

ARI Contractor Report 2002-04

Aircrew Coordination Exportable Training Package Student Guide

United States Army Aviation Center

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United States Army Research Institute for the Behavioral and Social Sciences

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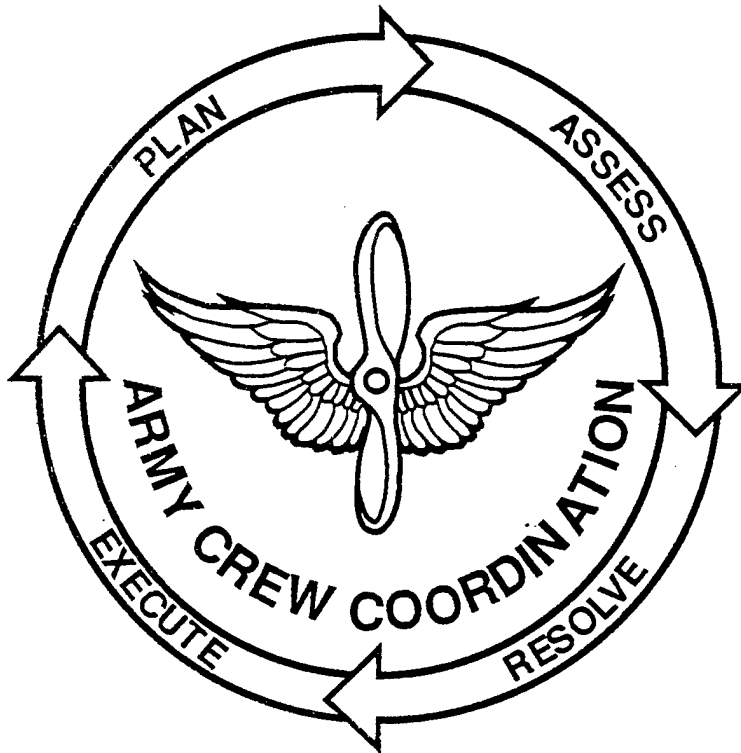
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**United States Army Aviation Center
Fort Rucker, Alabama**



**AIRCREW COORDINATION
EXPORTABLE TRAINING PACKAGE
STUDENT GUIDE**

December 1992

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Introducing the Student Guide

The Aircrew Coordination Course Student Guide includes the Student Handout, associated practical exercises, and supporting appendices. The Student Guide is described in detail below. Following the description of the guide, the procedures for its use are provided.

..... Description of the Student Guide

The Aircrew Coordination Course Student Guide, together with the associated practical exercises and supporting appendices, provides the information necessary for unit aircrews to understand the crew coordination principles presented during classroom instruction and practiced during simulator or flight instruction.

Unit aircrews will use the *Student Guide* 1) to take notes and file completed practical exercises in the Student Handout and 2) to provide a reference source for use during presentation of the Aircrew Coordination Course. The following sections describe the Student Guide and explain how it will be used.

Student Guide

The *Student Guide* consists of an Introduction, the Student Handout, and supporting appendices. The Student Handout provides a valuable source of crew coordination information for use during presentation of the Aircrew Coordination Course. The Student Handout will also be useful as a future reference for subsequent continuation crew coordination training and crew readiness level performance checks. The practical exercises and appendices to the guide contain supporting information necessary for the student to better understand the aircrew coordination principles presented during the classroom instruction. As the repository for much of the background information pertinent to the course, the appendices allow for upgrading to reflect current aircrew coordination information without having to rewrite the entire guide. Each of the Student Guide parts is described below. (Note: In that they cannot be reused and contain notes taken during the Aircrew Coordination Course for future reference, Sections 1 and 2 of the Student Guide are retained by the students upon completion of the course.)

Section 1 - Student Handout: The Student Handout is an outline form of the Aircrew Coordination lesson plan. Sufficient white space is provided for the training aircrews to take notes as unit instructors conduct the course.

Section 2 - Practical Exercises: This section is provided as a place-holder for each of the four practical exercises as they are completed by the students.

Appendix A - Hangar Talk: This appendix is a place holder for unit instructors to store recent FLIGHTFAX or other aviation-related documents covering crew coordination. In this way, current information may be provided to the unit aircrews between updates of the Aircrew Coordination Course.

Appendix B - Crew Coordination Errors: Definitions and Examples: Contains Army aviation accidents organized by the six aircrew coordination errors outlined in TC 1-210 and the ATMs. It provides another source for accident cases and a different point of view for selecting accidents to highlight specific crew coordination principles.

Appendix C - Selected Accidents by ATM Task: Provides Army aviation accidents organized by the ATM task being performed immediately before the onset of the emergency precipitating the accident. As with Appendix B, it provides another point of view from which to discuss violations of specific crew coordination principles.

Appendix D - Aircrew Coordination Case Studies: Contains narratives of Army aviation accidents that the instructor may select for analysis.

Appendix E - Aircrew Coordination Training Evaluation Guide: Contains the evaluation instructions for use in conjunction with the modified Aircrew Coordination Training Grade Slips. The grading and rating systems, rating factors, and behavioral anchors are also explained so that the training aircrews fully understand how they will be evaluated.

Appendix F - Simulator or Flight Mission Materials: Provides a listing of the materials required by the training aircrews for the simulator or flight missions flown during the Aircrew Coordination Course.

Appendix G - Background Reading: Selected readings in crew coordination are provided to add depth to the topics discussed during the Aircrew Coordination Course. Readings are cited in the Student Handout and the Student Read-Ahead 2. Students will be prepared to discuss reading assignments during the first hour of instruction subsequent to their assignment.

..... Use of the Student Guide

1. Section 1 of the Student Handout is to be used for note taking during conduct of the Aircrew Coordination Course.
2. Section 2 of the Student Handout is a place-holder for the four practical exercises completed by the unit aircrews during the Aircrew Coordination Course. The four practical exercises cover stress, premission planning and rehearsal, hazardous thought patterns, and communication.
3. Appendices A through G are provided as reference materials for use throughout the Aircrew Coordination Course. Training aircrews will refer to the appendices as directed by the unit instructor. It is very important that training aircrews be prepared to discuss background readings during the first hour of instruction on the day following their assignment. It is equally important to complete the practical exercises should the instructor assign them as homework.
4. Training aircrews are requested not to make any notes in the *Student Guide* other than in the Student Handout or on the practical exercises, which they will retain upon completion of the course. Because the *Student Guide* must be used for other classes, please handle it with the same care you would expect others to exercise.

1

Student Handout

What you will find in this section:

- ☒ The outline of the Aircrew Coordination Course, on which you will take notes.

Student Handout

CLASSROOM INSTRUCTION

Classroom Instruction: Instruction covering the background, research, and application of crew coordination principles.

..... **Introduction**

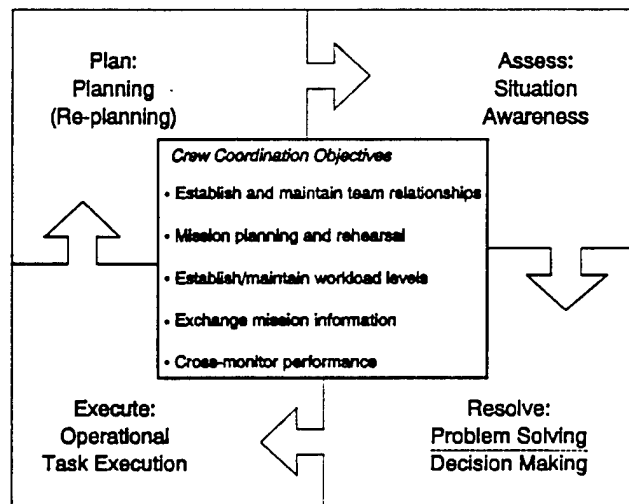
Academic instruction covering administrative data, course structure, training materials, learning objectives, and introductory information necessary to support subsequent instruction covering the crew coordination principles.

1. Administrative Data
 - a. Subject: Aircrew Coordination Course
 - b. Instructor(s): (Names and subjects; qualifications)
 - c. Administrative announcements
 - Sign-in roster
 - Schedule
 - Latrines
 - Phones or message center
 - Food and drink arrangements

- Training materials
 - Student Handout
 - Reference materials

2. Course Structure and Materials

a. Crew Coordination Model



- Logo
 - Crew functions
 - Detailed model (Appendix G, p. G-23)
- b. ATM Crew Coordination Elements and tasks
- Foundation for crew coordination
 - Crew Coordination Elements

-
- c. Crew Coordination Basic Qualities
 - Mission-level evaluation
 - Will define
 - d. Crew Coordination Objectives
 - The major difference
 - Behaviors will be defined, trained, and evaluated
 - e. Case study illustrations (Appendix D)
 - Actual Army aviation accidents
 - Exemplify requirement
 - f. *Student Guide*
 - Information for joint use
 - Valuable reference source
 - Background reading file
 - g. Simulator or flight training
 - Hands-on practical application
 - Crew coordination principles taught in the classroom
 - Four simulator or flight sessions (Table 1-1 on following page) during which students follow a crawl-walk-run progression

Table 1-1. Simulator or Flight Training Rides

Ride	Description	Remarks
1	Pretraining	"Baseline" ride
2	Training	"Crawl" ride
3	Training	"Walk" ride
4	Evaluation	"Run" ride

- Once all Army aviation aircrews are trained, we may do away with the crew coordination error accidents

Terminal Learning Objective: Upon completion of training, crewmembers (rated and nonrated) will be able to employ crew coordination principles to achieve safe, effective, and efficient performance of assigned flying missions.

Learning Objectives: With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

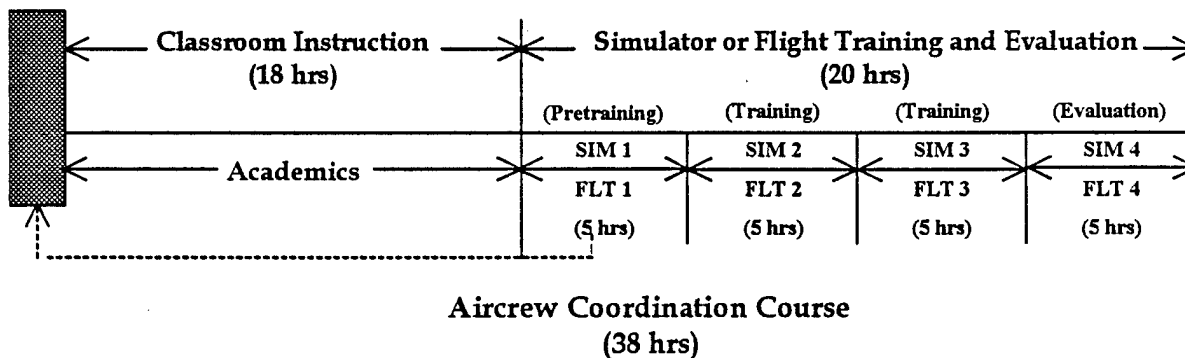
Learning Objectives for Hour 1

1. Describe the structure of the Aircrew Coordination Course and how it facilitates learning.
2. Define crew coordination.
3. Define crew coordination training.
4. Identify the unique features of aircrew coordination training.
5. Explain the importance of the new methods instituted by the Army to train and evaluate aviation personnel.

Note: Learning objectives will be reviewed prior to presenting each subsequent block. Learning objectives are imbedded in the text preceding the instruction.

- William James and MG Robinson quotes
- An attitudinal change in the Army is necessary to convert from individual pilot to crew operations

1. Overview of the Aircrew Coordination Course



- Position of the pretraining ride, the two training rides, and the evaluation ride
- Breakdown of each ride: premission planning (1.5 hours), simulator or flight (1.75 hours), and crew-level after-action review (1.75 hours); (5 hours per ride, 20 hours total)
- Break down of the Classroom Instruction: 4 hours of introduction, 12 hours on the crew coordination principles, 1 hour review, and 1 hour simulator or flight briefing (18 hours total)

2. Definition of Crew Coordination

Crew coordination is defined as the interaction between crewmembers (communication) and actions (sequence and timing) necessary for tasks to be performed efficiently, effectively, and safely. It involves the effective utilization of *all* available resources—hardware, software, and liveware.

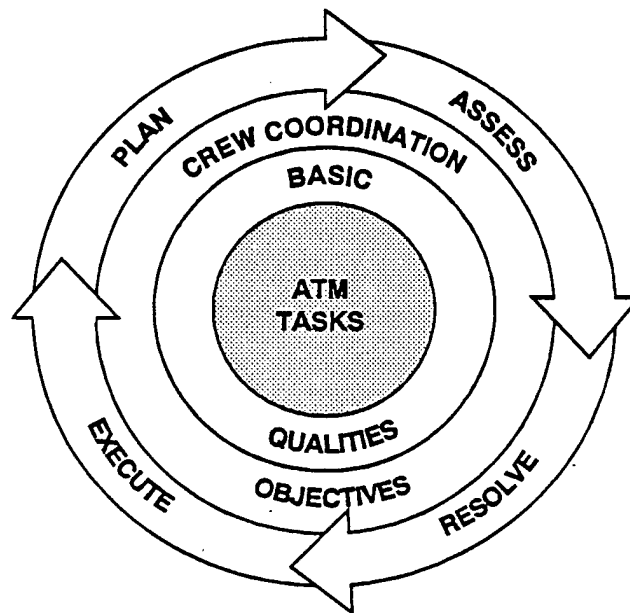
3. Description of Crew Coordination Training (TC 1-210)

Aircrew training must emphasize crew coordination as a vital part of the overall training program. It is a set of principles, attitudes, procedures, and techniques that transforms individuals into an effective crew

4. Features of Army Crew Coordination Training:

- a. Uses the Crew Coordination Model to describe crew functions
 - Crew functional cycle and the relationship of the Crew Coordination Objectives
 - Will discuss model
- b. Incorporates the eight ATM Crew Coordination Elements
 - USASC and ARI aviation accident analysis
 - Imbedded in each of the ATM tasks
 - Will show examples
- c. Provides an evaluation method using 13 Crew Coordination Basic Qualities
 - Looks at crew coordination
 - Will provide training

-
- d. Defines the five Crew Coordination Objectives to be achieved by each crew
- Makes Army crew coordination training unique
 - Is a set of defined behaviors
 - Can be measured
- e. Organizes instruction around the Crew Coordination Model, the ATM Crew Coordination Elements, the Crew Coordination Basic Qualities, and the Crew Coordination Objectives
- Crew Coordination in Army Aviation graphic



- Flows from ATM tasks to Basic Qualities to Crew Coordination Objectives to CCM functions
- f. Assimilates ideas and techniques from existing DoD and commercial aircrew coordination training programs
- Techniques such as the two-challenge rule, most conservative response, Bubba check, and use of excessive professional courtesy

-
- g. Emphasizes team formation, communications, premission planning, rehearsal, and crew-level after-action reviews
 - The core of crew coordination
 - Other actions essential
 - h. Uses multiple, situationally-driven decision making techniques
 - Two primary methods addressed
 - Must apply proper decision making technique
 - i. Utilizes standardized terminology during all mission phases
 - Literature is full of examples
 - j. Practical application of crew coordination principles during hands on training in the simulator or aircraft

5. What's New About How the US Army Trains and Evaluates Aircrews

- a. Battle rostering
- b. Individual and collective training integration
- c. Employment of situational training exercises
 - Unit instructors prepare scenarios
 - Evaluation of mission performance
- d. Leads to crew readiness level progression

e. Training philosophy

- Course will train crew coordination principles
- Principles will be practiced
- Application will be evaluated
- Evaluation factors

