Cockpit Resource Management Proficiency As a Factor of Primary Flight Training

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A Report

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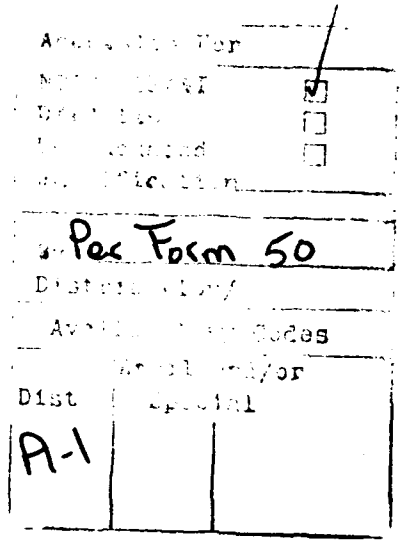

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CHAPTER ONE

The Problem

Introduction

Since the first dual piloted aircraft flew in 1911, aircrew have been attempting to communicate with one another in the cockpit. As aircraft have become more sophisticated the demands placed on crew members have increased dramatically. Aircrews have become more than manipulators of the controls, they now must consider all factors which may effect a flight from A to B. Often these factors will occur even before the aircraft leaves the ground. However, as the sophistication of aircraft has increased, little attention has been devoted toward the human factor in aviation (Dolgin & Gibb, 1989; Tsang & Vidulich, 1989). Statistics show that flight crews are responsible for approximately 80% of the accidents that occur (Parnell, 1985). The boom in technology and the resulting "changing role of fight crew as managers and decision makers rather than continuous manipulators of the controls" (Jensen, 1989, p. vii), have brought about a new term in aviation, Cockpit Resource Management (CRM). CRM attempts to explain and address the need and importance of "the communication process in the cockpit, and an analysis of the flight crew as a system, rather than as isolated individuals" (Woelfel & Stover, 1985, p. 387). With such a large percentage of aircraft accidents resulting from crew error, it is important to ask if CRM skills can be effectively taught to pilots. While a great amount of anecdotal evidence is

available on the effectiveness of CRM training, little empirical data to support these claims has been produced (Childester, Kanki & Helmreich, 1989; Helmreich Foushee & Benson, 1985). This paper will address the effectiveness of the flight training programs within the Naval Air Training Command at instilling CRM skills to newly designated flight personnel.

Problem Statement

Newly commissioned officers are trained within the Naval Air Training Command for a number of different roles and responsibilities associated with naval aviation. The specific training received is dictated by the type of operational aircraft the officer will eventually fly in the fleet. In general, student pilots will be trained to fly rotary-wing, multi-engine maritime patrol, or carrier jet aircraft. Student Naval Flight Officers (NFO) will be trained as weapon/mission specialists and co-pilots in multi-engine maritime patrol, carrier jet, or command and control aircraft.

Student pilots after six months of identical training are split into very specific and different training programs based on the aircraft type they are to fly operationally. Of particular interest are the officers selected for carrier jet training. These students will receive an additional twelve months of training resulting in designation as a Naval Aviator (NA) qualified to operate from the deck of an aircraft carrier. Upon designation as a Naval Aviator they are assigned to a Fleet Replacement Squadron

(FRS), receiving training and qualification in operational aircraft (Eddowes, 1989). Of 768 Naval Aviators designated to fly carrier jet aircraft from 1989 to 1991, 631 were assigned to multi-crewed aircraft (Tedesco, personal communication, Feb. 12, 1992). Unfortunately, newly designated Naval Aviators receive no training in Cockpit Resource Management during flight school (Alkov, 1989; Eddowes, 1989). After eighteen months of the most sophisticated aviation training in the world, approximately 80% of the Navy's newly designated carrier jet aviators were assigned to aircraft which require working as a team with one or more individuals and had received no training in Cockpit Resource Management.

Student NFOs after approximately six months of training in the same aircraft as their counterpart pilots, receive very specific training leading toward designation as weapons/mission specialists and co-pilots. This training is focused toward a variety of operational aircraft, all multi-crewed. Upon designation as Naval Flight Officers they are assigned to a FRS for additional training in multi-crewed operational aircraft. Student NFOs, trained for assignment to carrier jet aircraft, receive formal Cockpit Resource Management training throughout their syllabus of instruction in flight school (Tedesco, personal communication, Feb. 12, 1992).

Once assigned to the FRS, newly designated NFOs and Naval Aviators are trained together in operational aircraft designed to be operated by flight crew working as a team. It is suspected that

newly designated NFOs' and newly designated Naval Aviators' attitude toward CRM will differ, as measured by the Cockpit Management Attitudes Questionnaire (CMAQ).

Importance of Study

Cockpit Resource Management stresses the importance of team performance and communication in the cockpit (Hackman, 1987; Frankel, 1985). If by insuring aircrew are trained in the human factors of aviation, a reduction in accidents may result, saving lives and expensive aircraft (Halliday & Biegalski, 1987). Measuring the attitude toward CRM is the starting point for the design, conduct, and evaluation of such training. This study will estimate the degree of existing crew coordination within the selected sample and can be used to assess the influence of Cockpit Resource Management training programs within the U. S. Navy's A-6 community Fleet Replacement Squadrons.

More specifically, if a NFO's or Naval Aviator's attitude toward CRM is known subsequent to his or her assignment to a FRS, all parties involved can anticipate potential strengths and weaknesses encountered during training in multi-crew aircraft. In particular, for the newly designated NFO or Naval Aviator it will provide a starting point for formal CRM training in an operational setting. Prior to any flights in the FRS the newly designated officer will know his present view toward CRM and be better able to adjust and learn the skills required to work as a team within the cockpit environment (Hackman, 1987; Sams, 1989). For the

designers of the FRS training syllabus, knowing the attitude of the learners will provide a data base for evaluation of the course of instruction. By comparing pre and post training attitudes a method is provided to determine the effectiveness of the training syllabus as it applies to CRM (Helmreich & Foushee, 1985). Additionally, instructors in the FRS will be able to identify officers who may possibly have difficulty adjusting to multi-crew operations and provide additional instruction and monitor their progress throughout the training.

Assumptions and Limitations of the Study

The carrier jet community, consisting of the A-6 series aircraft, is extremely crew oriented. Of the 43 Class A mishaps within the A-6 community during 1985 to 1990, approximately 47% were the result of crew error. With such a large percentage of mishaps resulting from human error, it is important to ensure all newly trained A-6 aircrew receive training in CRM.

