>	11	4	2	-	1	-	<b>18</b>
<b>Being forced to do CRM training</b>	6	7	1	-	-	1	<b>15</b>
<b>Need to focus on fighters</b>	4	-	1	2	-	-	<b>7</b>
<b>USAF must show it's serious</b>	5	1	-	-	-	-	<b>6</b>
<b>Other positive comments</b>	9	6	13	18	5	2	<b>53</b>
<b>Other negative comments</b>	6	6	8	15	6	-	<b>41</b>

another term other than “CRM” for single-seat fighters. The next three highest responses were: to make sure CRM training was tactically relevant, to make CRM training applicable to single-seat fighters, and to use simulators to reinforce CRM training.

Table 7. Respondent suggestion topics to improve CRM training.

Suggestion	Responses
Assure concept of training (format, duration, frequency, etc) is enhancing the learning process	30
Assure course delivery is applicable to audience	22
Consider using another term other than “CRM” for single-seat fighters	20
Make all CRM training tactically relevant	13
General comments	13
Make CRM training applicable to single-seat fighters	9
Use of simulators to reinforce training	7
Do not force training to be accomplished	6
Leadership must support training	5
CRM instructors must have credibility	3

Based on the strength of the pilots’ suggestions and responses, these priorities should form a basis for considering alterations to the CRM training program in order to facilitate single-seat fighter pilots’ participation in the CRM training process.

**Interpretation of Assessment of Learning Styles.**

Everyone has a slightly different dominant learning style. Typically, *visual learners* must read words or see pictures, *auditory learners* must hear the ideas spoken to them, and *hands-on, kinesthetic, or tactile learners* must touch or contact the object to reinforce their learning process. The F-16 pilots interviewed self-identified themselves as 48.6% hands-on learners and 17.1% a combination of hands-on and visual learning (see Table 8). CRM courses should be designed to present material in more than one learning style in order to enhance learning.

Table 8. F-16 Pilot Learning Styles.