Learning Objectives for Hour 2

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

- 1. Explain the historical evolution of crew coordination training in the U.S. Army.**
- 2. Recognize the six aircrew coordination errors identified by the USASC/ARI Aviation Accident Analysis.**
- 3. Describe the four major actions resulting from the USASC/ARI Aviation Accident Analysis.**

1. History of Crew Coordination Research and Programs
 - a. Review of the crew coordination courses
 - (1) Northwest Airlines and Line Oriented Flight Training
 - (a) To improve crew coordination through the use of flight simulators
 - (b) Mission-oriented simulator flight training
 - (2) United Airlines and Command, Leadership, and Resource Management training
 - (a) Simulator research
 - (b) One of the best known comprehensive training programs
 - (3) FAA Advanced Qualification Program
 - (a) Outgrowth of the airlines crew coordination training programs
 - (b) Incorporates proficiency-based evaluations

-
- (4) US Army "Dynamics of Aircrew Communications and Coordination" (DACC)
 - (a) Initial aircrew coordination instruction
 - (b) Link between the old and new
 - (5) CAE - Link Aircrew Coordination Training
 - (a) AH-64 Training Brigade
 - (b) Critical success factors
 - (6) Human Error Accident Reduction Training (HEART)
 - (a) USASC training
 - (b) Contractual effort
 - (7) US Army Aviation Aircrew Coordination Course
 - (a) Builds on past experience
 - (b) Uses crew coordination information
 - (c) Focus
 - b. Findings from the analysis of rotary wing accident investigations (Appendix G, p. G-10)
 - (1) US Army Safety Center (USASC) and US Army Research Institute (ARI) analysis

(2) 596 accidents; 88 with aircrew coordination error (15%)
(Appendices B, C, and D)

(a) 41% of the crew coordination error accidents involved
communication failures

(b) 35% of the crew coordination error accidents involved workload
or prioritization failures

(3) Incidents resulted from failure to plan and mentally rehearse

(4) UH-60 and AH-64

2. Six Categories of Crew Coordination Errors Identified by the USASC/ARI Aviation
Accident Analysis

- a. Failure of the pilot on the controls (P*) to properly direct assistance from other
crewmembers
- b. Failure of a crewmember to announce a decision or action that affected the
ability of other crewmembers to properly perform their duties
- c. Failure of a crewmember to communicate positively (verbally and non-
verbally)
- d. Failure of the Pilot in Command (PC) to assign crew responsibilities properly
before and during the mission
- e. Failure of the P or other crewmembers to offer assistance or information that
was needed or had been requested previously by the P*
- f. Failure of the P* to execute flight actions in the proper sequence with the
actions of other crewmembers

3. Significant Actions Facilitated by the Identification of the Six Categories of Crew Coordination Errors

- a. Rewrite of TC 1-210
- b. Identification and definition of the eight ATM Crew Coordination Elements
- c. Redesign of the ATMs
- d. Development of an aircrew coordination course

Learning Objectives for Hour 3

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

1. Explain the purpose of TC 1-210.
2. Identify the correct definition for each of the ATM Crew Coordination Elements.
3. Describe how the Crew Coordination Elements were incorporated into the ATM tasks.
4. Explain the requirement for a comprehensive approach to the measurement of crew coordination and why the Basic Qualities were developed.

1. Revision of TC 1-210 and the ATMs

- a. Individual proficiency in the ATM tasks
- b. Absolute efficiency of Army aircraft
- c. Unit collective tasks are identified
- d. TC 1-210 links the individual, crew, and unit collective tasks together

2. Eight Crew Coordination Elements Defined

a. Communicate positively

Good cockpit teamwork requires positive communication among crewmembers. Communication is positive when the sender directs, announces, requests, or offers; the receiver acknowledges; and the sender confirms, based on the receiver's acknowledgement or action. Crewmembers must use positive communication procedures for the essential crew coordination actions identified in the description of each task. They should remain aware of the potential for misunderstandings and make positive communication a habit in the aircraft. Positive communication:

-
- Is quickly and clearly understood
 - Permits timely actions
 - Makes use of a limited vocabulary of explicit terms and phrases to improve understanding in a high-ambient-noise environment

b. Direct assistance

A crewmember will direct assistance when he cannot maintain aircraft control, position, or clearance. He also will direct assistance when he cannot properly operate or troubleshoot aircraft systems without help from the other crewmembers. Directives are necessary when one crewmember cannot reasonably be expected to know what or when assistance is needed by the other crewmembers. Examples are emergencies; the P*'s decision to change the sequence, timing, or priority of the P's or CE's assistance; and a P or CE who is relatively inexperienced in the mission being flown or the flight environment. Directives normally are not needed when the assistance required is part of a crewmember's assigned responsibility in the task description.

c. Announce actions

To ensure effective and well-coordinated actions in the aircraft, all crewmembers must be aware of expected aircraft movements and unexpected individual actions. Each crewmember will announce any action that affects the actions of the other crewmembers. Such announcements are essential when the decision or action is unexpected and calls for supporting action from the other crewmembers to avoid a potentially hazardous situation.

d. Offer assistance

A crewmember will provide the assistance or information that has been requested. He also will offer assistance when he sees that another crewmember needs help. All crewmembers must be aware of the flight situation and recognize when the P* deviates from normal or expected actions. They must never assume that the P* recognizes a hazard or the need for assistance.

e. **Acknowledge actions**

Communications in the aircraft must include supportive feedback to ensure that crewmembers correctly understand announcements and directives. Acknowledgements need to be short and need to positively indicate that the message was received and understood. "Roger" or "OK" may not be sufficient. The preferred method is to repeat critical parts of the message in the acknowledgment.

f. **Be explicit**

Crewmembers must avoid using terms that have multiple meanings; misinterpretations can cause confusion, delays, or accidents. Examples are "Right," "Back up," and "I have it." Crewmembers also must avoid using indefinite modifiers such as, "Do you see *that* tree?" or "You are coming in a *little* fast." In such cases, one crewmember may mistakenly assume that the other crewmember's attention is focused on the same object or event. More confusion arises when each crewmember interprets the terms differently.

Crewmembers should use clear terms and phrases and positively acknowledge critical information. During terrain flight, for example, the P must give enough information to permit the P* to fly the aircraft efficiently and safely over the intended route. He must provide navigation directions and information so that the P* does not have to concentrate on reading the instruments.

g. **Provide aircraft control and obstacle advisories**

Although the P* is responsible for aircraft control during terrain flight, the other crewmembers may need to provide aircraft control information regarding airspeed, altitude, or obstacle avoidance. Because wires are difficult to see, they are a major hazard to helicopters at NOE altitudes. Aircrews must anticipate wires along roadways; near buildings, antennas, and towers; or in combat areas where wire-guided missiles have been launched. Therefore, crewmembers wearing NVG must consider obstacle clearance a primary task directive.

Crewmembers should precede aircraft control and obstacle advisories by a positive command that immediately conveys the required action to the P*. A brief explanation of why the change is necessary should follow; for example, "Slow down, wires, 12 o'clock, 100 meters," or "Stop now, wires." In some instances, the CE may notice that the P* has let the aircraft move laterally or vertically away from a sling load. The CE should precede the advisory by a

positive directive; for example, "Up 2 feet, hold," or "Right two feet, hold." When the P* reaches the desired altitude or position, the CE should announce "Hold."

h. Coordinate action sequence and timing

Proper sequencing and timing ensures that the actions of one crewmember mesh with the actions of the other crewmembers.

3. How are Crew Coordination Considerations Reflected in Each ATM Task?

- a. ATM tasks include crew coordination procedures
- b. Inclusion of crew coordination in ATM tasks reflects philosophy that no task is an individual undertaking
- c. Features of the revised ATMs
 - (1) Crew coordination standards
 - (2) Duties, actions, and responsibilities of all crewmembers
 - (3) "Conduct Crew Mission Briefing" task added (Task 1000)
 - (4) Standardized terminology provided
 - (5) Examples of ATM crew coordination requirements
 - (a) Task 1001, Plan a VFR Flight
 - (b) Task 1016, Perform Hover Power Check
 - (c) Task 1028, Perform VMC Approach

d. Crew coordination is enhanced by battle-rostering and culminates in the effective execution of aircrew tasks. It includes:

- (1) Involvement of the entire crew
- (2) Development of standardized communication techniques
- (3) Assignment of specific task priorities and responsibilities
- (4) Involvement of each crewmember
- (5) Development of positive team relationships

Note: Battle-rostering and crew coordination are two separate concepts and are linked only by concurrent introduction into the training literature. Crew coordination is not learning how to operate an aircraft with a particular crewmember; it is a set of standardized operating procedures and techniques to be used in any situation.

4. Measurement of Crew Coordination: The requirement for a comprehensive approach to evaluation

- a. Task-level approach
- b. Comprehensive approach
 - (1) Establish and maintain flight team leadership and crew climate
 - (2) Permission planning and rehearsal accomplished
 - (3) Application of appropriate decision making techniques
 - (4) Prioritize actions and distribute workload

-
- (5) Management of unexpected events
 - (6) Statements and directives clear, timely, relevant, complete, and verified
 - (7) Maintenance of mission situational awareness
 - (8) Decisions and actions communicated and acknowledged
 - (9) Supporting information or actions sought from crew
 - (10) Crewmember actions mutually cross-monitored
 - (11) Supporting information or actions offered by crew
 - (12) Advocacy and assertion practiced
 - (13) Crew-level after-action reviews accomplished
 - Considers the "synergistic" effects of crew interrelationships on overall mission performance

Learning Objectives for Hour 4

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

1. Identify the correct definition for each of the five Crew Coordination Objectives.
2. Explain the purpose of the Crew Coordination Model.
3. Know how each Crew Coordination Objective contributes to flight safety and mission effectiveness.
4. Relate each Basic Quality to its associated Crew Coordination Objective.
5. Define the techniques adopted by the Aircrew Coordination Course; e.g., Two-Challenge Rule.

1. ATM Crew Coordination Elements and Basic Qualities are measured to determine whether or not the objectives of the crew coordination program have been achieved; i.e., the five Crew Coordination Objectives. These five Crew Coordination Objectives are:

- a. **Establish and Maintain Team Relationships**

To establish a positive working relationship that allows the crew to communicate openly and freely and to operate in a concerted manner.

- b. **Mission Planning and Rehearsal**

To explore, in concert, all aspects of the assigned mission and analyze each segment for potential difficulties and possible reactions in terms of the commander's intent

- c. **Establish and Maintain Workload Levels**

To manage and execute the mission workload in an effective and efficient manner with redistribution of task responsibilities as the mission situation changes

d. **Exchange Mission Information**

To establish intra-crew communications using effective patterns and techniques that allow for the flow of essential data between crewmembers

e. **Cross-Monitor Performance**

To cross-monitor each other's actions and decisions to reduce the likelihood of errors impacting mission performance and safety

2. **Crew Coordination Model Developed to Describe the Relationship of the Five Crew Coordination Objectives to the Crew Functional Cycle**

a. **Resulted from the Army crew coordination research effort**

(1) **PLAN:** Planning element

(2) **ASSESS:** Situation Awareness (SA) element

(3) **RESOLVE:** Problem Solving and Decision Making (PS&DM) element

(4) **EXECUTE:** Operational Task Execution (OTX) element (ATM tasks, battle drills)

(5) Replanning element starts cycle over again

b. **Go from detailed actions (ATM Crew Coordination Elements) to mission-level (Basic Qualities) to broad concepts (Crew Coordination Objectives).**

3. **Review of the Crew Coordination Objectives and Their Contribution to Flight Safety and Mission Effectiveness**

a. **Review of the five Crew Coordination Objectives**

(1) **Establish and maintain team relationships**

-
- (2) Mission planning and rehearsal
 - (3) Establish and maintain workload levels
 - (4) Exchange mission information
 - (5) Cross-monitor performance
- b. How does each Crew Coordination Objective contribute to flight safety and mission effectiveness?
- (1) Case studies will be used to analyze examples of good and bad crew coordination
 - (2) Illustrations for analysis will be selected from Army aviation accident cases (Appendix D; see also Appendices B and C)
 - (3) Analysis will consider how failure to observe ATM Crew Coordination Elements, Basic Qualities, and Crew Coordination Objectives contributed to the illustrated accident
4. Overview of the 13 Crew Coordination Basic Qualities (BQ) and Their Relationship to the Five Crew Coordination Objectives (CCO)
- a. CCO 1: Establish and maintain team relationships
 - (1) BQ 1: Establish and maintain flight team leadership and crew climate
 - b. CCO 2: Mission planning and rehearsal
 - (1) BQ 2: Pre-mission planning and rehearsal accomplished
 - (2) BQ 3: Application of appropriate decision making techniques

-
- c. CCO 3: Establish and maintain workload levels
 - (1) BQ 4: Prioritize actions and distribute workload
 - (2) BQ 5: Management of unexpected events
 - d. CCO 4: Exchange mission information
 - (1) BQ 6: Statements and directives clear, timely, relevant, complete, and verified
 - (2) BQ 7: Maintenance of mission situational awareness
 - (3) BQ 8: Decisions and actions communicated and acknowledged
 - (4) BQ 9: Supporting information and actions sought from crew
 - e. CCO 5: Cross-monitor performance
 - (1) BQ 10: Crewmember actions mutually cross-monitored
 - (2) BQ 11: Supporting information and actions offered by crew
 - (3) BQ 12: Advocacy and assertion practiced
 - (4) BQ 13: Crew-level after-action reviews accomplished

5. Descriptions of Techniques Referred to in the Aircrew Coordination Course

a. Two-challenge rule

The key to early response to incapacitation lies in the ability to establish a norm against which the results of incapacitation can be measured. The two-challenge rule provides for automatic assumption of duties from any crewmember who fails to respond to two consecutive challenges. This

overcomes our natural tendency to believe the pilot flying must know what he is doing, even as he departs from established parameters

b. Excessive professional courtesy

In general, we are hesitant to call attention to deficient performance in others, particularly if they are senior to us. Thus, even when one crewmember does point out performance which is outside of established parameters, it is typically done with very little emphasis. For example, a P will usually inform the PC* that he is "a little fast" or "a little low," no matter how far off the parameter he is

c. Most conservative response

Occasionally, there is disagreement in the cockpit which cannot be resolved due to lack of information. It is best to agree in advance to take the most conservative action in these situations until additional information is available

Academic instruction on crew coordination principles, which covers the in-depth definitions, discussion, performance criteria, and illustrations of the 13 Crew Coordination Basic Qualities organized under their respective Crew Coordination Objective.

Crew Coordination Objective 1: Establish and Maintain Team Relationships

- This Crew Coordination Objective has one Basic Quality:

- BQ 1: Establish and maintain flight team leadership and crew climate

Learning Objectives for Hours 5 and 6

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

1. Explain the difference between traditional leadership and functional (flight team) leadership.
2. Recognize the definition of a belief, attitude, skill, or behavior.
3. Describe the linkages between beliefs, assumptions, attitudes, and behaviors.
4. Determine the difference between effective and ineffective crews.
5. Implement the techniques for building effective flight teams.
6. Recognize the components of flight team leadership and followership.
7. Recognize the performance criteria for BQ 1.
8. Determine how BQ 1 and its associated Crew Coordination Elements were involved in Army aviation accidents.

- No related ATM Crew Coordination Elements

Basic Quality 1: Establish and Maintain Flight Team Leadership and Crew Climate

1. Definition of Basic Quality 1

This Basic Quality addresses the relationships among the crew and the overall climate of the flight deck. Aircrews are teams with a designated leader and clear lines of authority and responsibility. The PC sets the tone of the crew and maintains the working environment. Effective leaders use their authority but do not operate without the participation of other crewmembers. When crewmembers

disagree on a course of action, the crew must be effective in resolving the disagreement.