The population of this study is all newly designated NFOs and Naval Aviators assigned to the west coast A-6 Fleet Replacement Squadrons, VA-128 and VAQ-129, located at Naval Air Station Whidbey Island, Washington.

Officers selected for naval aviation training are extremely well educated and motivated toward their profession (Eddowes, 1989). Newly designated NFOs and Naval Aviators assigned to a FRS are at the peak of the learning cycle (Eddowes, 1989). Having recently

completed a 12-24 month training program with an attrition rate of approximately 19%, the designated officers are well trained and excited to begin training in operational aircraft (Gleisner, personal communication, Feb. 12, 1992). With such an extremely motivated and well trained population it is assumed that the selected sample will answer the attitude questionnaire truthfully and honestly. In addition, this population, having no previous experience with the A-6 community or exposure to any CRM training specific to operational aircraft, are assumed to be non-biased in attitude toward CRM in an operational setting. Since the subjects, all newly designated NFOs and Naval Aviators, are being evaluated after receiving their undergraduate flight training, no non-trained control group is available. Increasing acceptance of CRM training within Naval Aviation may in general increase positive attitudes toward CRM training and philosophy exclusive of any training (Alkov, 1989). Past research also shows that variability in results between groups receiving the same CRM training has been documented (Helmreich & Wilhelm, 1989). The suspected reason for this difference between groups has not yet been defined.

Definition of Terms

Cockpit Resource Management (CRM): The effective use and coordination of all skills and resources- hardware, software, liveware- available to the flight crew to achieve safe, efficient flight operations (Laber, 1987; Schwartz, 1989).

Pilot Judgment Training (PJT): Ground and in-flight training designed to teach individual judgment and decision making to pilots.

Line Oriented Flight Training (LOFT): Integration of classroom and simulator training used to teach decision making to crew members in multi-crew aircraft (Telfer, 1989).

Cockpit Management Attitude Questionnaire (CMAQ): Provides the means to assess individual attitudes related to Cockpit Resource Management (Helmreich, 1984; Gregorich, Wilhelm & Helmreich, 1988).

Naval Aviator (NA): Commissioned naval officer trained as a pilot. Receives designation as a NA upon completion of undergraduate flight training.

Naval Flight Officer (NFO): Commissioned naval officer trained as a weapons/mission specialist and co-pilot.
Receives designation as a NFO upon completion of undergraduate flight training.

Naval Air Training Command: The headquarters command responsible for the training of student Naval Flight Officers and student Naval Aviators.

Class A Mishap: A naval aviation mishap in which there is a loss of human life or more than $1 million in damage.

Operational Aircraft: Aircraft used for combat operations in support of naval forces.

Fleet Replacement Squadron (FRS): After a student Naval Flight Officer or student Naval Aviator completes undergraduate flight training he/she is assigned to a FRS for further training in operational aircraft to prepare for duty in the fleet.

A-6 Community: Naval aviation commands which fly either the A-6E or EA-6B aircraft.

A-6E Intruder: A low-level attack bomber which can deliver various ordnance in all types of weather. This operational aircraft is equipped with multi-mode radar and target-recognition computers. Seats one pilot (NA) and one bombardier/navigator (NFO).

EA-6B Prowler: Tactical electronic countermeasures, all-weather, attack aircraft. This operational aircraft seats one pilot (NA), one navigator (NFO), and two electronic combat officers (NFOs).

VA-(Attack Squadron): Aircrew assigned to this organization are trained to conduct combat operations in support of naval forces flying the A-6E aircraft.

VAQ-(Tactical Electronic Countermeasures Squadron): Aircrew assigned to this organization are trained to conduct combat operations in support of naval forces flying the EA-6B aircraft.

CHAPTER TWO

Literature Review

Beaty's (1969) early research on the human factors in aircraft accidents provides the ground work for an analysis of CRM. He suggests that flight crews should work together at all times as an integral unit "so they would know their abilities and personal quirks well, and would have worked out a method of operating as a team" (p. 43). Beaty feels each crew member need set roles and well defined responsibilities. An accident, cited by Beaty, where an aircraft was 10,000 feet off altitude due to "a lack of co-operation between the captain and the first officer" (p. 66) is typical of mishaps resulting from ineffective CRM. A review of selected literature (Buch & de Bagheera, 1985; Komich, 1985; Parnell, 1985), shows that while a large amount of training is devoted to physically flying the aircraft, little effort is made trying to teach decision making to flight crews.

Research (Telfer, 1989; Arnold & Jackson, 1985; Lester, Diehl & Buch, 1985) has identified a number of training areas which depend "more upon cognitive and affective learning than upon psychomotor skills" (Telfer, 1989, p. 168). Three specific areas of interest are; Pilot Judgment Training (PJT), Line Oriented Flight Training (LOFT), and CRM training. It is Telfer's (1989) opinion that CRM training has "brought an interactive and co-operative dimension on the individual's ability to utilize all available resources in the

cockpit" (p.168). While CRM training may have brought a new dimension to fight training, there needs to be a link between all areas in order to reduce judgment errors by flight crews (Telfer, 1989; Arnold et al., 1985). More specifically, the link should have PJT as the corner stone if human factors in aircraft accidents are to be reduced (Telfer, 1989).

Beaty (1969) indicates that "the biggest safety device in an aircraft is an individual's judgment" (p. 150) and suggests that judgment training be introduced to new pilots. Komich (1985) and Buch et al.(1985) feel that flight training presently places too much emphasis on the how (technical), as opposed to why pilots perform certain functions. The research (Buch et al., 1985; Parnell, 1985; Lester et al., 1985) shows that instructors can teach judgment in addition to teaching how to move aircraft controls. Lester et al. (1985) demonstrated that judgment errors can be reduced by introducing PJT into existing flight training programs. In particular, in limited observations, it was found integrating PJT into ground and in flight training was effective in actually improving pilot judgment (Lester et al., 1985). In addition, it was shown PJT only added about two hours to the total ground and flight time required for students to complete the private pilot course (Lester et al., 1985). The evidence suggests that judgment can be taught to pilots, but integration of PJT into existing training programs has been limited (Lester et al., 1985; Dolgin & Gibb, 1989; Telfer, 1985). Additionally, the instruction has been primarily focused on single-pilot operations (Telfer, 1989). It is, however, "recognized that human factors increase

considerably when more than one pilot is in the cockpit" (Telfer, 1989, p.171).