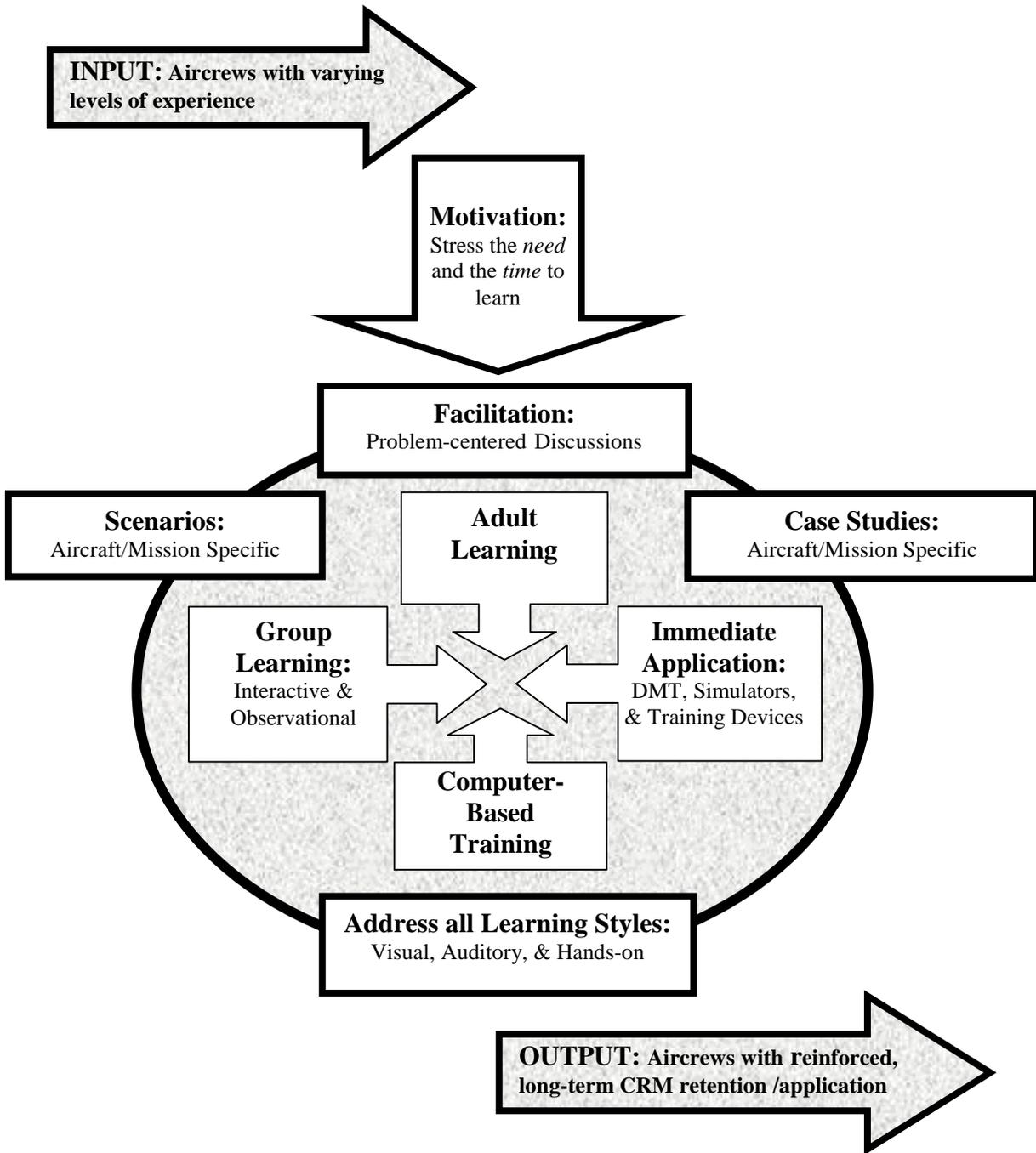
Learning Style	n	%
Hands-on Learner	17	48.6
Visual Learner	9	25.7
Hands-on/Visual Learner	6	17.1
Visual/Auditory Learner	3	8.6
Auditory Learner	0	0
Hands-on/Auditory Learner	0	0
No Assessment Made	1	2.7

Since research also indicates that aviators tend to be predominately hands-on learners, *immediate hands-on application*, such as using distributed mission training (DMT), simulators, interactive computer-based training or training devices, is very important. Research in advanced learned models for aviation education also reveals that in addition to incorporation of all learning styles for knowledge transfer, including the use of immediate hands-on application to improve long-term retention and application, the adoption of adult, cooperative, and observational learning principles and techniques should have reinforcing value in developing CRM training programs (Karp, 1998).

Over the last few decades, the learning model that has been generally used in all aviation education has remained predominately unchanged. Whether it involves the flight members, crew members in the front of the aircraft, or the mission crews in the back, aviation education has historically involved a highly structured presentation of information in a lecture format, possibly followed sometime in the future by practice in a simulator or the aircraft. While this “lecture now, application in the future” model of knowledge transfer may work relatively well with younger learners, research has shown that aviators, as well as other learners involved in highly technical courses of study, respond more efficiently to an adult learning model (Karp, 1996). When adult learning is combined with cooperative learning, learning style theory, and immediate application, the resulting *integrated CRM learning model* can become a powerful tool to transfer CRM knowledge for long-term retention and enhanced application (see Figure 1).

**Adult Learning Principles.** Research confirms that mature adults learn differently than younger learners. In fact, adults learn best when they believe that they have a *need to learn* and are *ready to learn*. Normally, adults are self-directed learners and require an instructor to paint a clear picture of *where* a course is going, and *why*, before they are willing to commit themselves to a learning enterprise. Adult learners are