Note: Traditional leadership centralizes leadership in the leader with followers fully dependent on the leader. Functional leadership assigns leadership and followership roles as the situation evolves. Flight team leadership recognizes the impact of leadership style on the working environment. Regardless of leadership style, final decision and direction authority is always retained by the PC.

2. Beliefs, Attitudes, Skills, and Behavior

- a. *Belief:* Mental acceptance of the truth or actuality of something
- b. *Attitude:* A frame of mind affecting one's thoughts or behavior
- c. *Skill:* Proficiency, ability, or dexterity; expertness
- d. *Behavior:* The actions or reactions of individuals under specified circumstances

3. Linkages Between Beliefs, Attitudes, and Behaviors

Note: Numbers in parentheses indicate the appropriate belief-Crew Coordination Objective 1-5 chain in which the belief, assumption, attitude, or behavior falls.

a. Old implicit beliefs

Beyond the pilot, the rest of the crew is backup and basically unimportant to the mission (1)

We can figure things out during the mission; we have to remain flexible (2)

Pilots can handle all workload alone (3)

Pilots are aware of all available decision options (4)

Pilots can collect and integrate all important decision information alone (4)

Pilots operating alone make the best decisions (4)

Pilots are infallible in their flying skills (5)

b. New explicit assumptions

The entire crew is critical to mission success (1)

Once airborne, there may be little time to develop and coordinate actions and decisions; contingencies and options should be developed and discussed before the need arises (2)

The quality of mission task performance is highest when the workload is effectively distributed across crewmembers (3)

Crews can effectively distribute task execution responsibilities (3)

A qualified crew will surface a greater range of decision options than the pilot alone will produce (4)

A more complete set of decision support information will be generated by the crew than by the pilot alone (4)

On average, decisions that consider crew recommendations will be better than decisions made by the pilot alone (4)

All crewmembers make mistakes (5)

Crewmembers can catch other crewmembers' mistakes before they have serious consequences (5)

c. Essential attitudes

My fellow crewmembers are an important resource; I need to use them and treat them with respect (Values crew)(1)

The best time to address risk and potentially hazardous or short lead time situations is on the ground if time is available; I must encourage the entire crew to provide input so each crewmember has a common understanding of the mission (Consider relevant mission factors)(2)

Overloads increase the risk of errors and poor mission performance; providing support to overloaded crewmembers is essential to effective mission execution (Provide or accept help)(3)

I may have information that is important to another crewmember; I must take action to ensure that he receives this information in a timely manner (Give information)(4)

Other crewmembers may provide important perspectives and information that I have not considered; I need to take action to ensure the delivery of this information to the group (Get information)(4)

Human errors are a fact of life, everyone makes them; they should be corrected with minimum disruption to ongoing tasks, mission execution, or to team relationships (Crew fallibility)(5)

d. Behaviors (Crew Coordination Objectives)

Establish and maintain interpersonal relationships to create and maintain a harmonious team atmosphere and to execute mission objectives (Establish and Maintain Team Relationships)(1)

Thoroughly plan each mission and rehearse difficult segments to reduce uncertainties and preclude problems from developing (Mission Planning and Rehearsal)(2)

Allocate workload in a reasonable manner across crewmembers (Establish and Maintain Workload Levels)(3)

Establish and maintain the same mission plan and a common frame of reference within each crewmember's mind in as much detail as possible (Exchange Mission Information)(4)

Expose the decision-maker to the full range of action options available at each important decision point (Exchange Mission Information)(4)

Check each other's actions for possible errors (Cross-Monitor Performance)(5)

4. Effective and Ineffective Crews

a. The effective crew

Effective crews are composed of assertive crewmembers who consistently engage in situational leadership. Each crewmember knows he/she is a productive member of the team and is willing to help fellow crewmembers without request. The entire crew participates as a team in the planning, execution, and after-action review phases of the mission. With the exception of high workload conditions or short lead times, an analytical style of decision making is employed and each crewmember feels free to express concerns or advocate a position. The cockpit climate is relaxed and friendly but professional in its execution of mission objectives. Crewmembers provide timely and clearly stated information to one another to maintain a common understanding of conditions, actions, and decisions. Critiques and after-action reviews are constructive and are anticipated as a learning experience to enhance future crew performance.

b. The ineffective crew

Ineffective crews are composed of crewmembers who are unable to balance task and personnel considerations. Crewmember's feelings may range from frustration to just being along for the ride; they generally do not help one another without direction. The sole planner and decision maker is the PC who provides only a cursory briefing to the crew. Crewmembers may be left wondering about their actions, duties and responsibilities. The cockpit climate is business-like; however, confusion is likely to occur during high workload and short lead time situations because only the PC understands the mission objectives and is unable to explain requirements under such conditions—even after the crisis has passed. Critiques and after-action reviews, when done, are accusatory and nonproductive. Unit personnel may express dissatisfaction when assigned to fly with a particular member of such a crew.

5. How to Build an Effective Team

a. Management style (Appendix G, p. G-55)

Nurturing: A nurturing manager (1, 9) would place emphasis on people ensuring crewmembers are happy, contented, and feel a sense of warmth and acceptance. He will want to cooperate to ensure efficient flight performance (people but not task oriented)

Autonomous: An autonomous manager (1, 1) would have a minimum response to both people and performance. He is only on the job to reach some private goal, maybe retirement. He is a coaster. He is visible and looks occupied without actually doing anything and contributes as little as possible without getting into trouble (neither people nor task oriented)

Balancer: A middle-of-the-road manager (5, 5) who adjusts to the tempo that others have come to adopt. He will not push for more even though the results obtained are less than what might have been accomplished by a different approach. In this way some progress is made and everyone feels that something has been done. When conflict arises, he adjusts by splitting the difference in ways that include compromise, accommodation, and adjustment (neither task nor people oriented)

Aggressive: An aggressive manager (9, 1) is a controller. He controls the situation in such a way that the human element interferes in a minimum way. He has little concern for thoughts, feelings, or attitudes of others. He uses authority to control and expects obedience or else—no ifs, ands, or buts (task but not people oriented)

Assertive: An assertive manager (9, 9) is a leader. He believes work is accomplished by committed people in pursuit of a common purpose based on a relationship of trust and respect. He is involved (both people and task oriented)

b. Theories X, Y, and Z

Theory X (autocratic approach) proposes all people are lazy and cannot be given responsibility. A Theory X leader would be directive, structuring, critical, and autocratic

Theory Y (democratic or participative approach) proposes that people are industrious and should be allowed to participate in the management function. A Theory Y leader would stress democratic procedures, participative decision making, and self-control

Theory Z (situational approach) proposes that managers need to combine characteristics of both Theory X and Y to be successful in current times

6. Flight Team Leadership and Followership

- a. Command authority
- b. Flight team leadership: Leadership may come from any crewmember with the appropriate technical knowledge, skills, and information at a given time; situationally driven
- c. Authority vs. assertiveness
- d. Assertiveness vs. aggressiveness

e. Followership

Every noncommand crewmember is responsible for actively contributing to the team effort, monitoring changes in the situation, and being assertive when necessary. With respect to upholding the command structure, there must be an attitude of professionalism in spite of any problems or barriers that may be caused by cultural factors and differences in perspective

f. Two-challenge rule

- Challenge to authority?
- Life threatening situation?
- Nonlife threatening situation?

g. Military grade and position considerations (Appendix G, p. G-35)

(1) Rank

- Commissioned and Warrant
- Enlisted

-
- (2) Duty position
 - Unit
 - Cockpit
 - h. Leadership principles (FM 22-100, Military Leadership; Chapters 2, 4, and 6)
 - (1) Know yourself and seek self-improvement
 - (2) Be technically and tactically proficient
 - (3) Seek responsibility and take responsibility for your actions
 - (4) Make sound and timely decisions
 - (5) Set the example
 - (6) Know your soldiers and look out for their well-being
 - (7) Keep your subordinates informed
 - (8) Develop a sense of responsibility in your subordinates
 - (9) Ensure the task is understood, supervised, and accomplished
 - (10) Build the team
 - (11) Employ your unit in accordance with its capabilities

i. FM 22-101, Leadership Counseling

- Personal and performance counseling
- ABCs of counseling and a checklist

j. Motivation

(1) Goal directed

(2) Leader provides conditions

- Approachable
- Open-minded
- Realist
- Goals and standards set

(3) Several levels of motivation (lowest to highest level)

- *Compliance*: I do it because I have to!
- *Identification*: I do it because he does it!
- *Internalization*: I do it because I want to!

k. Coercion

(1) Command climate

- Commander "A" considers subordinate comments in the decision making process.

-
- Commander "B" ignores subordinate inputs in reaching his decisions.
- (2) Command pressures
 - Subtle
 - Blatant
 - (3) Cockpit pressures
- l. Disagreement and differences
 - (1) Disagreement and differences are inevitable.
 - (2) Conflict is not always "bad."
 - (3) Resolution of conflict.
 - m. Critical phases of team building (Appendix G, p. G-35)
 - (1) Unit orientation and battle-rostering phase considers factors such as:
 - Unit organization, unit climate, previously formed teams, interpersonal relationships, command relationships
 - Basic flying tasks and cockpit technology
 - Roles of crewmembers and general characteristics of incumbents
 - Basic norms of conduct regulating crewmember behavior

-
- (2) Premission planning and rehearsal phase
 - First "working" meeting
 - Duties and responsibilities specified
 - Unit procedures
 - (3) Task execution phase
 - High workload
 - Low workload
 - (4) Crew-level after-action review phase
 - Self-critique
 - Lessons learned
 - Value derived by those with a stake in the mission
 - Value derived by crew
 - Value derived by individual
 - (5) Remain overnight (RON) and temporary duty (TDY) mission considerations
 - Fine tune
 - Destroy

n. Team management problems in the cockpit (Appendix G, p. G-55)

- (1) Lack of support
- (2) SOP ignored
- (3) Stress problems
- (4) Judgement problems
- (5) Emotional problems
- (6) Get-home-itis
- (7) Management problems
- (8) Discipline problems
- (9) Leadership problems
- (10) Communications problems

7. Performance Criteria for Basic Quality 1: Establish and Maintain Flight Team Leadership and Crew Climate (see Appendix E, Basic Quality 1)

Rating Factors:

Leadership Style

<i>Superior</i>	+	PC actively establishes an open climate where crewmembers freely talk and ask questions
	+	PC considers each crewmember to be an important contributor to mission success

-
- Acceptable* • PC permits an open climate with some discussion and questioning among crewmembers
• PC acknowledges each crewmember as part of the team
- Very Poor* - PC creates a restrictive climate by means of an authoritarian management style
- Some crewmembers feel ignored by the PC and are reluctant to speak up

Professional Respect

- Superior* + Each crewmember is valued for their expertise and judgement
+ Rank and experience differences do not influence the willingness of crewmembers to speak up
- Acceptable* • Crewmembers show an acceptable level of professional courtesy to one another
• Rank and experience differences do not induce any obvious conflicts or inhibit communication
- Very Poor* - Crewmembers openly or indirectly belittle one another
- Rank and experience differences are an obvious source of conflict and inhibit communication

Resolving Disagreements

- Superior* + Alternative viewpoints are considered a normal and occasional part of crew interaction
+ Disagreements are handled in a professional manner without involving personal attacks or defensive posturing
- Acceptable* • Some alternative viewpoints are tolerated and they do not lead to obvious disruption of teamwork
• Disagreements do not involve obvious attacks of character or defensive posturing
- Very Poor* - Disagreements exist among the crewmembers, but are rarely surfaced for resolution
- Conflicts may involve personal attacks and result in a disruption of teamwork

Crewmember Attitudes

- Superior* + PC actively monitors the attitudes of crewmembers and offers feedback when necessary
- + Each crewmember actively displays a proper concern for balancing safety with mission accomplishment
- Acceptable* • PC takes steps to correct obvious displays of improper or hazardous attitudes
- Crewmembers do not display obvious disregard for safety during the mission
- Very Poor* - PC exhibits a hazardous attitude, or tolerates such an attitude in other crewmembers
- Displays of hazardous attitudes by one or more crewmembers may jeopardize flight safety

8. Illustrations of Crew Coordination Objective 1: Establish and Maintain Team Relationships (see Appendix D)

Crew Coordination Objective 2: Mission Planning and Rehearsal

- This Crew Coordination Objective has two Basic Qualities:
 - BQ 2: Prepermission planning and rehearsal accomplished
 - BQ 3: Application of appropriate decision making techniques

Learning Objectives for Hours 7, 8, and 9

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

1. Explain "collective visualization."
2. Describe unique Army aviation environmental factors that make mission planning and rehearsal a necessity.
3. Identify the flight planning and rehearsal steps.
4. Recognize the performance criteria for BQ 2.
5. Determine how BQ 2 and its associated Crew Coordination Elements were involved in Army aviation accidents.

- Related ATM Crew Coordination Elements are:

Coordinate action sequence and timing: Proper sequencing and timing ensures that the actions of one crewmember mesh with the actions of the other crewmembers

Basic Quality 2: Prepermission Planning and Rehearsal Accomplished

1. Definition of Basic Quality 2:

Prepermission planning includes all preparatory tasks associated with planning the mission. These tasks include VFR flight planning (ATM Task 1001), IFR flight planning (ATM Task 1002), or terrain flight mission planning (ATM Task 1033/2078), performance planning (ATM Tasks 1003 & 1004), assigning crew-

member responsibilities (Unit SOP and ATM Task 1000), and all required briefings and brief-backs.

- Discuss collective visualization

Pre-mission rehearsal involves the crew collectively visualizing and discussing expected and potential unexpected events for the entire mission. This process requires all crewmembers to think through contingencies and actions for difficult segments, tasks, or unusual events associated with the mission and developing strategies to cope with contingencies.

Time available determines how much pre-mission planning and rehearsal is completed prior to flight or in the cockpit. Mission changes received in-flight will necessitate in-flight planning and rehearsal.

- Less planning time = higher mission risk

Although the pilot-in-command is responsible for leading mission planning and review, the entire crew should actively participate. For multi-aircraft operations, the air mission commander is responsible and all aircrews should participate.

The overall objective of pre-mission planning and rehearsal, from a crew coordination point of view, is to ensure the entire crew understands all the mission requirements and their role in accomplishing the requirements.