The limited amount of integration of judgment training into pilot training programs has resulted in airlines relying on LOFT to teach decision making skills to flight crews (Arnold et al., 1985). Telfer (1989) describes LOFT as the integration of classroom training with simulator training. LOFT training is a method of instruction where flight crews are "given realistic and critical decisions to make in an operational (but simulated) situation" (Telfer ,1989, p.168). LOFT can best be viewed as the introduction of judgment training at a latter stage in a pilot's development (Arnold et al., 1985). LOFT is the application of PJT toward multi-piloted aircraft. Arnold et al. (1985) describes LOFT as an integral part of a training program which can be used to teach CRM. The work of Stark (1989) suggests the use of simulators to train personnel in certain activities. In particular, the advantage of a simulator is "its ability to represent elements of a mission task which are important to the operator to be trained and, second, its ability to control the conditions of training to facilitate, enhance, and ensure learning" (Stark, 1989, p. 110). This view of simulators as teaching critical skills is demonstrated in the studies of Arnold et al. (1985) and Frankel (1985). In this research flight crews' performances are taped then reviewed and critiqued by all parties involved to better understand one another's role in the cockpit. However, in most instances LOFT is the first exposure to any form of judgment training for the majority of pilots and considerable

time is spent teaching the basic human factors to individuals currently assigned to multi-crew aircraft (Arnold et al., 1985; Babcock & Istock, 1985).

Since it appears that the skills necessary for effective CRM can be taught through PJT and LOFT (Lester et al.,1985), when is it best to introduce new pilots to the concept of CRM? Telfer (1989) feels that if the aspects of PJT, LOFT, and CRM are "perceived as facets of a larger entity, rather than separate foci for instruction, the process can be started earlier with greater success" (p. 168). Lester et al. (1985) has shown that judgment can be taught at the primary level of training and be effective in reducing the human factor in aircraft accidents. Kramer (1985) suggests that judgment training be introduced at the entry level and be regulated by the FAA. Strauch (1985) feels "the effectiveness of CRM may depend on when the pilot is trained in CRM as much as the type of training program received" (p. 440). Sams (1989) feels since CRM skills are difficult and expensive to develop in latter stages of training, aircrew should receive comprehensive training in management, decision making, communications and interpersonal skills throughout all stages of instruction.

The integration of CRM training into military operations has been successful and has shown to reduce mishap rates (Alkov, 1989; Cavanagh & Williams, 1987; Hallidy & Biegalski, 1987). More specifically, within the United States Navy, it was found that once initial resistance toward CRM training was overcome the

training was enthusiastically endorsed (Alkov, 1989). Presently within the Navy the majority of CRM training is focused toward designated aircrew (Alkov, 1989). Additional research, however, suggests that there is a need for initial training for student as well as designated military aircrew (Hatch & Nelson, 1987; Alkov, 1989). In particular, existing CRM training needs to be formalized and become an integral part of military flight training (Hatch et al., 1987).

In recent years CRM has grown "from its infancy to one of the most impressive training programs, both, in the airline industry and in military aviation, resulting in greatly changed attitudes concerning the importance of team performance and communication behavior in the cockpit" (Jensen, pg. iv, 1989). Unfortunately, while the explosion of CRM training programs is impressive, there is very little empirical evidence available to support the claims of it's effectiveness (Childester, Kanki, & Helmreich, 1987; Dolgin et al., 1989; Helmreich & Wilhelm, 1989).

Research suggests that crew effectiveness in multi-crew aircraft is largely determined by the technical skills, attitudes, and personality of crew members (Gregorich et al., 1989; Helmreich, 1984). Flight training programs, however, have historically used technical skills as a measure of aircrew effectiveness with little emphasis being placed on the importance of personality and attitude (Childester & Foushee, 1989; Gregorich et al., 1989). Research has shown that personality and attitude have a significant influence on the effectiveness of aircrew working as a

team (Gregorich et al., 1989; Helmreich, Foushee & Benson, 1985; Helmreich, 1984). Helmreich (1987) suggests concentration on attitude as opposed to personality, because attitudes are more easily changed. In addition, an instrument is available to measure the attitude of aircrew toward CRM.

The Cockpit Management Attitude Questionnaire (CMAQ) contains twenty-five questions describing attitudes derived from NASA research on crew coordination (Helmreich et al., 1985; Helmreich, 1984). The CMAQ utilizes three concepts as standard measures of CRM effectiveness. The first concept, Communication and Coordination, deals with views toward interpersonal awareness, communication, and crew coordination among crew members (Gregorich et al., 1989). The second, Command Responsibility, deals with the aircraft commander's role and responsibility and whether other crew members should question his decisions and authority (Helmreich et al., 1989). The final concept, Recognition of Stressor Effects, deals with an individual's attitude toward "his/her reactions and capabilities under conditions of high stress" (Helmreich et al, pg. 692, 1989). A positive correlation between actual observed intercrew performance and the attitudes measured by the CMAQ have been validated (Geis, 1987; Helmreich et al, 1989 & 1985). It is through use of the CMAQ that a means is available to empirically evaluate the effectiveness of CRM training programs.

CHAPTER THREE

Methodology

Subjects

A homogeneous group consisting of 13 newly designated NFOs and 8 newly designated Naval Aviators assigned to VA-128 and VAQ-129 were surveyed. All of the surveyed aircrew were in the first three weeks of their respective training program within the FRS and had completed no LOFT or CRM training sessions taught by the FRS. The subjects were all Navy Lieutenants, Lieutenants Junior Grade, Ensigns, or Marine First Lieutenants between 24-31 years old. The Naval Aviators averaged 615 total flight hours and the NFOs 157 total flight hours. None had any flight experience in operational jet aircraft.

Procedures

The questionnaire (see Appendix A) was forwarded to the participating squadrons and administered to the subject aircrew in a classroom setting. The completed questionnaires were collected and returned. The NFOs response on each item of the questionnaire was compared with the Naval Aviators response on corresponding items using an analysis of variance.

Instrument

The Cockpit Management Attitude Questionnaire (CMAQ) was modified slightly (see Appendix A) to be more applicable to the A-6 community. It consisted of the twenty five items from the CMAQ and five items concerning issues specific to the unique mission of the A-6E and EA-6B aircraft. Included were ten background items which identified demographic information. A seven point Likert scale was employed, ranging from completely agree to completely disagree.