Figure 1. Integrated Cockpit/Crew Resource Management Learning Model



unwilling to wait until some time in the future to use their knowledge; they want to *apply knowledge immediately*. Furthermore, research has shown that while adults are least likely to learn in a “lecture-only” environment, they *learn exceptionally well in guided discussions*, after they have been exposed to the baseline knowledge. Additionally, adult learners, such

as aircrews who use highly sophisticated technology, respond very positively to multimedia presentations when they are integral to those facilitated discussions. The use of visually and auditorially engaging computer-based training, which could include DMT, simulators and other interactive training devices, can enable the aircrews to immerse themselves in the application of

CRM skills during the multimedia learning process. Also, videotape capture of key events in DMT, simulators, and training device missions, during unfolding, complex CRM scenarios coupled with facilitated discussions, can be highly valuable reinforcement training vehicles. Adults also *learn very well from each other*. Again, research indicates that by being involved in discussions within a peer group, adults are very successful in attaining knowledge and retaining it. Additionally, adults benefit from observing others, especially peers who have attained the group's respect, like flight instructors or evaluators. Adult learning is also enhanced by working in groups, especially if they are involved in *problem-centered discussions*. Working a problem with multiple facets is a more effective tool for reinforcing a long-term application rather than memorizing a series of definitions and facts (Karp, 1998).

**Additional CRM Research Topics.** While reviewing participant responses to open-ended interview questions, several high response trends were identified. It is important to note that these trends were not the result of specifically asked questions, but they occurred spontaneously during interviews relating to CRM core behaviors and skills (see Tables 9 & 10).

Table 9. Common primary data responses

Common participant response	%
Indicated that they do not like the term CRM	40
Indicated that CRM is done but is not called CRM in fighters	82

Table 10. Common core CRM behavior data responses

Common participant response	%
Indicated that CRM principles are important in briefing	97
Indicated that CRM principles are important in debriefing	87
Indicated that a good flight lead is characterized by:	
-Being a good communicator	58
-Having good people skills	39
-Being knowledgeable	33
-Being a good pilot	15
-Aggressiveness	15
-Being a good overall leader	6
Indicated that wingmen should speak up:	
-In flight	91

-When issue may affect mission (including training mission)	47
-During briefing & debriefing	41
-For bad feelings or if uncomfortable with situation	33
Preferred method for wingmen to question or non-concur with lead during flight	
-Plain English	40
-“Knock-it-off” call	30
-Ask questions	23
-Other methods	7

**Summary of Interview Response Interpretations.** The F-16 pilots interviewed displayed high enthusiasm for their mission and an in-depth knowledge of fighter operations. However, many pilots did not indicate a full understanding of the breadth of the Air Force CRM program, or the transfer of the training to enhanced combat readiness and effectiveness.

Currently each major command is responsible for developing its own CRM program. Consequently, there have been variances in the content and magnitude of CRM training that pilots have received in UPT, formal training, and continuation training in the operational units. These training programs, which may differ in delivery format and subject matter, present an environment in which pilots may understand CRM skills and behaviors from different perspectives and to different retention and application levels. Transferring between major commands could also result in negative learning. Additionally, pilots who have recently gone through UPT and initial weapons systems training have more formal CRM training than pilots who have been in the Air Force longer. This could create a situation where the “older” pilots, including instructors and flight leaders, do not view CRM behaviors and skills with the same perspective as the “younger” pilots.

## CONCLUSIONS (from interview response data)

1. Potential modifications to single-seat fighter CRM should consider the pilots' perceptions, sensitivities, and attitudes in order to enhance CRM acceptance and incorporation into everyday flight operations.

The term “CRM” conveys a negative connotation to many F-16 pilots because of its origins in multi-crew aircraft. Forty percent (40%) of the respondents indicated that they did not like the term “CRM.” Thirty-three percent (33%) of the responses on attitudes toward F-16 CRM training indicated that CRM is not a common or desired point of reference to single-seat fighter pilots. Sixteen percent (16%) of the suggestions to improve CRM training recommended using another

“term.” An interesting side note was that pilots who had previous multi-crew fighter experience did not react as negatively toward the term “CRM,” as did pilots who only had single-seat fighter experience. In a similar perspective, 82% of the pilots said that they were already doing CRM, but it was not called “CRM.”