2. Unique Requirements of the Army Flight Environment

a. Fixed wing critical 11 minutes

- Three minutes
- Eight minutes

b. Safety window (Appendix G, p. G-123)

- Block of airspace centered on airfield
- Surface to 2000' AGL

-
- Takeoff to en route climb phase
 - Final approach fix (FAF) to taxi
 - Small % of total flight time vs 80% of accidents
 - Crew procedural vs. mechanical errors
 - Workload at peak within window
- c. Rotary wing tactical missions operate within hazardous flight regimes nearly all the time
- Terrain flight
 - Short reaction times to emergencies or unexpected events
 - Degraded environmental conditions
 - Night and NVD flight
 - Technique: Rely on well-trained, immediate action procedures, drills, and planning
- d. Fatigue causes performance degradation
- Larger deviations
 - More frequent lapses
 - Distraction

-
- Selectivity
 - Timing
- e. High probability crew coordination error operational profiles
- (1) Tactical terrain flight missions at night
 - (2) Cruise phase of terrain flight
 - (3) Crew briefings
 - (4) Night proficiency and transition missions
 - (5) Taxi phase of administrative or support missions
 - (6) Landing approach
 - (7) Hovering flight
 - (8) Hovering flight
 - (9) Premission planning
- f. Events present in aviation accident cases
- (1) Sudden loss of visual reference
 - (2) Nuisance malfunctions
 - (3) Evasive maneuvers during formation flight

-
- (4) NVG descents over low contrast surfaces
 - (5) Approaches into tight LZs with numerous obstacles
 - (6) Maneuvering close to obstacles
 - (7) Wire avoidance
 - (8) Threat evasive maneuvers
 - (9) Inadvertent IMC

3. Flight Planning and Rehearsal (FM 1-400, TC 1-201, TC 1-204, Unit SOP)

a. Flight planning

- (1) Acquire or update mission information (OPORD, FRAGO, Aircrew Mission Briefing). Clarify mission requirements, commander's intent and seek additional guidance as required. Verify when mission is complete.
- (2) Determine actions, duties, and mission responsibilities (unit SOP).
- (3) Collect and analyze information pertaining to all aspects of the mission (METT-T). Coordinate with supported unit(s).
- (4) Plan the mission.
 - Plan
 - Determine
 - Determine threat suppression

-
- Determine mission
 - Fratricide and rules of engagement
- (5) Visualize and actively rehearse the mission to assess risks, identify potential problem areas, and develop alternative courses of action.
 - (6) Conduct crew briefing to review and discuss the plan (ATM Task 1000).
- b. The flight planning sequence
- (1) Conduct map & aerial photo reconnaissance
 - (2) Review NOTAMs and enemy/friendly reports
 - (3) Assess METT-T and radio navigation considerations
 - (4) Select mode(s) of terrain flight
 - (5) Select movement technique(s)
 - (6) Select routes
 - (7) Complete performance planning
- c. The rehearsal sequence
- (1) Analyze overall mission; define requirements
 - (2) Break the mission into functional segments

-
- (3) Visualize "flying through" each segment; consider flight corridors, LZ times, special equipment use
 - (4) Identify segments where time pressure, communication requirements, navigation demands, threat exposure, etc., are high
 - (5) Identify potential problems and assess risk
 - (6) Develop strategies
- d. Factors affecting the planning and rehearsal process
- (1) Time available to plan
 - (2) Type of mission
 - (3) Crew's familiarity with current tactical situation, area of operations, unit SOP, and the planning process.
 - (4) Completeness and thoroughness of unit SOP
 - (5) Experience and proficiency level of the individual crewmembers and the crew itself
 - (6) Information available to the crew
- e. Prioritizing the planning and rehearsal process
- (1) Determine time available
 - (2) Determine critical segments of the mission

(3) Determine critical information, computations, or actions required for planning or rehearsal

(4) Delegate planning responsibilities

(5) Rehearse critical segments

(6) Brief results to all concerned

f. Planning and rehearsal benefits for aircrews

(1) Increases understanding of mission requirements

(2) Prepares crewmembers to anticipate other crewmember's needs and assist each other

(3) Improves crew's ability to establish and maintain proper lead time and to maintain overall mission situational awareness

(4) Improves synchronization, both internally and externally

(5) Facilitates the decision making/problem solving process

(6) Reduces risk

4. Performance Criteria for Basic Quality 2: Pre-mission Planning and Rehearsal Accomplished

Rating Factors:

Prepermission Flight Planning

- Superior* + PC actively insures that all actions, duties, and mission responsibilities are partitioned and clearly assigned to specific crewmembers
- + Each crewmember is actively involved in the mission planning process to insure a common understanding of mission intent and operational sequence
- + Planning activities are prioritized to insure that critical items are addressed within the available planning time
- Acceptable* • No obvious assignments are overlooked regarding critical actions, duties, or mission responsibilities
- All crewmembers have a general understanding of mission intent and operational sequence; each crewmember participates at least minimally in the planning process
- Planning activities are generally prioritized within the available time; no major component of the mission overlooked
- Very Poor* - One or more critical actions, duties, or mission responsibilities are overlooked during the prepermission planning process
- One or more crewmembers have an inadequate or incorrect understanding of mission intent or operational sequence due to lack of involvement in planning process
- Little attention is given to prioritizing planning activities within the available planning time; some components of the mission are neglected

Prepermission Rehearsal

- Superior* + Alternative courses of action are identified in anticipation of potential changes in METT-T factors; crew is fully prepared to implement contingencies as necessary
- + Crewmembers mentally rehearse the entire mission by visualizing and discussing potential problems, contingencies, and responsibilities
- Acceptable* • Some attention is given to identifying alternative courses of action; crew can react to changes in METT-T factors, but some additional planning will be required
- Crewmembers give some attention to discussing potential problems, contingencies, and responsibilities; they do not mentally rehearse all critical flight segments or sequences

-
- Very Poor* - Little or no attention is paid to identifying alternative courses of action; changes in METT-T factors would require substantial replanning by crewmembers
- Crew fails to discuss or rehearse critical flight segments and sequences; they begin the mission with marginal understanding or agreement concerning potential problems, contingencies, or responsibilities

In-Flight Replanning and Rehearsal

- Superior* + PC actively insures that crewmembers take advantage of low workload periods to rehearse upcoming flight segments
- + Crewmembers continuously review remaining flight segments to identify required adjustments; planning consistently keeps ahead of critical lead times
- Acceptable* • Crewmembers engage in some in-flight rehearsal of up-coming flight segments; no major coordination problems arise that can be attributed to a failure to rehearse
- Crewmembers occasionally review remaining flight segments to identify required adjustments; planning generally keeps ahead of critical lead times
- Very Poor* - Little or no attention is given to in-flight rehearsal of up-coming flight segments; coordination problems can be attributed to a failure to rehearse
- Through inattention, crewmembers frequently fall behind in anticipating required adjustments as the mission progresses; in-flight planning consistently appears rushed

5. Illustrations of Basic Quality 2: Pre-mission Planning and Rehearsal Accomplished (see Appendix D)

Learning Objectives for Hours 7, 8, and 9 (Cont.)

6. Define decision making and identify the key decision maker.
7. Identify the correct decision-making technique for a given situation.
8. Explain the hazardous thought patterns and their countermeasures.
9. Recognize the performance criteria for BQ 3.
10. Determine how BQ 3 and its associated Crew Coordination Elements were involved in Army aviation accidents.

Basic Quality 3: Application of Appropriate Decision Making Techniques

6. Definition of Basic Quality 3:

Decision making is the act of rendering a solution to a problem and defining an action plan. It must involve risk assessment. The quality of decision making and problem solving throughout the planning and execution phases of the mission is based on the information available, time urgency, and level of involvement and information exchange among crewmembers. The crew's ability to apply an appropriate decision making technique based on these criteria has a major impact on the manner and quality of their resultant actions. Although the entire crew should be involved in the decision making and problem solving process, the pilot-in-command (PC) is the key decision maker.

7. Decision Making Models or Style

Two contrasting models or styles are available: analytical decision making and automatic, or pattern-recognition, decision making. Each style may be appropriate depending on the available time and other situational factors including levels of risk.

a. Analytical style

- (1) Useful in dealing with structured problems
- (2) Systematic approach

-
- (3) Thorough—more data taken into account
 - (4) More time consuming
 - b. Automatic style
 - (1) Based on prior training and experience
 - (2) Influenced by premission planning and rehearsal
 - (3) Useful in dealing with unstructured problems
 - (4) Quick and creative but little time for consultation
 - (5) May not consider all data
 - c. The classic (analytical) decision making process (FM 22-100)
 - (1) Identify the problem
 - (2) Gather information
 - (3) Develop alternative courses of action
 - (4) Analyze and compare courses of action
 - (5) Make a decision; select a course of action
 - (6) Make a plan

-
- (7) Implement and evaluate the plan
 - (8) Examples
 - d. Automatic (pattern-recognition) decision making process
 - (1) Identify the problem
 - (2) Recognize familiarity of the situation
 - (3) Generate and evaluate options through mental simulation (one at a time)
 - (4) Implement first plausible option
 - (5) Inform the crew
 - (6) Examples
 - e. Key differences between the two styles
 - (1) Driven by time available
 - (2) Information gathering
 - (3) Developing alternatives
 - (4) Selecting alternatives
 - f. Application of decision style
 - (1) Each is appropriate, depending on the time and circumstances

-
- (2) All crewmembers should be allowed input to the decision making process when time permits
 - (3) All decisions and actions should be announced to other crewmembers
- g. Importance of decision making process on crew coordination
- (1) It supports the goal of crew coordination
 - (2) Achieves synergy
 - (3) Fosters an environment of good communication and leadership

8. Hazardous Attitudes that Impede the Decision-making Process

a. Anti-authority

- Don't like people
- Resentful
- Likely after deciding to separate
- Antidote: Follow the rules. *They are usually right.*

b. Impulsivity

- Need to do something
- Don't stop
- Antidote: Not so fast! *Think first.*

c. Invulnerability

- Accidents
- More likely
- Antidote: *It could happen to me!*

d. Macho

- Try to prove they are better
- Take risks
- Need
- Ego gratification
- Antidote: *Taking chances is foolish!*

e. Resignation

- Think
- Attribute outcome
- Leave decisions
- Can result
- Antidote: *I'm not helpless! I can make a difference.*

f. "Get-there-itis"

- Desire to reach destination
- Blocks awareness
- Antidote: *Nothing will happen if I don't get there as planned. There's always another day.*

g. Overconfidence in another crewmember

- Could be
- Possibly swayed
- Generally not
- Antidote: *My fellow crewmembers are not infallible.*

9. Performance Criteria for Basic Quality 3: Application of Appropriate Decision Making Techniques (see Appendix E, Basic Quality 3)

Rating Factors:

High Time Stressed Decisions

- Superior + Crewmembers consistently rely on a pattern-recognition decision process to produce timely responses; deliberation is minimized, consistent with available decision time
- + Crewmembers consistently display an ability to focus on only the most critical factors influencing their choice of response
- + Crewmembers efficiently prioritize their specific information needs, consistent with available decision time

-
- Acceptable* • Crewmembers generally avoid excessive deliberation when it is inconsistent with the time urgency of the decision; decisions meet minimal time requirements
- Crewmembers generally address the most critical factors, but may be occasionally distracted by secondary issues
 - Crewmembers generally request only information that is obtainable within the available decision time
- Very Poor* - Crewmembers display an inflexible decision style, frequently engaging in excessive deliberation; delayed decisions frequently compound the difficulties faced by the aircrew
- Crewmembers may lose focus and become distracted by secondary factors
 - Crewmembers delay critical decisions by seeking information that is unattainable within the available decision time

Moderate/Low Time Stress Decisions

- Superior* + Crewmembers consistently rely on an analytical decision process to produce high quality decisions; deliberation is encouraged, consistent with available decision time
- + Crewmembers consistently consider all important factors influencing their choice of action, seeking the most unbiased decision possible
 - + Crewmembers consistently seek out all available information relative to the factors being considered
- Acceptable* • Crewmembers generally engage in some deliberation, avoiding decisions that appear to reflect impulsive or hazardous attitudes
- Crewmembers generally address the important factors influencing their choice of action, avoiding obvious decision biases or gaps in logic
 - Crewmembers generally seek out the most important information relative to the factors being considered
- Very Poor* - Crewmembers display an inflexible decision style, frequently responding in an impulsive manner with little or no deliberation; impulsive decisions frequently compound the difficulties faced by the crew
- Crewmembers overlook one or more important factors influencing their choice of action; one or more types of decision biases are evident in their thinking
 - Crewmembers fail to seek out one or more important pieces of available information relative to the factors being considered

10. Illustrations of Basic Quality 3: Application of Appropriate Decision Making Techniques (see Appendix D)

Crew Coordination Objective 3: Establish and Maintain Workload Levels

- This Crew Coordination Objective has two Basic Qualities:
 - BQ 4: Prioritize actions and distribute workload
 - BQ 5: Management of unexpected events

Learning Objectives for Hour 10

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

1. Identify the two factors than must be avoided to achieve effective workload management.
2. Explain the importance of task prioritization on workload management.
3. Recognize the performance criteria for BQ 4.
4. Determine how BQ 4 and its associated Crew Coordination Elements were involved in Army aviation accidents.

- Related ATM Crew Coordination Elements are:

Direct assistance: A crewmember will direct assistance when he cannot maintain aircraft control, position, or clearance

Offer assistance: A crewmember will offer assistance when he sees that another crewmember needs help

Coordinate action sequence and timing: Proper sequencing and timing ensures that the actions of one crewmember mesh with the actions of the other crewmembers

Basic Quality 4: Prioritize Actions and Distribute Workload

1. Definition of Basic Quality 4:

This Basic Quality measures the effectiveness of time and workload management. It assesses the extent to which the crew, as a team, avoids distractions from essential activities, distributes and manages workload, and avoids individual task overload.

2. Prioritizing Actions and Distributing Workload

a. Importance of prioritizing actions and distributing workload

- (1) Errors relating to this quality accounted for 35% of the crew coordination errors
- (2) Many Army aviation accidents and incidents occur during periods of high workload
- (3) Four of the six types of crew coordination errors identified in the ATM relate to this Basic Quality (para 1-3b, TC 1-210)
 - Failure to direct
 - Failure to offer
 - Failure to assign
 - Failure to sequence
- (4) Mismanagement of workload results in degraded mission performance

b. Workload in the Army's complex, dynamic flight environment

- (1) *Mental* versus
- (2) *High* versus

(3) Classification of tasks

- Critical tasks
- Important tasks
- Routine tasks

c. Causes of high workload

- (1) Poor planning and rehearsal
- (2) Unexpected events
- (3) Weather and the environment
- (4) ATC
- (5) Cockpit design
- (6) Mission complexity
- (7) Crew endurance

d. Effects of high workload

- (1) Difficulties in achieving good performance
- (2) Difficulty with aircraft control
- (3) Uncertainty/indecision/discomfort

-
- (4) Lose normal scan
 - (5) Temporal distortion
 - (6) Difficulty communicating
- e. Managing high workload
- (1) Delegate
 - New ATM tasks
 - Unit SOP
 - Crew mission briefing (ATM Task 1000)
 - (2) Prioritize
 - Aircraft control
 - Obstacle clearance
 - (3) Expand time available
 - (4) Monitor

f. Effects of low workload

- (1) Inattention
- (2) Drowsiness/boredom
- (3) Complacency

g. Managing low workload

- (1) Rehearse and refine
- (2) Recheck
- (3) Review

h. Operationally-related distractions

- (1) Caution and warning
- (2) Conflicting
- (3) Cockpit
- (4) Checklists

i. Non-operationally-related distractions

- (1) Financial
- (2) Medical

(3) Family

(4) Supervisors/Peers

(5) Must cope with non-operationally-related distractions

j. Dealing with operationally related distractions (maintaining our focus of attention)

(1) Ignore

(2) Delay

(3) Delegate

(4) Handle

3. Performance Criteria for Basic Quality 4: Prioritize Actions and Distribute Workload (see Appendix E, Basic Quality 4)

Rating Factors:

Task Prioritization

- Superior* . + Crewmembers are consistently able to identify and prioritize competing mission tasks; flight safety and other high-priority tasks are never ignored; low-priority tasks are appropriately delayed until they do not compete with more critical tasks
- + Crewmembers consistently avoid non-essential distractions; distractions have no impact on task performance
- Acceptable* • Crewmembers are generally able to maintain a focus on flight safety and other high-priority mission tasks; task prioritization is acceptable, but could be improved
- Crewmembers generally avoid non-essential distractions; some distractions arise, but have no impact on flight safety

-
- Very Poor* - Low-priority tasks are occasionally attended to at the expense of flight safety or other higher priority mission tasks; significant compromises in flight safety occur
- Crewmembers may be distracted by non-essential events and radio traffic; distractions result in compromises in flight safety

Workload Distribution

- Superior* + PC actively manages distribution of mission tasks to prevent any crewmember from being task overloaded, especially during critical phases of flight
- + Crewmembers are consistently aware of workload buildup on others and react quickly to adjust distribution of task responsibilities
- Acceptable* • Distribution of cockpit workload is not optimal, but no serious incidents of task overload occur with any one crewmember
- Crewmembers maintain some awareness of workload buildup on others; workload is adjusted before serious compromise to flight safety occurs
- Very Poor* - Maldistribution of cockpit workload occurs; task overload of one or more crewmembers may relate significantly to an issue of flight safety
- Crewmembers are generally unaware of workload buildup on others; little or no attempt is made to adjust the distribution of task responsibilities before significant compromises to flight safety occur

4. Illustrations of Basic Quality 4: Prioritize Actions and Distribute Workload (see Appendix D)

Learning Objectives for Hour 10 (Cont.)