CHAPTER FOUR

Reporting of Data

Demographic Data

Tables 1-2 and Graphs 1-4 presented below summarize the demographic data associated with the surveyed aircrew.

Table 1

Flight Hour Summary

Group	n	Mean	S.D.
NFO	12	156.76	83.74
Pilot	8	615.00	804.38
Pilot*	7	331.42	65.93

* Excluding NFO to Pilot transition

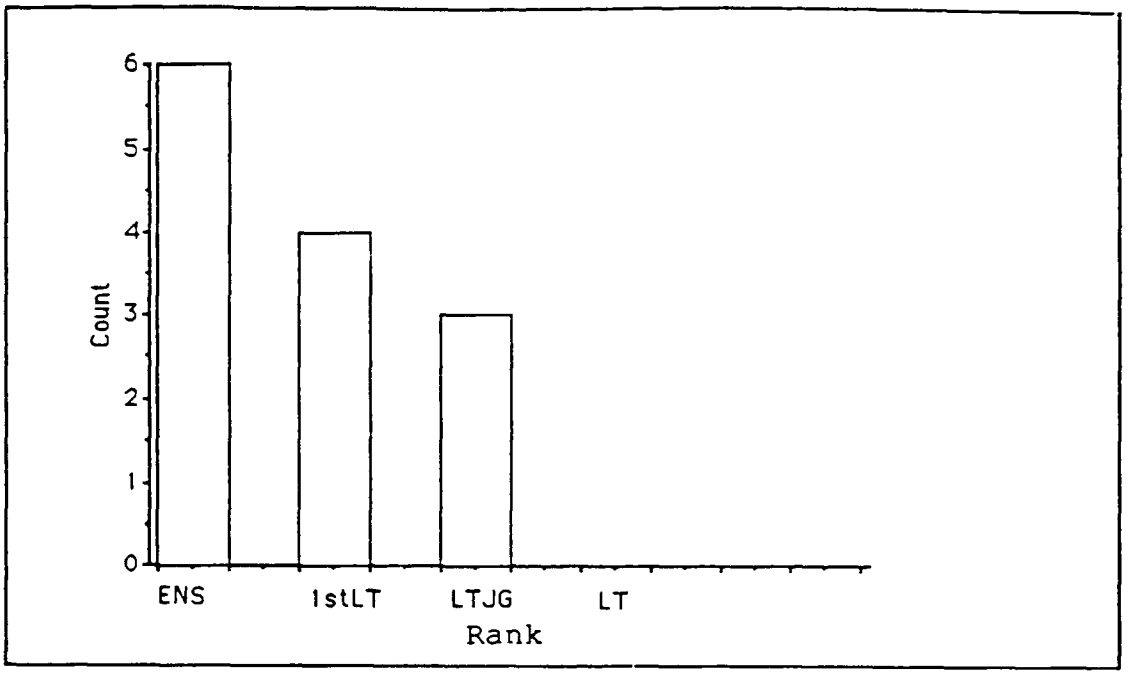
Table 2

Age Comparison

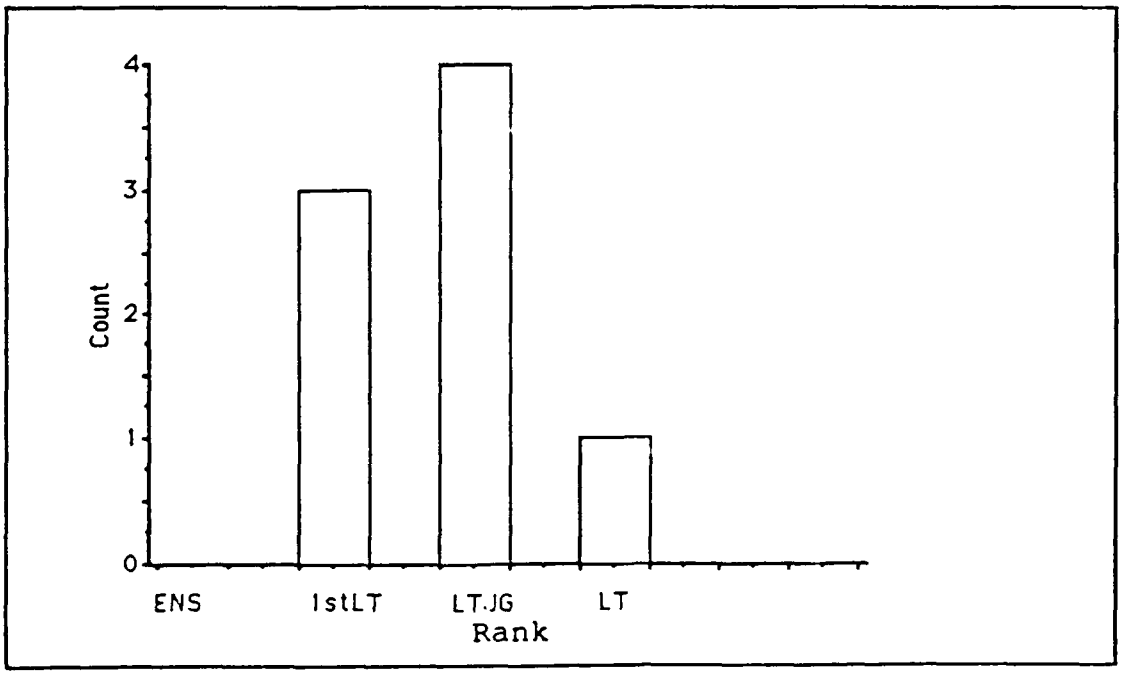
Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig.
NFO	13	25.54	1.33	18.42	0.0004	Yes
Pilot	8	28.375	1.69			