2. The structure of the CRM training was important to many F-16 pilots. Forty-one percent (41%) of the suggestions to improve the training focused around assuring that the concept of training (delivery format, duration, frequency, etc.) enhances the learning process and is applicable to an audience of single-seat fighter pilots. Additionally, CRM training does not appear to be integrated into F-16 simulator training. Twenty-three of the interview responses (11.3%) indicated that there was no CRM training conducted in the F-16 simulators.

3. Personal learning styles were easily self-identified by the F-16 pilots. Forty-nine percent (49%) assessed themselves to be “hands-on learners,” 26% thought that they were “visual learners,” 17% felt that they were a combination of “visual and auditory learners,” and no F-16 pilot (0%) thought he was an “auditory learner.” While most F-16 pilots (66%) were either hands-on learner or a combination hands-on/visual learner, they implied that most of their CRM training in AETC was by lecture, using auditory and visual learning formats.

4. CRM training is not consistent within the F-16 community. Eighty percent (80%) F-16 pilots interviewed had not had CRM-specific academics in Undergraduate Pilot Training. This reflects the fact that CRM training has only been introduced over the past few years. For pilots who did not receive CRM training in UPT, CRM initial, instructor, and continuation training are also provided in AETC and in the gaining major commands. While AETC provides CRM training in F-16 Formal Training, it is not necessarily in the same format as that which is provided during CRM continuity training in the gaining major commands.

### **IMPLICATIONS (from overall interviews)**

1. Some F-16 pilots did not understand the breadth of the issues that fall under the overall umbrella of the Air Force CRM program. However, they do have a good working knowledge of the individual components (USAF CRM behaviors highlighted in bold print) in relationship to their mission:

Most F-16 pilots had an excellent understanding of the need for in-depth **mission planning/debrief**. Most

pilots used squadron standards for delegating mission planning responsibilities.

Most F-16 pilots had a comprehensive understanding of **flight (crew) coordination/flight integrity** and the roles of the flight leader and the element leader, but there were variances as to the wingman’s role in communication. Most F-16 pilots lean toward the school of thought where the wingman is encouraged to speak up during the mission planning and the flight; however, there were some exceptions.

Most F-16 pilots have a broad understanding of **risk management/decision making**, but there was some variance as to when a flight leader should seek assistance from outside the flight.

Most F-16 pilots had a very good understanding of **task management** and in-flight prioritization.

Most F-16 pilots had an excellent understanding of in-flight **communication** within the four-ship and with other flights and outside agencies.

Most F-16 pilots had a very good understanding of **situational awareness** and how to maintain it or regain it.

2. F-16 instructor training (in AETC) does not appear to have a broad CRM component that focuses on teaching instructors how to recognize or correct shortfalls in the students’ understanding of, and implementation of, CRM behaviors and skills. If the instructors are to carry the responsibility of assuring that CRM skills and behaviors are a part of every flight and simulator, then those instructors should have frequent CRM refresher training to highlight recent innovations and developments in CRM and aviation human factors.

3. Pilots appeared to prefer interactive CRM training with problem-centered facilitation, in contrast to classroom lecture. Some respondents stated a preference for aircraft and mission case-studies and problem-solving exercises. Some F-16 pilots expressed a willingness to do more training in simulator missions that integrated CRM concepts, but not as “separate CRM events.” However, pilots who had used the ACC/USAFE, PC-based, situational CRM trainer, generally did not think that it was time-effective because it took too long to familiarize pilots with the generic controls.