5. Define unexpected events.
6. Describe the types of unexpected events and the best ways to prepare for their management.
7. Recognize the performance criteria for BQ 5.
8. Determine how BQ 5 and its associated Crew Coordination Elements were involved in Army aviation accidents.

Basic Quality 5: Management of Unexpected Events

5. Definition of Basic Quality 5:

This Basic Quality measures the crew's performance under unusual circumstances that may involve high levels of stress. Both the technical and managerial aspects of coping with the situation are important.

6. Management of Unexpected Events

a. Types of unexpected events

(1) Malfunctions

- What types of malfunctions would involve crew coordination?

(2) Inadvertent IMC

- What crew coordination actions are required for IIMC?

(3) Encounters with threat

(4) Sudden loss of visual reference near the ground

-
- (5) Unusual environmental conditions
 - (6) Near mid-air collisions
 - (7) Short notice in-flight mission change

b. Preparing for unexpected events

- (1) Technical and tactical proficiency
 - Knowledge
 - Training
 - Practice
- (2) Pre-mission planning and rehearsal
 - Assigning duties and responsibilities
 - Rehearsing "anticipated" events
- (3) Reminders during in-flight periods of low workload

c. Coping with unexpected events through interrelated use of all available resources

- (1) Internal resources
 - Aircrew
 - Equipment
 - Information

-
- (2) External resources
- Time
 - Other aircraft
 - Tactical controlling agency
 - ATC
 - Technical representatives

7. Performance Criteria for Basic Quality 5: Management of Unexpected Events
(see Appendix E, Basic Quality 5)

Rating Factors:

Crew Preparation and Composure

- Superior* + Crew actions reflect extensive rehearsal of emergency procedures in prior training and premission planning and rehearsal
- + Crewmember actions and information exchange are highly coordinated with minimal verbal direction from the PC
- + Crewmembers respond in a composed, professional manner
- Acceptable* • Crew actions reflect consistent understanding of emergency procedures; responses are adequately standardized to avoid significant conflicts or misunderstandings
- Crewmember actions and information exchange proceed smoothly, although moderate direction from the PC is necessary
- Crew composure is tense, but not flustered
- Very Poor* - Crew actions reflect misunderstanding of emergency procedures; little or no evidence of prior rehearsal during training or premission planning
- Crew actions and information exchange require extensive direction from the PC in order to avoid significant conflicts or misunderstandings
- Crew composure is disorganized and flustered

Resource Management

- Superior* + Each crewmember appropriately or voluntarily adjusts individual workload and task priorities with minimal verbal direction from the PC
- + Each crewmember is effectively utilized in responding to the emergency; workload is efficiently distributed
- Acceptable* • Each crewmember appropriately adjusts workload and task priorities, although moderate direction from the PC is necessary
- Each crewmember is utilized in responding to the emergency, with no major maldistributions of workload
- Very Poor* - One or more crewmembers fails to appropriately adjust workload during the course of the unexpected event resulting in a significant compromise to flight safety
- One or more crewmembers is inappropriately utilized or underutilized, resulting in a significant compromise to flight safety or mission performance; other crewmembers experience task overload

8. Illustrations of Basic Quality 5: Management of Unexpected Events (see Appendix D)

Crew Coordination Objective 4: Exchange Mission Information

- This objective is critically important to crew coordination. Key words in the definition are: communications, patterns and techniques, and information flow. This Crew Coordination Objective has four Basic Qualities:
 - BQ 6: Statements and directives clear, timely, relevant, complete, and verified
 - BQ 7: Maintenance of mission situational awareness
 - BQ 8: Decisions and actions communicated and acknowledged
 - BQ 9: Supporting information and actions sought from crew

Learning Objective(s) for Hours 11, 12, and 13

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

1. Identify the components of information transfer.
2. Explain the communication model and barriers to communicating.
3. Identify the factors affecting effective communications.
4. Recognize the performance criteria for BQ 6.
5. Determine how BQ 6 and its associated Crew Coordination Elements were involved in Army aviation accidents.

- Related ATM Crew Coordination Elements are:

Communicate positively: The sender directs, announces, requests, or offers; the receiver acknowledges; and the sender confirms based on the receiver's acknowledgement or action

Direct assistance: Crewmember directs assistance when cannot maintain aircraft control, position, or clearance; cannot operate aircraft systems without help; not expected to know what assistance is needed

Announce actions: All crewmembers must be aware of expected aircraft movements and alert to unexpected individual actions

Acknowledge actions: Supportive feedback to positively indicate that the message is received and understood

Be explicit: Crewmembers must avoid terms with multiple meanings; misinterpretations cause confusion; avoid indefinite modifiers

Basic Quality 6: Statements and Directives Clear, Timely, Relevant, Complete, and Verified

1. Definition of Basic Quality 6:

This Basic Quality refers to the completeness, timeliness, and quality of information transfer. It includes the use of standard terminology and the crew's feedback techniques to verify information transfer. Emphasis is on the quality of instructions and statements associated with navigation activities, obstacle clearing activities, and instrument readouts.

2. Communication Model

a. Communication process

- (1) Transmission of information
- (2) Receipt of information
- (3) Interpretation of information
- (4) Feedback if required

-
- (5) Transmit if necessary
 - (6) Acknowledgement of information receipt
 - (7) Confirmation of acknowledgement
- b. Barriers to communications
- (1) Physical
 - (2) Mental
 - (3) Word usage
 - (4) Interpersonal

3. Effective Communications

- a. Effective speaking
- (1) Standardized terminology
 - (2) Avoid local terms and slang
 - (3) Use Signal Operating Instructions (SOI)
 - (4) Position "mike" correctly
 - (5) Concise brevity essential
 - (6) Know what you want to say

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- b. Effective listening (Listening is hard work; active feedback)
 - (1) Attend to sender
 - (2) Ask questions if unsure of message
 - (3) Restate message if necessary
 - (4) Acknowledge verbally or by action
 - c. Nonverbal communications
 - (1) Signals must be standardized and responses closely monitored
 - (2) Words and symbols on forms and maps must be legible, decipherable
 - (3) Body language
 - d. Briefings
 - (1) Crew briefings set the tone for the entire mission
 - (2) Passenger briefings extremely important from safety aspect
 - (3) In-flight briefings necessary to provide updated common understanding of the mission for all crewmembers
 - (4) Crew-level after-action debriefings assess crew effectiveness and identify lessons learned to improve future performance
 - e. Critiques and feedback
 - (1) Crew self-critique as mission progresses

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- (2) Extremely important upon mission completion
 - (3) Not demeaning in nature
 - (4) Task-based, not person-based
- f. Aircrew communications
- (1) Pre-mission planning phase
 - (2) In-flight phase
 - High workload conditions
 - Low workload conditions
 - Sterile cockpit conditions
 - Irrelevant communications
 - (3) Post-mission phase
 - (4) Inquiry and questioning
 - (5) Advocacy and assertion
 - (6) Gender considerations (Appendix G, p. G-111)
 - (7) ATM examples of aircrew communications

4. Performance Criteria for Basic Quality 6: Statements and Directives Clear, Timely, Relevant, Complete, and Verified (see Appendix E, Basic Quality 6)

Rating Factors:

Adequacy and Timeliness

- Superior* + Call-outs are made on a consistent basis
+ Statements and directives are consistently offered in a timely manner
- Acceptable* • Call-outs are generally made; no major omissions
• Statements and directives are generally offered in a timely manner; no delays that compromise safety or mission
- Very Poor* - Call-outs are frequently ignored; significant compromises to safety or mission
- Statements and directives are frequently late, creating additional workload pressure; significant compromises to safety or mission

Clarity

- Superior* + Crewmembers consistently use standard terminology for all communications
+ Statements and directives are clear and concise
- Acceptable* • Crewmembers generally use standard terminology; no major misunderstandings
• Statements and directives communicate clear messages; ambiguity is generally avoided
- Very Poor* - Crewmembers fail to use standard terminology, resulting in misunderstandings
- Statements and directives contain ambiguous references or irrelevant information

Acknowledgement

- Superior* + Crewmembers actively seek feedback when no acknowledgement from another crewmember
+ Crewmembers consistently acknowledge understanding of intent; consistently request clarification when necessary

Acceptable • Crewmembers seek feedback when it appears that another crewmember misunderstands

- Crewmembers generally acknowledge messages and request clarification when necessary; no significant misunderstandings occur

Very Poor - Crewmembers disregard the need for feedback; misunderstandings occur between crewmembers

- Crewmembers frequently fail to acknowledge messages; misunderstandings occur

5. Illustrations of Basic Quality 6: Statements and Directives Clear, Timely, Relevant, Complete, and Verified (see Appendix D)

Learning Objectives for Hours 11, 12, and 13 (Cont.)

6. Identify the elements of mission situational awareness.
7. Explain the significance of maintaining mission situational awareness.
8. Describe the group mind.
9. Recognize the performance criteria for BQ 7.
10. Determine how BQ 7 and its associated Crew Coordination Elements were involved in Army aviation accidents.

Basic Quality 7: Maintenance of Mission Situational Awareness

6. Definition of Basic Quality 7:

This Basic Quality considers the extent to which crewmembers keep each other informed regarding the status of the aircraft and mission completion. This information reporting helps maintain a high level of situation awareness among the flight crew. Information reported includes: (Factors or elements)

- Aircraft position and orientation
- Equipment status
- Personnel status
- Environment and battlefield conditions
- Changes to mission objectives (External support, time)

Crew-wide situation awareness is an essential element of safe flying and effective crew performance.

7. Maintenance of Mission Situational Awareness

a. Situational awareness influencers

- (1) Experience \
- (2) Training / Inseparable
- (3) Physical flying skills
- (4) Spatial orientation
- (5) Physical and emotional health
- (6) Attitude

b. Pattern recognition

- (1) Instrument orientation
- (2) Flight procedures

c. In-flight appraisal

- (1) Crew at same level of awareness
- (2) Limited by lowest level of awareness
- (3) State of the cockpit and the aircraft

d. Problem identification and assessment

- (1) Action required

(2) Time available

(3) Environment

8. Group Mind (Appendix G, p. G-73)

a. Conscious mind

- Everything known
- Determines crew's level

b. Subconscious mind

- Essential information
- Limits crew's

c. Situational awareness problems

(1) Boredom

(2) Complacency

(3) Uncertainty

(4) Frustration and anger

9. Performance Criteria for Basic Quality 7: Maintenance of Mission Situational Awareness (see Appendix E, Basic Quality 7)

Rating Factors:

Crew Awareness

- Superior* + Crewmembers routinely update each other; changes are highlighted and acknowledged
+ Crewmembers take personal responsibility for scanning the entire flight environment
- Acceptable* • Crewmembers occasionally update each other; no major compromises to safety or mission
• Crewmembers take personal responsibility for notifying others of significant changes
- Very Poor* - Crewmembers disregard keeping each other informed; compromises to safety or mission occur
- Crewmembers confine their attention to their assigned area of scanning responsibility

Awareness Inhibitors

- Superior* + Crewmembers actively discuss conditions and situations that can compromise situational awareness (e.g., stress, boredom, fatigue)
- Acceptable* • Crewmembers adjust scanning and reporting patterns with changing mission demands
- Very Poor* - Crewmembers appear unaware of factors that can compromise situational awareness; factors affect crewmember scanning

10. Illustrations of Basic Quality 7: Maintenance of Mission Situational Awareness (see Appendix D)

Learning Objectives for Hours 11, 12, and 13 (Cont.)

11. Explain the results of failure to communicate and acknowledge decisions and actions.
12. Describe the value of positive communication and standardized procedures in communicating and acknowledging decisions.
13. Recognize the performance criteria for BQ 8.
14. Determine how BQ 8 and its associated Crew Coordination Elements were involved in Army aviation accidents.

Basic Quality 8: Decisions and Actions Communicated and Acknowledged

11. Definition of Basic Quality 8:

This Basic Quality pertains to the extent to which decisions and actions are actually made and announced to the crewmembers after input is solicited from them. Crewmembers should respond verbally or with the appropriate adjustment to their behaviors, actions, or control inputs to clearly indicate that they understand when a decision has been made and what it is. Failure to do so may confuse crews and lead to uncoordinated operation.

Note: Due to time constraints in certain situations, often there is little or no time for crew input to a decision. In this case, decisions should be acknowledged verbally or through coordinated, preplanned action.

12. Positive Communication

- a. Standardized terminology (Minimum conversation)
 - Standard words and phrases
 - Positive command

-
- b. Nonverbal communications
 - Behavior, actions, control input
 - Standard hand-and-arm signals
 - c. Accepted procedures
 - (1) Announce transfer of controls
 - (2) Use two-challenge rule
 - (3) Eliminate surprises and enhance teamwork

13. Performance Criteria for Basic Quality 8: Decisions and Actions Communicated and Acknowledged (see Appendix E, Basic Quality 8)

Rating Factors:

Communication of Decisions and Actions

<i>Superior</i>	+	Crewmembers announce decisions and actions, provide rationale and intentions as time permits
	+	Nonflying crewmember verbally coordinates transfer of controls or inputs before action
<i>Acceptable</i>	•	Crewmembers verbally announce decisions and actions; confusion and surprise are avoided
	•	Nonflying crewmember verbally coordinates transfer of controls or inputs before action
<i>Very Poor</i>	-	Crewmembers may fail to announce decisions and actions; ambiguous body signals or utterances; confusion or surprise exist
	-	Nonflying crewmember may make unannounced control inputs

Clarification and Acknowledgement

- Superior* + Crewmembers consistently acknowledge announced decisions or actions, provide feedback on impact on other crew tasks
+ Crewmembers promptly request clarification of decisions or actions, as appropriate
- Acceptable* • Crewmembers generally acknowledge announced decisions or actions; instances of major confusion are avoided
• Crewmembers request clarification of decisions or actions if confusion arises
- Very Poor* - Crewmembers frequently fail to acknowledge announced decisions or actions; confusion arises
- Crewmembers ignore need to clarify actions or decisions; surprise and confusion compromise safety or mission

14. Illustrations of Basic Quality 8: Decisions and Actions Communicated and Acknowledged (see Appendix D)

Learning Objectives for Hours 11, 12, and 13 (Cont.)

15. Explain the effects of management style on requests for support from other crewmembers.
16. Explain how cockpit climate affects requests for supporting information or actions.
17. Recognize the performance criteria for BQ 9.
18. Determine how BQ 9 and its associated Crew Coordination Elements were involved in Army aviation accidents.