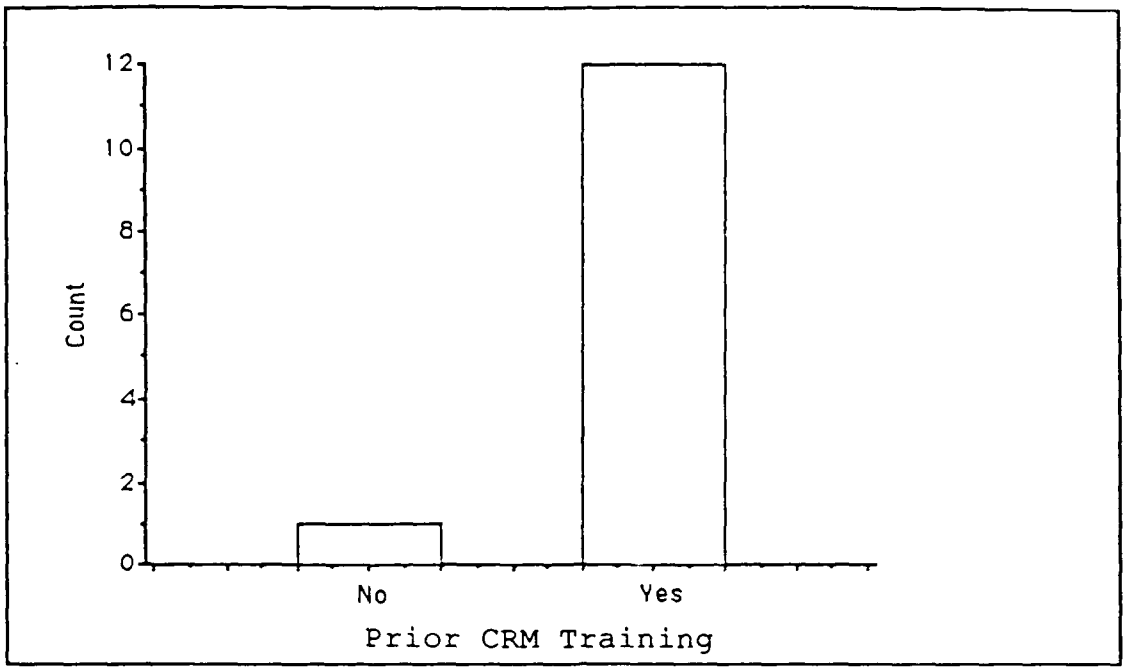
Indicates that pilots are older than NFOs for the selected sample at the 0.05 significance level.



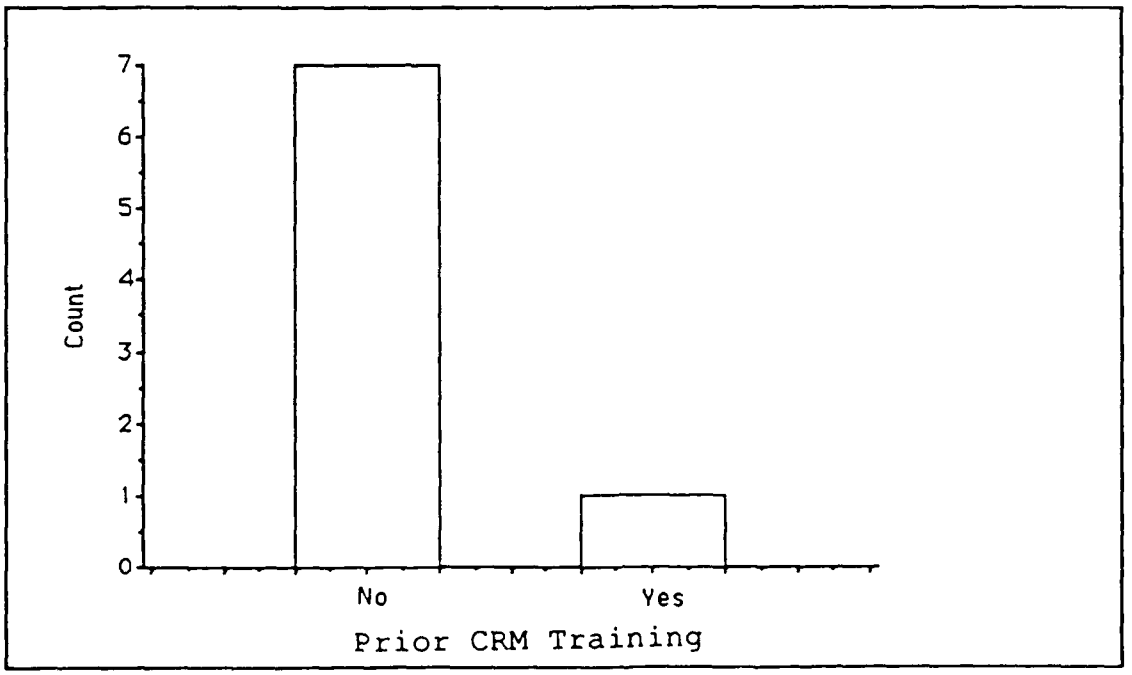
Graph 1: Rank of selected sample of NFOs.



Graph 2: Rank of selected sample of Naval Aviators.



Grapn 3: Selected sample of NFOs with prior CRM training.



Graph 4: Selected sample of Naval Aviators with prior CRM training.

Survey Data

Tables 3-32 presented below represent the statistical findings associated with the corresponding research question on the Cockpit Management Attitude Questionnaire (see Appendix A).

Table 3

Survey Question 1

Strict utilization of the chain of command is essential for effective crew performance.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	12	3.83	2.37	0.08	0.7858	No
Pilot	8	4.13	2.23			

Table 4

Survey Question 2

Aircrew members should feel obligated to mention their own psychological stress or physical problems to other aircrew members before or during a mission.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	6.15	0.80	3.49	0.0774	Marg.*
Pilot	8	5.13	1.73			

*Denotes significantly different at the 0.10 level.

NFO responses indicate that NFOs feel more obligated to mention own psychological stress or physical problems to other aircrew members before or during a mission than do Pilots.

Table 5

Survey Question 3

It is important for all crew members to provide constructive criticism about procedures and techniques of others.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	5.85	1.07	2.95	0.1000	Marg.*
Pilot	8	5.13	0.64			

*Denotes significantly different at the 0.10 level.

NFO responses indicate that NFOs feel more strongly than do Pilots that it is important for all crew members to provide constructive criticism about procedures and techniques of others.

Table 6

Survey Question 4

I am more prone to make minor mistakes during periods of high workload than I am in routine mission situations.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	4.23	1.54	0.25	0.6219	No
Pilot	8	4.63	2.06			

Table 7

Survey Question 5

The Pilot in Command is primarily responsible for the safety of each mission.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	4.39	2.18	3.66	0.0711	Marg.*
Pilot	8	6.13	1.73			

*Denotes significantly different at the 0.10 level.