## RECOMMENDATIONS

1. Consideration should be given to either changing the term “Cockpit/Crew Resource Management” (CRM) to something less offensive to single-seat fighter pilots, or minimizing the use of that term with single-seat fighter pilots and making the same specific CRM training more “transparent.”
2. Air Education and Training Command and the gaining operational major commands should stress that instructors and evaluators must carry the CRM banner in everyday operations. CRM role modeling and constant reinforcement by unit instructors and evaluators are pivotal to the retention of CRM behaviors and skills. Instructors and evaluators should stress CRM behaviors and skills on every flight and in every simulator. This can be accomplished in a “transparent manner” without using the term “CRM;” however, all of the CRM behaviors and skills must still be covered.
3. Instructor and evaluator CRM refresher training should be frequent enough to insure a heightened focus on CRM skills and behaviors and knowledge of the recent developments in CRM facilitation.
4. AETC and the gaining operational major commands should work together to assure that AETC is providing aircraft-/mission-specific CRM training that supports the gaining commands’ requirements and that the gaining major commands are conducting CRM training which is building on the format and structure delivered in UPT and aircraft/mission specific formal training. Consistency of behavior, skills, and terminology is the foundation of long-term reinforcement, retention, and application.
5. CRM continuation training for AETC training units, as well as operational units, must underscore CRM behaviors and skills, as outlined in *AFI 11-290, Cockpit/Crew Resource Management Training Program*, to assure that pilots are aware of the depth of the CRM issues and the breadth of CRM interrelationships, not only within their own flying operation, but also organizations external to the flying units, such as air traffic control and maintenance.
6. CRM training should use facilitation of discussion to capitalize on adult learning models and to minimize “lecturing,” while using interactive computer-based training to stimulate class dialogue. Nonattribution discussion and modeling by respected peers within the class are highly effective reinforcement tools. An experienced facilitator, with mission/aircraft credibility and experience, should be required to perform this important task.
7. Formal and continuation academic training should incorporate interactive, hands-on, visual, and auditory delivery methods to include aircraft- and mission-specific case studies, computer-based training (CBT), and video reenactments of good and bad examples of CRM.
8. Formal and continuation CRM training should be structured to incorporate hands-on application *immediately* after CRM academic training. Distributed Mission Training (DMT) in linked simulators would be the most reinforcing if facilitated in the debriefing by a qualified CRM instructor. If DMT is not available, aircraft-specific simulators should be used on training missions, with scenarios designed to create CRM “events” which must be addressed (either by the pilot acting as lead, wingman, or part of a crew). These scenarios would require the simulator instructor to perform multiple, scripted roles of individuals outside the cockpit, such as flight leader, wingman, air traffic control, etc.
9. If DMT or simulator missions with CRM scenarios are not available, consideration should be given to developing an aircraft-specific, PC-based, flight training device, with embedded self-generating CRM scenarios, for use as a CRM procedural trainer with a facilitated debriefing.
10. Adopt an Integrated CRM Learning Model, using adult learning principles, cooperative group learning, and learning style theory, including immediate hands-on application, to enhance reinforced, long-term retention and application of CRM principles, behaviors, and skills (see Figure 1).
11. Conduct further research to determine the validity of single-seat fighter pilot statements regarding CRM. While this study focused on personal attitudes, the next step would be to conduct research using direct observation of pilot CRM behavior during briefing, flight operations, and debriefing. This observation research will help identify three significant factors: (a) how well single-seat fighter pilot statements about their attitudes toward CRM represent their actual use of CRM in everyday operations, (b) identification of key CRM behaviors of highly effective single-seat fighter pilots, and (c) which specific CRM skills and behaviors should receive the most emphasis during instructor and continuation training because of the uniqueness of each aircraft community. Additionally, this research should help determine the best method to measure CRM performance within individual flying units. This type

of research has been successfully performed with multi-crew aircraft (Silverman, Spiker, Tourville, & Nullmeyer, 1998), but has not yet been attempted with fighters.

### FINAL COMMENTS

This research was initiated to determine single-seat fighter pilots' attitudes toward CRM and the pilots' suggestions to improve CRM training. In addition to the statistical presentations and interpretations in this paper, the F-16 pilots' expanded comments are detailed in an Air Force Research Laboratory technical report (Karp, Condit, & Nullmeyer, In Press). A review of this technical report, rich in quotations and narrative, should help further explain the underlying foundational attitudes of F-16 pilots toward CRM training and provide insight into potential enhancements for CRM training for the single-seat, fighter pilot community.

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