Basic Quality 9: Supporting Information and Actions Sought from Crew

15. Definition of Basic Quality 9:

This Basic Quality has to do with the extent to which support information and support actions are sought from the crew by another crewmember, usually the PC. Depending upon the management style and the crew climate, crewmembers should feel free to raise questions during the flight regarding plans, revisions to plans, actions to be taken and the status of key mission information

16. Factors Influencing Request for Supporting Information and Actions (conditions necessary to openly ask for information or assistance)

a. Cockpit climate

- (1) Requests versus directives
- (2) Permit and encourage crewmember perspectives and questions
- (3) Positive team building
- (4) Shared understanding of the mission

b. Inputs and assistance

- (1) Broad base of available information
- (2) Informed decision making
- (3) Distribution of tasks
- (4) Mission plan common frame of reference

c. Inquiry

- (1) Constructive skepticism
- (2) Objective concern
- (3) Not a challenge
- (4) Searching for information

17. Performance Criteria for Basic Quality 9: Supporting Information and Actions Sought from Crew (see Appendix E, Basic Quality 9)

Rating Factors:

Solicitation of Crew Input

<i>Superior</i>	+	Crewmembers are encouraged to raise issues or offer information about safety or mission
	+	Crewmembers alert to impending decisions and actions; crewmember information solicited
<i>Acceptable</i>	•	Crewmembers occasionally raise safety or mission issues; no significant compromises
	•	Crewmembers occasionally solicit information on impending decisions and actions; no significant compromises

-
- Very Poor* - Crewmembers ignore or stifle input; view inputs as unwelcome; major safety compromises
- Crewmembers do not keep others informed of impending decisions and actions; safety compromises occur

Solicitation of Crew Assistance

- Superior* + Crewmembers consistently request assistance from others before they become overloaded or must divert their attention from a critical task
- Acceptable* • Crewmembers occasionally request assistance from others when they have become overloaded; no safety compromises arise from task overloads
- Very Poor* - Crewmembers fail to request assistance from others after becoming task overloaded; compromises to safety or mission occur

18. Illustrations of Basic Quality 9: Supporting Information and Actions Sought from Crew (see Appendix D)

Crew Coordination Objective 5: Cross-Monitor Performance

- This Crew Coordination Objective has four Basic Qualities:
 - BQ 10: Crewmember actions mutually cross-monitored
 - BQ 11: Supporting information and actions offered by crew
 - BQ 12: Advocacy and assertion practiced
 - BQ 13: Crew-level after-action reviews accomplished

Learning Objectives for Hours 14, 15, and 16

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

1. Explain the purpose of cross-monitoring crew performance.
2. Explain the relationship between cross-monitoring of performance and the achievement of tasks done to standard.
3. Describe the importance of, and techniques for, breaking the Error/Judgment Chain.
4. Recognize the performance criteria for BQ 10.
5. Determine how BQ 10 and its associated Crew Coordination Elements were involved in Army aviation accidents.

-
- Related ATM Crew Coordination Elements are:

Offer assistance: A crewmember will offer assistance when he sees another crewmember needs help; must never assume that the P* recognizes a hazard or the need for assistance.

Provide aircraft control and obstacle advisories: Crewmembers may need to provide aircraft control information regarding airspeed, altitude, or obstacle avoidance.

Basic Quality 10: Crewmember Actions Mutually Cross-Monitored

1. Definition of Basic Quality 10:

This Basic Quality has to do with the extent to which a crew uses cross-monitoring as a mechanism to avoid errors. Crewmembers are capable of catching each other's errors. Such redundancy is likely to be particularly important when crews are fatigued or overly focused on critical task elements, and thus more prone to make errors.

Note: This Basic Quality does not imply that task responsibilities are not clearly defined or that crewmembers are not technically qualified. It answers the question "To what extent do crewmembers help an individual assigned primary responsibility for a task or action by reviewing the quality of that individual's task execution and alerting him to any mistake noted?"

2. Reasons for Mutually Cross-Monitoring Crewmember Actions

a. Concern for task accomplishment according to standards

(1) ATM provides task standards

- Involvement of each crewmember in monitoring the need for assistance in coping with terrain, visual conditions, mission, and other stressors
- The P must warn the P* anytime he detects an unexpected deviation from the airspeed or altitude that exceeds the standard; loss of ground reference; or deviation from intended flight path

-
- (2) SOP reflects unit experience; a living document
- b. Recognition of information overload
- (1) No or confused reaction
 - (2) May require a division of responsibility
 - (3) Remedy: Use of standard terminology assists in reducing information overload
- c. Recognition of task saturation
- (1) Confusion with respect to procedures or priorities
 - (2) Forget finer points of task procedures
 - (3) Training, and then doing tasks to standard, reduces probability of task overload
 - (4) Remedy: Offer assistance or take controls after verifying lack of response (two-challenge rule not to be taken lightly)
- d. Recognition or announcement of *incapacitation*; involves more than just task execution—may involve capability to function as a crewmember
- (1) Subtle incapacitation
 - Latent effects
 - Crew relationship should tolerate

(2) Gross incapacitation

- Intoxication or "hung-over"
- Bona fide illness

(3) Incapacitation must be resolved

- Situationally dependent; don't let "good ol' boy network" influence decision
- Subtle incapacitations may require a redistribution of duties and responsibilities, especially if transitory
- Gross incapacitations may require mission cancellation, command action

3. Error/Poor Judgment Chain

a. Links in Error/Poor Judgment Chain

- Cues to loss of situational awareness (Appendix G, p. G-123)
- Accidents tend to result from a series of errors or events—an error chain; must find the weak link and break

(1) Ambiguity (Two or more sources of information do not agree)

(2) Fixation or preoccupation (Focused attention to exclusion of all other activity)

(3) Empty feeling or confusion (Unsure of the state of the aircraft or its condition)

-
- (4) Violation of minimums (Intentional or unintentional)
 - (5) Undocumented procedures (Use or consideration of an undocumented procedure)
 - (6) Nobody flying the aircraft
 - (7) Nobody looking out the window
 - (8) Failure to meet targets (hard times not met; locations not found; carelessness; attitude)
 - (9) Unresolved discrepancies (do not press for resolution; can repeat with unfortunate results)
 - (10) Departure from SOP (Either doesn't know or intentionally deviates from procedure; risky behavior)
 - (11) Failure to establish common understanding of mission between crewmembers (precludes effective cross-monitoring if all crewmembers do not know what is supposed to happen)
- b. Must recognize and break error chain as early as possible
- (1) Recognition is the key element
 - (2) Crew coordination training is a solution
 - (3) Technique for raising the situation awareness level of all crewmembers to the same level

c. Other techniques to break error chain

- (1) Two-challenge rule
- (2) Positive team building
- (3) Detailed premission planning and rehearsal
 - All crewmembers have the same understanding of the mission
 - Freedom to invoke the two-challenge rule, avoidance of excessive professional courtesy, and most conservative response

4. Performance Criteria for Basic Quality 10: Crewmember Actions Mutually Cross-Monitored (see Appendix E, Basic Quality 10)

Rating Factors:

Scanning for Crew Performance

- Superior* + Crewmembers acknowledge that crew error is a common occurrence, requiring active involvement of all crewmembers in detecting and breaking the error chains that lead to accidents
- + When errors are noted, the crewmember committing the error is quickly informed and/or assisted in a professional manner
- + Crewmembers are constantly alert for crew errors, assuming responsibility for monitoring their own performance and that of others for errors affecting flight safety or mission effectiveness
- Acceptable* • Crewmembers understand that human errors can occur during the mission, occasionally requiring the monitoring and intervention by all crewmembers
- Crewmembers assume some responsibility for monitoring the performance of others; no significant compromises to flight safety or effectiveness arise from neglect of cross-monitoring
 - When errors are noted, the crewmember committing the error is informed and/or assisted; [however, some improvement is possible in the timeliness or manner of monitoring]

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- Very Poor* - Crewmembers believe or act as if human error is a rare occurrence
- Crewmembers assume only the responsibility for monitoring their own performance; significant incidents of crew error remain undetected by others until flight safety or effectiveness is significantly compromised
 - When errors are noted, the crew may use the opportunity to insult or berate the crewmember committing the error

Two-Challenge Rule

- Superior* + Two-challenge rule is thoroughly discussed by crewmembers prior to execution of mission
- + Two-challenge rule is effectively implemented, if required, with minimal compromise to flight safety
- Acceptable* • Two-challenge rule is acknowledged by crewmembers prior to mission execution
- Two-challenge rule is implemented, if required, but results in some confusion or tension between crewmembers
- Very Poor* - Crewmembers ignore the two-challenge rule, leaving its implementation ambiguously defined
- Crewmembers fail to implement two-challenge rule when required, resulting in significant compromise to flight safety

5. Illustrations of Basic Quality 10: Crewmember Actions Mutually Cross-Monitored (see Appendix D)

Learning Objectives for Hours 14, 15, and 16 (Cont.)

6. Recognize the definition of BQ 11: Supporting information and actions offered by crew.
7. Explain how the crew's offering of assistance indicates the quality of the working relationship.
8. Recognize the performance criteria for BQ 11.
9. Determine how BQ 11 and its associated Crew Coordination Elements were involved in Army aviation accidents.

Basic Quality 11: Supporting Information and Actions Offered by Crew

6. Definition of Basic Quality 11:

This Basic Quality addresses the extent to which crewmembers anticipate and offer support information and support actions to the decision maker, usually the PC, when it becomes apparent that a decision must be made or an action taken.

7. Considerations with Respect to Supporting Information and Actions Offered by Crew

a. ATM requirement

- (1) Crew Coordination Element 3: A crewmember will provide the assistance or information that has been requested. He also will offer assistance when he sees that another crew member needs help
- (2) Involvement of each crewmember in monitoring the need for assistance of other crewmembers
- (3) Identified as Crew Coordination Error 5 (failure to offer assistance or information) in the USASC/ARI accident analysis

b. Indicator of effective team building

- (1) ATM requirement may not ensure that required assistance or information is forthcoming
- (2) Cockpit climate must be supportive of free information exchange and assistance to others; crewmembers asking the tasked crewmember if he needs specific information or an action accomplished prior to the actual requirement is a good indicator of the crew's working relationship
- (3) Assistance rendered only in the event of precluding loss of life indicates severe interpersonal problems which increases the mission risk factor and works against the continued association of the affected crew

c. Techniques to enhance the offering of assistance and information by crewmembers

- (1) Must first build a team using techniques and leadership principles taught earlier in the course
- (2) Employ effective techniques
 - Rules of common courtesy
 - Behavior modification
 - Praise in public; criticize in privacy
 - Constructive, not destructive, criticism
 - Stronger measures as appropriate
 - Excessive professional courtesy discouraged
 - Two-challenge rule in effect

- Most conservative response taken

(3) Crew-level after-action reviews accomplished

- Will discuss later, but is a means, given a good working relationship, to getting crewmembers to open up and express dissatisfactions or unrealized expectations.
- Consideration and resolution of "gripes"

8. Performance Criteria for Basic Quality 11: Supporting Information and Actions Offered by Crew (see Appendix E, Basic Quality 11)

Rating Factors:

Anticipation and Offering of Required Information

<i>Superior</i>	+	Crewmembers consistently anticipate the need to provide information or warnings to PC or pilot on the controls during critical phases of flight
	+	Required information and warnings are consistently provided in a timely manner
<i>Acceptable</i>	•	Crewmembers provide information or warnings to PC or pilot on the controls when requested; no significant compromises to flight safety or mission performance arise due to failure to offer critical information or warnings
	•	Required information and warnings are generally provided in a timely manner; no significant compromises to flight safety or effectiveness arise due to lack of timeliness of supporting information or warnings
<i>Very Poor</i>	-	Crewmembers fail to provide information or warnings requested by PC or pilot on the controls, or provide information and warnings only reluctantly; significant compromises to flight safety or mission performance may occur as a result
	-	Required information or warnings, when offered, are late; significant compromises to flight safety and effectiveness may occur as a result

Anticipation and Offering of Required Assistance

- Superior* + Crewmembers consistently anticipate the need to provide task assistance to PC or pilot on the controls during critical phases of flight
+ Required task assistance is consistently provided in a timely manner
- Acceptable* • Crewmembers provide task assistance to PC or pilot on the controls when requested; no significant compromises to flight safety or effectiveness arise due to failure to offer critical information or warnings
• Required task assistance is generally provided in a timely manner; no significant compromises to flight safety or mission performance arise due to lack of timeliness of supporting assistance
- Very Poor* - Crewmembers fail to provide task assistance requested by PC or pilot on the controls, or provide assistance only reluctantly; significant compromises to flight safety and mission performance may occur as a result
- Required task assistance, when offered, is late; significant compromises to flight safety and effectiveness may occur as a result

9. Illustrations of Basic Quality 11: Supporting Information and Actions Offered by Crew (see Appendix D)

Learning Objectives for Hours 14, 15, and 16 (Cont.)

10. Define conditions under which advocacy and assertion could be impractical.
11. Explain the difference between assertive and aggressive behavior.
12. Recognize the performance criteria for BQ 12.
13. Determine how BQ 12 and its associated Crew Coordination Elements were involved in Army aviation accidents.

Basic Quality 12: Advocacy and Assertion Practiced

10. Definition of Basic Quality 12:

This Basic Quality concerns the extent to which crewmembers advocate a course of action they consider best, even when it may be in disagreement with others. *Note: Except under extreme emergency conditions, where time is absolutely critical, it is usually in the crew's best interest to hear the full range of options available.*

11. Advocacy and Assertion

a. What is advocacy?

- (1) Stronger than a recommendation, which is a positive declaration in favor of a set of possibilities
- (2) Is the obligation to speak out in support of a course of action different than that being planned or followed. Also involves listening to other viewpoints that may be contradictory in nature.

b. What is assertion?

- (1) To state a position with some force or conviction

-
- (2) The forceful, nonthreatening statement of a belief, feeling, position, or idea concerning a situation with which one is uncomfortable
 - (3) The five-step advocacy process is to:
 - Get the attention of the individual
 - State the concern
 - State the problem
 - Offer a solution, and then
 - Obtain agreement.
 - Major, I don't think we should be out here cruising 500 feet above the trees. Last intel reports indicated heavy ground small arms fire and we're pretty exposed at this altitude. I think we should get down right above the trees, if possible. Don't you think that makes sense?
 - What if assertive statement doesn't work and you are still convinced that the proposed course of action is dangerous?

c. Importance of advocacy and assertion

- (1) Reduces frustration by allowing the free expression of ideas which crewmembers may be holding back for various reasons
- (2) Introduces the decision maker to a wider range of options than might be otherwise available
- (3) Prevents intimidation by older, more experienced crewmembers where an idea is held to be of value
- (4) Builds team cohesion because crewmembers know their ideas will be heard and considered; they are important to the decision process

-
- (5) Should be fostered; especially in terms of a "devil's advocate" to examine alternative courses of action

d. What advocacy and assertion are not

- (1) Not an attack upon, or disrespect of, command authority
- (2) Not aggressive behavior in that it is not hostile

12. Performance Criteria for Basic Quality 12: Advocacy and Assertion Practiced
(see Appendix E, Basic Quality 12)

Rating Factors:

Advocacy

- Superior* + Time permitting, crewmembers consistently provide rationale for their recommended plans and courses of action; a professional atmosphere is maintained
- + Crewmembers consistently request feedback to insure that others have correctly understood their statements or rationale
- + Time permitting, crewmembers practice good listening habits, allowing others to state their rationale before commenting on the recommended plans or courses of action
- Acceptable* • When misunderstanding is apparent, crewmembers provide rationale for their recommended plans and courses of action; some level of objectivity is maintained
- Crewmembers request feedback when it becomes obvious that others have misunderstood their statements or rationale
- Time permitting, crewmembers generally allow others to explain their recommendations before interrupting
- Very Poor* - Crewmembers frequently justify their recommendations on rank or experience level, rather than logic; personality conflicts occasionally result from this behavior
- Crewmembers give little concern to insuring that others have correctly understood their statements or rationale; misunderstandings are permitted to continue

-
- Crewmembers display a closed mind with regard to accepting recommendations from others; decisions and actions are overly influenced by a crewmember who possesses a dominant personality

Assertion

- Superior* + PC actively promotes objectivity in the cockpit by encouraging junior crewmembers to speak up regardless of rank or experience level
- + Junior crewmembers do not hesitate to speak up when they disagree with others; junior crewmembers understand that more experienced aviators can occasionally commit errors or lose situational awareness
 - + Every crewmember displays a sense of responsibility for adhering to flight regulations, operating procedures, and safety standards
- Acceptable* • PC tolerates junior crewmembers to speak up regardless of rank or experience level
- Junior crewmembers voice disagreements when asked; junior crewmembers speak up when they observe obvious errors being committed by more experienced aviators
 - Crewmembers speak up when they believe that flight regulations, operating procedures, or safety standards are being violated
- Very Poor* - PC uses rank or experience factors to impose authoritarian control over other crewmembers
- Crewmembers are generally reluctant to challenge a senior or more experienced aviator, even when they know themselves to be correct; junior crewmembers generally assume that the senior crewmember knows what he is doing, regardless of the facts
 - Crewmembers deny personal responsibility for flight safety, and may allow others to violate known flight regulations, operating procedures, or safety standards because of rank and experience level

13. Illustrations of Basic Quality 12: Advocacy and Assertion Practiced (see Appendix D)

Learning Objectives for Hours 14, 15, and 16 (Cont.)