Pilot's responses indicate that Pilots feel more strongly than do NFOs that the Pilot in Command is primarily responsible for the safety of each mission.

Table 8

Survey Question 6

Each crew member should monitor other crew members for signs of stress or fatigue, and should discuss the situation with the crew member.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	6.00	0.71	2.32	0.1446	No
Pilot	8	5.34	1.19			

Table 9

Survey Question 7

Good communications and crew coordination are as important as technical proficiency for the safety of flight.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	6.69	0.48	0.07	0.7894	No
Pilot	8	6.75	0.46			

Table 10

Survey Question 8

Aircrew members should be aware of and sensitive to the personal problems of the other crew members.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	5.00	1.08	0.04	0.8395	No
Pilot	8	4.86	1.73			

Table 11

Survey Question 9

The pilot should verbalize plans for procedures or maneuvers and should be sure that the information is understood and acknowledged by crew members affected.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	6.39	0.65	0.82	0.3779	No
Pilot	8	6.00	1.31			

Table 12

Survey Question 10

Other crew members should not question the decision or actions of the Pilot in Command except when these actions threaten the safety of the flight.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	2.54	1.61	3.11	0.0941	Marg.*
Pilot	8	3.87	1.81			

*Denotes significantly different at the 0.10 level.

Pilot's responses indicate that Pilots feel more strongly than NFOs that other crew members should not question the decision or actions of the Pilot in Command except when these actions threaten the safety of the flight.

Table 13

Survey Question 11

Crew members should alert others to their actual or potential work overloads.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	5.77	0.93	0.78	0.3869	No
Pilot	8	6.13	0.84			

Table 14

Survey Question 12

Even when fatigued, I perform effectively during critical flight maneuvers.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	4.31	1.65	0.23	0.6348	No
Pilot	8	4.63	1.06			

Table 15

Survey Question 13

Pilots in Command should encourage other crew members to question procedures during normal operations and in emergencies.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	5.92	1.26	6.39	0.0205	Yes
Pilot	8	4.62	0.92			

NFO responses indicate that NFOs more completely agree than do pilots that Pilots in Command should encourage other crew members to question procedures during normal operations and in emergencies.

Table 16

Survey Question 14

A debriefing and critique of procedures and decisions after each mission is an important part of developing and maintaining effective crew coordination.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	6.69	0.48	0.06	0.8028	No
Pilot	8	6.63	0.74			

Table 17

Survey Question 15

My performance is not adversely affected by working with an inexperienced or less capable crew member.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	4.69	1.38	5.37	0.0325	Yes
Pilot	7	3.28	1.11			

NFO responses indicate that NFOs somewhat agree that their performance is not adversely affected by working with an inexperienced or less capable crew member than do Pilots.

Table 18

Survey Question 16

Overall, successful mission accomplishment is primarily a function of the aircraft commander's flying proficiency.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	2.01	1.23	2.73	0.1146	No
Pilot	8	3.13	1.64			

Table 19

Survey Question 17

Correcting the procedures and techniques of others should be avoided since it can lead to tensions between crew members.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	2.93	1.66	0.22	0.6469	No
Pilot	8	3.25	1.34			

Table 20

Survey Question 18

Crew members should voice their concerns even if they are contrary to decisions which have already been made.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	5.31	1.44	0.94	0.3444	No
Pilot	8	4.63	1.77			

Table 21

Survey Question 19

The pre-mission aircrew briefing is important for safety and effective crew management.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	6.92	0.28	1.16	0.2943	No
Pilot	8	6.75	0.46			

Table 22

Survey Question 20

Effective crew coordination requires crew members to take into account the personalities of the other crew members.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	5.92	1.03	0.22	0.6477	No
Pilot	8	6.13	0.84			

Table 23

Survey Question 21

All crew members should share responsibility for prioritizing activities in high workload situations.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	6.45	0.66	0.48	0.4958	No
Pilot	8	6.25	0.71			

Table 24

Survey Question 22

A truly professional aircrew member can leave personal problems behind when flying a mission.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	5.16	1.57	0.11	0.7430	No
Pilot	8	5.37	1.30			

Table 25

Survey Question 23

My decision making ability is as good in emergencies as in routine mission situations.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	4.62	1.61	4.62	0.0448	Yes
Pilot	8	6.00	1.30			

Pilot's responses indicate that Pilots more completely agree than do NFOs that their decision making ability is as good in emergencies as in routine mission situations.

Table 26

Survey Question 24

Training seldom interferes with safe and effective mission accomplishment.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	5.23	1.42	0.00	0.9755	No
Pilot	8	5.25	1.28			

Table 27

Survey Question 25

Leadership of the aircrew team is expected to come solely from the Pilot in Command.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	1.46	0.66	8.50	0.0089	Yes
Pilot	8	2.86	1.55			

NFO responses indicate that NFOs more completely disagree than do Pilots that leadership of the aircrew team is expected to come solely from the Pilot in Command.

Table 28

Survey Question 26

NFO's questions and suggestions should be considered by the pilot.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	6.62	0.65	0.42	0.5248	No
Pilot	8	6.38	1.06			

Table 29

Survey Question 27

When flying with a Mission Commander or Pilot in Command for the first time, a crew member should not offer suggestions of opinions unless asked.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	2.15	1.41	0.00	0.9625	No
Pilot	8	2.13	1.25			

Table 30

Survey Question 28

It is better to let someone do their job the way they are used to rather than offering what you believe to be a better solution.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	2.15	1.41	3.55	0.0751	Marg.*
Pilot	8	3.38	1.51			

*Denotes significantly different at the 0.10 level.

NFO responses indicate that NFOs more completely disagree than do pilots that it is better to let someone do their job the way they are used to rather than offering what you believe to be a better solution.

Table 31

Survey Question 29

Because NFOs have no pilot training, they should limit their attention to the rest of the mission and aircraft systems.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	1.46	0.66	1.59	0.2231	No
Pilot	8	2.13	1.73			

Table 32

Survey Question 30

Pilots in Command who accept and implement suggestions from the crew are lessening their stature and reducing their authority.

Significance level set at .05 -- Analysis of Variance

Group	n	Mean	S.D.	F-Value	Prob.	Sig
NFO	13	1.08	0.28	2.99	0.1000	Marg.*
Pilot	8	1.34	0.52			

*Denotes significantly different at the 0.10 level.

NFO responses indicate that NFOs more completely disagree than do pilots that Pilots in Command who accept and implement suggestions from the crew are lessening their stature and reducing their authority.

CHAPTER FIVE

Conclusion and Recommendations

Discussion and Recommendations

Within the surveyed sample of NFOs, all subjects were of the rank of Lieutenant Junior Grade, First Lieutenant, or Ensign (see Graph 1). All but one NFO had received CRM training during undergraduate flight training (see Graph 3). The flight experience range was from 80 to 350 total flight hours (see Table 1).

The selected sample of Naval Aviators were of the rank of Lieutenant Junior Grade or First Lieutenant with a flight experience range between 250 and 440 total hours (see Table 1 & Graph 2). One surveyed newly designated aviator, a Navy Lieutenant, is a NFO to pilot transition with 2,600 total flight hours. Approximately 2,000 of his flight hours were as a NFO in Multi-engine Maritime Patrol aircraft. The transition aviator was the only surveyed Naval Aviator to have any CRM Training (see Graph 4). The effect on the results of his inclusion in the selected sample is not known at this time.

Between groups, the pilots were significantly older by approximately 3 years in comparison to the NFOs (see Table 2). The pilot training program is approximately 1 to 1-1/2 years longer than that of NFOs and may account for the age difference.

Review of the survey data indicates that ten of the thirty questions were significantly or marginally significantly different (see Tables 4, 5, 7, 12, 15, 17, 25, 27, 39, & 32). These differences suggest that there is a difference in attitude toward CRM between the surveyed NFOs and Naval Aviators.

Survey questions 23 and 2 address the concept of Recognition of Stressor Effects and deal with an individual's capabilities under conditions of high stress.

Question 23 is significant at the 0.05 level (see Table 25) and indicates that pilots more completely agree than do NFOs that their decision making ability is as good in emergencies as in routine mission situations. Throughout flight training, student Naval Aviators receive a significant amount of LOFT type training dedicated to handling emergency situations. NFOs, during flight school, receive limited training and exposure to the thought process and actions required during emergencies. The data suggests that due to this limited exposure to LOFT type emergency procedure training, NFO's decision making ability may not be as good in emergencies as in routine mission situations.

Handling emergency situations in a multi-crew environment is taught in-depth at the FRS. However, integration of LOFT sessions dealing with emergency situations could be added to the NFO undergraduate training. This training could assist in preparing NFOs for the emergency procedure training received within the FRS. Additional study of students at the completion

of the FRS training is warranted in this area to investigate the effectiveness of the LOFT training provided by the FRS.

Survey question 2 was marginally significant (see Table 4), with NFO's responses higher than those of pilots. Having received CRM training, NFOs are aware of the importance of understanding the psychological effects on performance and safety. This training may make NFOs more likely to share their feelings in order to improve crew effectiveness. The data suggests that aviators, having received no CRM training may be reluctant to discuss their capabilities under conditions of high stress. Additional research has shown that through CRM training pilots' attitudes have shifted to agree with the statement in Question 2 (Alvkov, 1989).

Questions 3, 15, and 28 deal with the concept of Communication and Coordination. These questions deal with views toward interpersonal awareness, communication, and crew coordination among crew members (Gregorich et al. , 1989).

Questions 3 and 28 are marginally significant (see Tables 5 & 30) and suggest that NFOs more completely agree with a critical evaluation of others performances. Having received CRM training during undergraduate flight training, NFOs are aware of the importance of evaluating other crew members performance in order to improve the overall effectiveness of the aircrew team. The data suggests, that pilots having little exposure to flying with another crew member and no previous CRM training are less likely

to evaluate the performance of others. Examination of the data shows both groups' responses are at the high end of the scale, suggesting that some form of peer evaluation is acceptable to the sample as a whole. This area warrants further investigation comparing newly designated aviators' attitudes concerning Communications and Coordination to that of more experienced aviators.

Question 15 is significant at the 0.05 level (see Table 17) and suggests a difference in performance while flying with crew members of lesser experience. NFOs throughout flight training are taught to be an integral member of the crew and fly with instructor pilots of varying experience levels. Pilots, however, have limited exposure to instructors of lesser experience and fly a large number of solo missions. This lack of exposure of flying with another individual as a peer and level of instructor pilot experience may, contribute to the difference in responses. This area needs to be studied further by possible comparison of student jet pilots to student maritime patrol pilots, who learn to act as a team with peers during undergraduate flight training.

Of the ten survey questions which are significantly or marginally significantly different five questions; 5, 10, 13, 25, and 30, address the concept of Command Responsibility.

Command Responsibility deals with the aircraft commander's role and responsibility, and whether other crew members should

question his decisions and authority (Helmreich, et al. , 1984). CRM stresses the importance of crew members working as a team in order to effectively accomplish the overall mission. The data for the five questions (see Tables 7, 12, 15, 27, & 32) suggest a difference in attitude between NFOs and Naval Aviators concerning the aircraft commanders role. The responses on these five questions suggest that NFOs more completely agree that command responsibility is shared in the cockpit and that the decisions of the Pilot in Command can be questioned if required.

Currently by not being trained in CRM, many newly designated Naval Aviators may arrive at the FRS with a "Single-Seat" mentality. This attitude could require additional CRM training to change possible habit patterns which may prevent easy transition to a multi-crew environment. In today's sophisticated tactical jet aircraft it is imperative that newly designated Naval Aviators receive training in this vital area. It is not necessary to change the current undergraduate syllabus, but rather to modify it to address the concept of Command Responsibility as it applies to CRM. It should stress that all crew members, regardless of designator, are a vital resource in the cockpit and an integral member of the aircrew team. By integrating the input of all resources, electronic or human, into the decision making process, crew effectiveness and safety could increase. While, during undergraduate training, student Naval Aviators may not fly with another crew member in the capacity of a peer, he or she must be aware of the fact that in future assignments they may be flying in a multi-crew aircraft

requiring shared responsibilities and decision making. The concept of Command Responsibility requires additional research to investigate the attitudes of Naval Aviators in comparison to NFOs upon completion of the FRS.

Overall, evaluation of the data should be viewed with some caution based on the small sample size. It is recommended that all newly designated NFOs and Naval Aviators assigned to the FRS be administered the CMAQ in order to develop a larger data base, increasing confidence and reliability of results. Additionally, a longitudinal study of the survey sample should be completed to compare survey responses at the completion of the FRS syllabus.