14. Identify the occasions upon which the crew can review and critique their actions.
15. Differentiate between the crew-level after-action review and the perform after-landing tasks requirements.
16. Conduct a crew-level after-action review using the Crew-Level After-Action Review Checklist.
17. Recognize the performance criteria for BQ 13.
18. Determine how BQ 13 and its associated Crew Coordination Elements were involved in Army aviation accidents.

Basic Quality 13: Crew-Level After-Action Reviews Accomplished

14. Definition of Basic Quality 13:

This Basic Quality has to do with the extent to which the crew reviews and critiques their actions during or following a mission segment, during low workload periods, or during the post-flight debrief.

15. Crew-Level After-Action Reviews

- a. Must instill practice at individual crew level
- b. Assists in team building
 - (1) Mission accomplishment--final phase
 - (2) Enhances and fine tunes

-
- c. Identify enhancements to:
 - (1) Unit operations
 - (2) Aircrew as a team
 - (3) Individual crewmember
 - d. What an after-action review is not:
 - (1) DA Form 5484-R brief-back
 - (2) Lecture by the PC
 - e. What an after-action review is:
 - (1) Professional discussion of training events or operational missions
 - (2) Structured review process that allows training participants to discover for themselves what happened, why it happened, and how it can be done better
 - (3) Compares execution with operational expectations (OPORD/Air Mission Briefing, premission planning goals, mission objectives)
 - f. After-action reviews (FM 25-100, FM 25-101)
 - (1) Types
 - Informal
 - Formal

-
- (2) After-action reviews--
- Focus on training, mission objectives, and crew interactions
 - Emphasize the meeting of standards
 - Identify important lessons learned
 - Share the lessons among all participants
- g. After-action review considerations
- (1) Avoid critique or lecture
 - (2) Relate events to final results
 - (3) Discuss alternative courses of action and possible results
 - (4) Avoid nonrelated events
 - (5) Do not damage self-esteem or cohesiveness
 - (6) Goal is for each crewmember to accurately assess own performance
- h. Crew-Level After-Action Review Checklist (Table 1-2, p. 1-104)
- Format
 - Provides

-
- Stresses
 - Closes the loop

16. Conduct Crew-Level After-Action Review (p. 1-105)

Table 1-2. Crew-Level After-Action Review Checklist

1. All crewmembers present.
2. Restate mission objectives.
3. METT-T considerations.
- 4.* Conduct review for each mission segment:
 - a. Restate planned actions/interactions for the segment.
 - b. What actually happened?
 - (1) Each crewmember states in own words.
 - (2) Discuss impacts of crew coordination requirements, aircraft/equipment operation, tactics, commander's intent, etc.
 - c. What was right or wrong about what happened?
 - (1) Each crewmember states in own words.
 - (2) Explore causative factors for both favorable and unfavorable events.
 - (3) Discuss crew coordination strengths and weaknesses in dealing with each event.
 - d. What must be done differently the next time?
 - (1) Each crewmember states in own words.
 - (2) Identify improvements required in the areas of team relationships, mission planning, workload distribution and prioritization, information exchange, and cross-monitoring of performance.
 - e. What are the lessons learned?
 - (1) Each crewmember states in own words.
 - (2) Are changes necessary to:
 - (a) Crew coordination techniques?
 - (b) Flying techniques?
 - (c) SOP?
 - (d) Doctrine, ATM, TMs?
5. Effect of segment actions and interactions on the overall mission?
 - (1) Each crewmember states in own words.
 - (2) Lessons learned?
 - (a) Individual level.
 - (b) Crew level.
 - (c) Unit level.
6. Dismiss crewmembers.
7. Advise Operations of significant lessons learned.
8. Incorporate significant lessons learned in subsequent missions.

* This step may also be accomplished during periods of low in-flight workload to resolve disagreement or to critique significant decisions, actions, and interactions affecting mission performance. In-flight review of a segment does not preclude its coverage during the AAR.

Crew-Level After-Action Review Checklist

1. All crewmembers present. (Yes)
2. Restate mission objectives.
3. METT-T considerations.
4. Conduct review for each mission segment:
 - a. Restate planned actions/interactions for the segment.
 - b. What actually happened?
 - (1) Each crewmember states in own words.
 - (2) Discuss impacts of crew coordination requirements, aircraft/equipment operation, tactics, commander's intent, etc.
 - c. What was right or wrong about what happened?
 - (1) Each crewmember states in own words.
 - (2) Explore causative factors for both favorable and unfavorable events.
 - (3) Discuss crew coordination strengths and weaknesses in dealing with each event.

-
- d. What must be done differently the next time?
 - (1) Each crewmember states in own words.
 - (2) Identify improvements required in the areas of team relationships, mission planning, workload distribution and prioritization, information exchange, and cross-monitoring of performance.
 - e. What are the lessons learned?
 - (1) Each crewmember states in own words.
 - (2) Are changes necessary to:
 - (a) Crew coordination techniques?
 - (b) Flying techniques?
 - (c) SOP?
 - (d) Doctrine, ATM, TMs?
5. Effect of segment actions and interactions on the overall mission?
- (1) Each crewmember states in own words.
 - (2) Lessons learned?
 - (a) Individual level.
 - (b) Crew level.
 - (c) Unit level.

-
6. Dismiss crewmembers. (Simulate)
 7. Advise Operations of significant lessons learned.
 8. Incorporate significant lessons learned in subsequent missions.
-

17. Performance Criteria for Basic Quality 13: Crew-Level After-Action Reviews Accomplished (see Appendix E, Basic Quality 13)

Ratings Factors:

Critique and Improvement of Crew Performance

<i>Superior</i>	+	Crew critiques major decisions and actions, identifying options and factors that should have been discussed, and outlining ways of improving crew performance in future missions
	+	Critique of crew decisions and actions is conducted in a professional manner; finger-pointing is avoided, with emphasis on education and improvement of crew performance
<i>Acceptable</i>	•	Crew reviews major decisions and actions, focusing on obvious errors, and identifying ways of avoiding those errors in future missions
	•	Critique of crew decisions and actions avoids personality conflicts or other attitudes that would detract from the discovery of improved procedures
<i>Very Poor</i>	-	Crew avoids any discussion of major decisions and actions; obvious errors are ignored with little or no concern about improving crew performance in future missions
	-	After-action reviews consist of finger-pointing; little or no collaborative spirit is exhibited; the crew appears likely to repeat poor performance

18. Illustrations of Basic Quality 13: Crew-Level After-Action Reviews Accomplished (see Appendix D)

1. Course Overview

- Defined crew coordination
- Described crew coordination training

2. Features of Army Crew Coordination Training

- Crew Coordination Model
- Crew Coordination Elements
- Basic Qualities
- Crew Coordination Objectives
- Organized instruction from detailed tasks to broad objectives
- Ideas from military and commercial aircrew coordination courses
- Emphasizes team formation, communications, premission planning, rehearsal, and crew-level after-action reviews
- Multiple decision-making techniques
- Standardized terminology
- Hands-on using simulator or aircraft

3. What's new in Army Training and Evaluation of Aircrews

- Battle-rostering

-
- Individual to collective training
 - Situational training exercises
 - Crew readiness level progression
 - Train as fight
4. History of Crew Coordination Research and Programs
- Reviewed crew coordination courses
 - Discussed USASC and ARI aviation accident analysis
5. Findings from the Rotary Wing Accident Analysis
- 41% communications failures
 - 35% workload or prioritization failures
6. Six Categories of Crew Coordination Errors
- Failure to direct assistance
 - Failure to announce a decision or action
 - Failure to communicate positively
 - Failure to assign crew responsibilities
 - Failure to offer assistance or information
 - Failure to execute actions in proper sequence

7. Revision of TC 1-210 and ATMs

- Linked individual, crew, and unit collective tasks
- Implemented accident analysis findings

8. Eight ATM Crew Coordination Elements Defined

- Communicate positively
- Direct assistance
- Announce actions
- Offer assistance
- Acknowledge actions
- Be explicit
- Provide aircraft control and obstacle advisories
- Coordinate action sequence and timing

9. Requirement for Crew Coordination Measurement

- Task-level approach satisfactory for individual evaluations
- Comprehensive approach needed for crew-level evaluations
- Developed Basic Qualities as bridge between ATM tasks and Crew Coordination Objectives

Basic Qualities (13)

- Establish and maintain flight team leadership and crew climate
- Pre-mission planning and rehearsal accomplished
- Application of appropriate decision making techniques
- Prioritize actions and distribute workload
- Management of unexpected events
- Statements and directives clear, timely, relevant, complete, and verified
- Maintenance of mission situational awareness
- Decisions and actions communicated and acknowledged
- Supporting information or actions sought from crew
- Crewmember actions mutually cross-monitored
- Supporting information or actions offered by crew
- Advocacy and assertion practiced
- Crew-level after-action reviews accomplished

11. Defined Crew Coordination Objectives (5)

- Establish and maintain team relationships
- Mission planning and rehearsal
- Establish and maintain workload levels
- Exchange mission information
- Cross-monitor performance

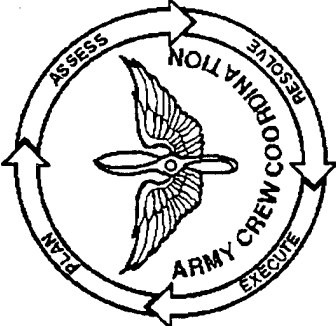
12. Described the Crew Coordination Model and Functions (Logo)

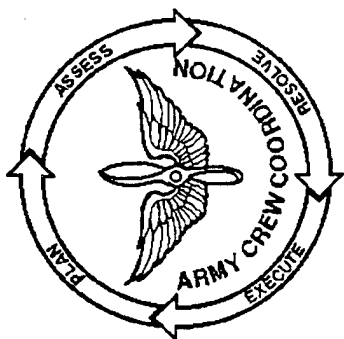
- Plan
- Assess
- Resolve
- Execute

13. Reviewed Each Crew Coordination Objective and Associated Basic Quality in Detail:

- Definition
- Supporting instructional information
- Performance criteria for Superior, Acceptable, and Very Poor Performance
- Analyzed cases from the Army accident data base and FLIGHTFAX to illustrate the results of failure to observe sound crew coordination principles

Relationship of ATM Aircrew Coordination Elements, Basic Qualities, and Aircrew Coordination Objectives (Cross-walk Chart)

ATM Aircrew Coordination Elements										Aircrew Coordination Basic Qualities										Crew Coordination Objectives									
																													
Communicate Positively	Direct Assistance	Announce Actions	Offer Assistance	Acknowledge Actions	Be Explicit	Provide Aircraft Control and Obstacle	Action Sequence/Timing											Establish and Maintain Team Relationships	Mission Planning and Rehearsal	Establish and Maintain Workload Levels	Exchange Mission Information	Cross-Monitor Performance							
								1. Establish and maintain flight team leadership and crew climate	XX																				
							X	2. Pre-mission planning and rehearsal accomplished							XX														
	X							3. Application of appropriate decision making techniques							XX	X													
	X		X					4. Prioritize actions and distribute workload								XX													
			X			X		5. Management of unexpected events	X							XX													
XX				X	XX			6. Statements and directives clear, timely, relevant, complete, and verified									XX												
X								7. Maintenance of mission situational awareness									XX												
		XX		XX				8. Decisions and actions communicated and acknowledged									XX												
	XX							9. Supporting information and actions sought from crew								X	XX												
		XX				XX		10. Crewmember actions mutually cross-monitored										XX											
			XX					11. Supporting information and actions offered by crew								X		XX											
		XX						12. Advocacy and assertion practiced										XX											
								13. Crew-level after-action reviews accomplished									X	XX											
																		XX											



SIMULATOR OR FLIGHT TRAINING AND EVALUATION

Scenario-based mission-oriented simulator or flight training during which the aircrews will apply crew coordination principles under the guidance of an instructor, who will also evaluate their progress. Evaluation guidance is located in Appendix E.

Learning Objectives for Hour 18

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

1. Describe the advantages of scenario-based training and the role of the instructor.
2. Define the difference between the grading and rating systems employed in aircrew coordination training.
3. Comply with all requirements specified in the simulator or flight training crew briefing.

..... Introduction

A one-hour academic block of instruction covering scenarios, grading and rating system, and the crew briefing prior to the actual simulator or flight portion of the course.

1. Scenarios and the Role of the Instructor

- a. Standardized simulator or flight scenarios will be used to ensure uniformity of training
- b. Instructor will use the Aircrew Coordination Training Grade Slip (discussed later) to record evaluation information during simulator or flight missions. Two of the four missions are training missions; the first (pretraining ride) and fourth (evaluator ride) missions will be formally evaluated.

2. Crew Coordination Evaluation (Appendix E)

a. Relationship of the Basic Qualities to ATM task grades

- (1) ATM tasks have incorporated the relevant Crew Coordination Elements
- (2) ATM task grade will consider aircrew coordination, technical flight skills, and the Crew Coordination Basic Qualities appropriate to the ATM task
- (3) Performance of each Basic Quality will be assessed on a total mission basis with respect to how the Basic Quality was employed collectively by the crewmembers throughout the several tasks composing the mission

b. Aircrew Coordination Training Grade Slips

- (1) Similar to currently fielded grade slips
- (2) Will discuss grading and rating schemes next

c. Introduction of the crew coordination grading scheme for tasks or mission

- (1) Grade of "S" given for acceptable performance
- (2) Grades of "S+" and "S-" given for exceptional or less than acceptable performance, respectively
- (3) Grade of "U" given for unacceptable performance
 - If given for a task, does not render entire flight unsatisfactory
 - If given for a mission, the entire flight was unsatisfactory
 - If given for an evaluation ride, remedial training is required

-
- d. Introduction of the Crew Coordination Basic Quality rating scheme
 - (1) Rating of "1" given for "Very Poor" performance
 - (2) Rating of "4" given for "Acceptable" performance
 - (3) Rating of "7" given for "Superior" performance
 - e. Importance of training feedback from the instructor
 - (1) Positively reinforces behaviors in a timely manner
 - (2) Allows poor behaviors to be analyzed and corrected
 - (3) Videotape (if used) allows one to see oneself as others see them; provides an opportunity for self-critique and assessment that can be reinforced by comments from the crew and the instructor
 - f. Videotaping confidentiality considerations
 - (1) No confidentiality requirements if not videotaped
 - (2) If videotaped, videotape will be used to support the instructor's critique and then reused or erased
3. Simulator or Flight Training Crew Briefing
- a. Report to the Simulator Facility or flight line per schedule
 - b. Instructor will issue the required planning materials and brief the mission. A total of 1.5 hours is scheduled to brief and plan the mission.