Conclusion

Today's sophisticated multi-crew aircraft have changed the role of pilots from manipulators of controls to managers of systems and decision makers (Jensen, 1989). Statistics show that a large percentage of aircraft accidents are the result of poor crew coordination and poor judgment. (Parnell, 1985: Tsang,et al., 1989). Since the changing role of flight crews and a large percentage of accidents are both associated with crew coordination, it would follow that Naval Aviators should be trained in this area. The survey results suggest that there is a difference, particularly in the area of Command Responsibility, between how newly designated Naval Aviators and NFOs view Cockpit Resource Management. Unfortunately, within the United States Navy, future carrier Naval Aviators receive no CRM training during undergraduate flight training. Since it has been

shown that PJT can be integrated into entry level training (Lester et al., 19[illegible], it could be used as a foundation for further CRM training in multi-crew aircraft. If all student Naval Aviators were introduced to PJT during undergraduate training, latter CRM training in their careers, perhaps, could be more effective. By starting with PJT and progressing to LOFT and CRM training, all newly designated aviators would have exposure to the human factor side of aviation. Additional studies comparing pilots exposed to PJT early in their training to pilots not exposed to such training need to be conducted. This research could be used to evaluated the different groups' retention of and proficiency in CRM skills.

In summary, there is a need to integrate the human elements of aviation into the early training of Naval Aviators. This integration will require a change in the current process of instruction within the Naval Air Training Command, placing more emphasis on the cognitive aspects of aviation. Regardless of the process and conduct of the training it is imperative it be introduced if accident rates can be reduced.

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Appendix A

Social Security # _____ Date _____

A-6/EA-6 AIRCREW SURVEY

I. Aircrew Attitudes

We are collecting data on current attitudes in military operations. This survey measures your thoughts and feelings; it is not an assessment of your learning. All data will remain strictly confidential! The identification number allows us to relate your future surveys to this one.

Please answer by writing beside each item the number from the scale below that best reflects your personal attitude. Note: when we use the words "crew" or "crew members" , we mean everyone in the aircraft unless otherwise noted.

******Scale******

1	2	3	4	5	6	7
Disagree Completely	Mostly	Somewhat	Neutral	Somewhat	Mostly	Agree Completely

1. _____ Strict utilization of the chain of command is essential for effective crew performance.

2. _____ Aircrew members should feel obligated to mention their own psychological stress or physical problems to other aircrew members before or during a mission.

3. _____ It is important for all crew members to provide constructive criticism about procedures and techniques of others.

4. _____ I am more prone to make minor mistakes during periods of high workload than I am in routine mission situations.

5. _____ The Pilot in Command is primarily responsible for the safety of each mission.

6. _____ Each crew member should monitor other crew members for signs of stress or fatigue, and should discuss the situation with the crew member.

Please go on to the next page

******Scale******

1 2 3 4 5 6 7

Disagree Completely — Mostly — Somewhat — Neutral — Somewhat — Mostly — Agree Completely

7. _____ Good communications and crew coordination are as important as technical proficiency for the safety of flight.

8. _____ Aircrew members should be aware of and sensitive to the personal problems of the other crew members.

9. _____ The pilot should verbalize plans for procedures or maneuvers and should be sure that the information is understood and acknowledged by crew members affected.

10. _____ Other crew members should not question the decisions or actions of the Pilot in Command except when these actions threaten the safety of the flight.

11. _____ Crew members should alert others to their actual or potential work overloads.

12. _____ Even when fatigued, I perform effectively during critical flight maneuvers.

13. _____ Pilots in Command should encourage other crew members to question procedures during normal operations and in emergencies.

14. _____ A debriefing and critique of procedures and decisions after each mission is an important part of developing and maintaining effective crew coordination.

15. _____ My performance is not adversely affected by working with an inexperienced or less capable crew member.

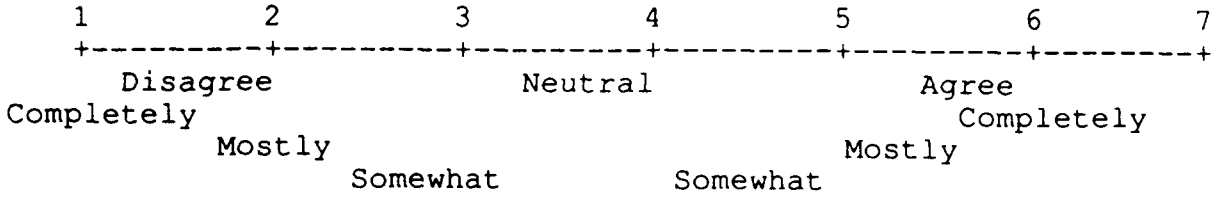
16. _____ Overall, successful mission accomplishment is primarily a function of the aircraft commander's flying proficiency.

17. _____ Correcting the procedures and techniques of others should be avoided since it can lead to tensions between crew members.

18. _____ Crew members should voice their concerns even if they are contrary to decisions which have already been made.

Please go on to the next page

******Scale******



19. _____ The pre-mission aircrew briefing is important for safety and effective crew management.

20. _____ Effective crew coordination requires crew members to take into account the personalities of the other crew members.

21. _____ All crew members should share responsibility for prioritizing activities in high workload situations.

22. _____ A truly professional aircrew member can leave personal problems behind when flying a mission.

23. _____ My decision making ability is as good in emergencies as in routine mission situations.

24. _____ Training seldom interferes with safe and effective mission accomplishment.

25. _____ Leadership of the aircrew team is expected to come solely from the pilot in command.

26. _____ NFO's questions and suggestions should be considered by the pilot.

27. _____ When flying with a Mission Commander or Pilot in Command for the first time, a crew member should not offer suggestions of opinions unless asked.

28. _____ It is better to let someone do their job the way they are used to rather than offering what you believe to be a better solution.

29. _____ Because NFOs have no pilot training, they should limit their attention to the rest of the mission and aircraft systems.

30. _____ Pilots in Command who accept and implement suggestions from the crew are lessening their stature and reducing their authority.

II. Background Information

Squadron _____

Rank _____

Designator _____

Years of Military Flying _____

Total Military Flight Hours _____

Total Flight Hours (Military and Civilian) _____

Year of Birth _____

III. Crew Coordination Training History

Have you had formal training in aircrew coordination?

_____ Yes _____ No

If yes, where? _____

When? _____

Describe it: _____