-
- c. Simulator or flying time to execute the flight plan is 1.75 hours
 - d. Time allotted for the crew-level after-action review is 1.75 hours
 - e. In planning the mission, flying the mission, or reviewing the mission, employ all the appropriate crew coordination principles and techniques learned in the classroom
 - f. During the premission planning, flight, and crew-level after-action review phases of the mission, the instructor will be observing and evaluating. On the pretraining and first training rides, the instructor will offer advice, make suggestions with respect to crew activities, and answer any crew questions--and remember, there is no such thing as a dumb question. On the second training ride, the crew will be expected to work on its own with minimum intervention by the instructor to offer advice, suggestions, or to answer questions. The third training ride will be evaluated for course completion and, for battle-rostered crews, progression to Crew Readiness Level 1 (optional)
 - g. For the pretraining and first and second training rides, the instructor will conduct a critique of the entire mission from premission planning to crew-level after-action review. During this critique, the grades assigned to the ATM tasks performed, the ratings assigned to the Basic Qualities involved, any comments on such grades and ratings, and, if videotaped, the videotape, will be used by the instructor to debrief the crew. Instructors will conduct a standard debriefing for the evaluation mission (third training ride)
 - h. During the instructor critique/debriefing, the crew will participate by querying the instructor, advocating certain positions or actions taken, and by asserting themselves whenever they may feel a point should be made or explained. In this light, the critique/debriefing can be viewed as another opportunity to practice the crew coordination principles learned in the classroom. We trust that you will use this opportunity to your crew's advantage.
4. Learning Objectives for Simulator or Flight Training (Hours 1 - 20)

Learning Objectives for Hours 1 through 20

With the aid of classroom notes or furnished doctrinal publications, and while in the classroom, simulator facility, or aircraft, the student, without error, will be able to:

- 1. Accomplish premission planning and rehearsal.**
- 2. Perform a tactical mission in the simulator or aircraft.**
- 3. Conduct a crew-level after-action review.**
- 4. Employ crew coordination principles during the instructor/crew debrief.**

- Comply with simulator/flight schedule as follows:

1. Premission Planning and Rehearsal

- Planning and rehearsal time is 1.5 hours.
- Plan and rehearse the mission using the crew coordination principles learned in the classroom.

2. Simulator or Flight Mission

- Flying time is 1.75 hours.
- Fly the scenario missions according to the plan. Apply crew coordination principles and techniques throughout each mission, as appropriate.

3. Crew-Level After-Action Review

- Crew-level after-action review time is 1.75 hours.
- Conduct the after-action review in accordance with the Crew-Level After-Action Review Checklist.

4. Instructor Critique/Debriefing

- Part of the crew-level after-action review period.
- Use this occasion as an opportunity to further practice newly acquired crew coordination skills by challenging remarks, grades, or ratings.

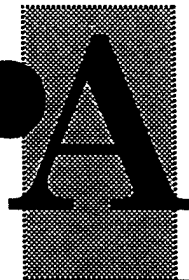
2 Practical Exercises

What you will find in this section:

Your instructor will pass out the following practical exercises to you during the course; insert the exercises in this section.

- ☒ Stress
- ☒ Planning and Rehearsal
- ☒ Hazardous Thought Patterns
- ☒ Communication





Hangar Talk

What you will find in this appendix:

- ☑ This appendix is a place-holder to store recent FLIGHTFAX articles, other aviation-related publication articles, and short vignettes written by IPs covering accidents and aircrew coordination.

Crew Coordination Errors: Definitions and Examples

What you will find in this appendix:

- ☑ Definitions and examples of each of the six crew coordination errors

B

Crew Coordination Errors: Definitions and Examples

The crew coordination errors on the following pages have been identified from an in-depth analysis of U.S. Army rotary wing aviation accidents. Each crew coordination error is illustrated with brief narratives to assist you in recognizing or distinguishing the types of errors that contribute to aviation accidents.

Please note that it is quite possible for the aircrews to be committing errors throughout the entire flight. Although such errors might reduce mission effectiveness, they do not necessarily translate into accidents. Such errors translate into accidents when there is insufficient time to identify and recover from the error under unforgiving circumstances. In general, however, an increase in the frequency of errors reduces the aircrew's overall mission effectiveness and raises the potential for an accident.

Please note that the crew coordination errors do not consider individual flight skill deficiencies, poor individual judgement, or failure of an individual to follow established procedures. Such incidents were excluded from consideration as crew coordination errors. The analysis of Army rotary wing aviation accidents revealed that a significant number involved highly experienced aircrews. The crew coordination errors occurred because of interfering habit patterns and the failure of experienced aviators to effectively communicate and coordinate their actions in the cockpit.

Crew Coordination Error 01

Failure of the P* to properly direct assistance from the other crewmembers.

Definition:

Good aircrew coordination requires that the P* requests assistance during critical maneuvers, when monitoring flight parameters, or when performing required actions inside the cockpit. The crew coordination error occurs when crewmembers possess an "I can do this myself" attitude. When nonflying crewmembers are not directed to assist in the highest priority task, the error then involves a failure to recognize task priority, rather than a failure to utilize all available crew resources.

Examples:

1-1 The PC* assumed the controls from the P after the P had experienced difficulty in correctly aligning a night, unaided approach to a poorly illuminated landing zone (landing zone was obscured by background lights from a nearby town). Instead of directing the P to assist in monitoring and calling out airspeed and altitude, the PC* relied on degraded visual references to control his approach. The P called out "Watch your closure," but was unable to provide sufficient warning before the aircraft descended into trees and crashed. [UH-60A]

1-2 After flying more than two hours under NVG conditions, the P* announced that he was too tired to continue on the controls during a search and rescue mission. The PC assumed the controls, but failed to (1) determine if the P was able to provide further assistance and (2) direct the P to assist in terrain flight map navigation and obstacle avoidance.

Continuing with the mission, the PC* attempted a terrain flight approach along a valley to an intended landing site. Subsequently, the aircraft struck a set of high tension wires extending across the approach valley. [UH-60A]

1-3 On a night, unaided mission over water, the PC* assumed the controls at 100 feet AGL and attempted to maneuver underneath a thunderstorm. Without directing the P to assist in monitoring and calling out altitude, the PC* began to perform a number of tasks simultaneously: instrument cross checks, radio calls, aircraft control, and reset of the force trim switch. The PC* subsequently became task saturated and allowed the aircraft to descend unnoticed into the water. [OH-58C]

1-4 During an NVG flight at 400 feet AGL, the aircrew experienced a low engine RPM warning signal. Without requesting the P to perform an engine cross check (required by the aircraft's

technical manual), the PC* erroneously assumed that an engine failure had occurred and began to set the aircraft up for an NVG autorotation. Without announcing his intentions, the P removed his goggles and turned on both the white landing light and the white cockpit lights. The landing light came on momentarily and burned out, leaving both crewmembers temporarily blinded. The subsequent autorotation was performed poorly because of degraded visual references and the aircraft struck the ground. [OH-58C]

1-5 The PC* was making a second attempted aft wheel landing to a 25° sloping terrain. Instead of directing the CE to provide rear clearance assistance with the aft main rotor blades, the PC* directed the CE to "Call the wheels down." This action required the CE to lie face down with his head extended over the ramp. In this position, the CE was unable to properly judge main rotor blade clearance with the sloping terrain. Subsequently, the aft main rotor blades struck the sloping terrain as the PC* lowered the aircraft. [CH-47B]

Crew Coordination Error 02

Failure of a crewmember to announce a decision or an action that affected other crewmembers' ability to perform their duties properly.

Definition:

Good aircrew coordination requires a crewmember to inform other crewmembers when he is about to take an action that will affect the duties or performance of the other crewmembers. This includes informing others when unilaterally deferring or abandoning a high priority task for a lower priority task and when making a positive transfer of controls. Failure to make a positive transfer of controls may result in a destabilized situation in which two crewmembers unknowingly interfere with one another or, at a minimum, produce erroneous feedback cues.

Examples:

2-1 While in terrain flight, the PC* (left seat) initiated a right turn without announcing his intention or requesting clearance assistance from the P (right seat). The P had his attention inside the cockpit for map navigation, and the CE was also seated on the left side of the aircraft. Subsequently, the aircraft's main rotor blades struck a tree on the right side of the aircraft. [UH-60A]

2-2 While initiating a climbout after takeoff on an NVG mission, the aircrew saw the master caution light illuminate. The PC* switched the panel lighting from NVG to DIM mode, while the P began to scan the instruments to identify the problem. Without announcing his action or requesting the P to assume control of the aircraft, the PC* diverted his attention inside the cockpit to assist in the problem diagnosis. While both the PC* and P had their attention diverted inside the cockpit,

the aircraft descended and impacted the ground. [UH-60A]

2-3 During terrain flight over the desert (50 feet AGL and 90 knots), the PC* noticed that the P's attention was diverted to the rear cabin. Without querying the P or informing him of his interest, the PC* diverted his own attention from flying to investigate the distraction. When the PC* again directed his attention forward, he noticed that the aircraft had lost considerable altitude. A subsequent aft cyclic control input caused the tail wheel of the aircraft to strike the ground. [UH-60A]

2-4 During an NVG flight at 400 feet AGL, the aircrew experienced a low engine RPM warning signal. Without requesting the P to perform an engine crosscheck (required by the aircraft's technical manual), the PC* erroneously assumed that an engine failure had

occurred and began to set the aircraft up for an NVG autorotation. Without announcing his intentions, the P removed his goggles and turned on both the white landing light and the white cockpit lights. The landing light came on momentarily and burned out, leaving both crewmembers temporarily blinded. The subsequent autorotation was performed poorly because of degraded visual references and the aircraft struck the ground. [OH-58C]

2-5 The P* was practicing night unaided landings to an inverted Y without the use of landing lights. Several earlier landings

had occurred with excessive approach speed. On the final landing attempt, the P* allowed the aft portion of the aircraft's skids to impact the ground at an excessive rate of descent. The P* immediately increased the collective in an attempt for another approach. Without announcing his intentions or actions, the PC simultaneously attempted to lower the collective upon hearing a loud noise. The subsequent conflicting control inputs, culminating with a sudden release of the collective by the P*, resulted in the aircraft striking the ground a second time. The second impact with the ground sheared the aircraft's aft crossbrace. [UH-1H]

Crew Coordination Error 03

Failure of crewmembers to communicate positively (verbally or nonverbally).

Definition:

Good aircrew coordination requires crewmembers to communicate positively so that there is a common understanding of the state of the aircraft and the actions expected and required of each crewmember. Misunderstandings can arise when one crewmember (1) assumes that the other crewmembers automatically understand what is happening or what is expected; (2) uses incomplete, unfamiliar, or ambiguous phrases; (3) fails to verify that the other crewmember has heard and correctly understood the communication; or (4) uses excessive professional courtesy (e.g., "you're a little fast"), which does not provide specific information needed to accomplish the task.

Examples:

3-1 PC (left seat) saw a tree on left side of the approach path to a confined area but misadvised P* through use of non-specific "Don't turn left" warning. Still unaware of the trees, the P* allowed the main rotor blade to strike the tree. [UH-1H]

3-2 While flying NOE along a river, the PC was concerned about not yet acquiring wires marked on a hazard map. Just as he instructed the P* to stop the aircraft, the CE saw another set of wires and called out "Wires!" without giving distance, direction, or clearance. The P* overreacted to the ambiguous warning with abrupt aft cyclic, causing the tail rotor to strike the water. [UH-1H]

3-3 After experiencing whiteout conditions in a hover taxi over snow, the PC directed the P* to increase altitude. When whiteout conditions persisted, the PC

twice directed the P* to "Move forward." However, the P* did not realize that the PC specifically wanted him to move forward at a faster speed to outrun the blowing snow. As a result, the PC assumed controls and overtorqued the engine to escape the blowing snow. [UH-1H]

3-4 While touching down on a concrete pad in a confined area, the CE noticed that the aircraft's skids extended excessively over the rear edge of the pad. He directed the P* to "Move forward"; however, this warning was given without sufficient reason or urgency to divert the P*'s attention to the problem. As the P* lowered the collective, the aircraft rocked backwards off of the pad. Subsequent overcontrol of the cyclic by the P* resulted in a dynamic rollover. [UH-1H]

3-5 The P* assumed the controls on an NVG mission over water after the PC announced "I've had it, you got it." Not realizing that the PC was temporarily incapacitated and unable to assist with altimeter callouts, the P* continued a left descending turn with the intention to level

off at 50 feet AGL. After passing below 50 feet AGL, the PC quickly called out altitude at 38 feet and again at 20 feet AGL. Finally, the PC applied collective; however, the aircraft was descending too fast to avoid impacting the water.
[UH-60A]

Crew Coordination Error 04

Failure of the PC to assign crew responsibilities before and during the mission.

Definition:

Good aircrew coordination requires that crew responsibilities are properly assigned prior to takeoff and reiterated during the mission and in critical situations. This type of error occurs frequently in rotary wing operations when maintaining clearance from surrounding obstacles is critical. When clearance responsibilities are not properly assigned, the pilot flying is forced to rely exclusively on his own limited visibility. Accidents that result from this situation typically involve the aircraft striking an obstacle on the side opposite from the pilot flying.

Examples:

4-1 PC* (right seat) was attempting to maintain a "wing" position in a 2-ship, 25 feet AGL flyover demonstration. The PC* did not assign the P (left seat) any clearance responsibilities prior to takeoff, nor did he direct the P to assist in maintaining clearance with the other aircraft during the flyover. During this maneuver, the PC* allowed the main rotor blade to underlap the main rotor blade of the other aircraft. The P advised the PC* that they were too close to the other aircraft and the P's subsequent right cyclic input caused the two rotor blades to mesh, resulting in the crash of both aircraft. [UH-1H]

4-2 Prior to practicing confined area landings as part of a 3-ship formation, the PC* failed to assign any clearance responsibilities to the CE. During one of the approaches, the CE was occupied inside of the aircraft tuning a LORAN-C navigational radio and was not providing

clearance assistance. The aircraft's main rotor blades subsequently struck a tree during approach. [UH-1H]

4-3 Prior to approaching a sloped area with marginal clearance for the main rotor blade, the PC* failed to advise the CE that continual assistance was required in clearing the main rotor blades. During the hovering off-load operations the CE ceased clearing assistance and started to assist the passengers in disembarking from the aircraft. The aircraft's main rotor blades subsequently drifted into the sloped terrain. [UH-1H]

4-4 Prior to practicing fast rope operations on an NVG mission, the PC failed to advise the CE of the proper procedure for ensuring that troops were clear of the ropes prior to takeoff. During the actual operation, the CE improvised the procedure by looking underneath the

aircraft to clear the ropes on the opposite side of the aircraft. The last troop was delayed leaving the opposite side of the aircraft and was hidden by the aircraft's structure when the CE announced to the P* "Ropes clear." The aircraft ascended with one troop still clinging to the rope. The troop subsequently fell from the rope and was killed. [UH-60A]

4-5 Prior to taking off at dawn on a terrain flight mission, the PC* failed to assign clearance responsibilities to a newly rated P. Both pilots had noticed a tactical antenna near the intended flight path; however, the P did not provide any clearance assistance during the takeoff. During the takeoff, the antenna became obscured against the dark terrain and was struck by the aircraft as the PC* initiated a right climbing maneuver. [OH-58A]

Crew Coordination Error 05

Failure of the P or other crewmembers to offer assistance or information that was needed or had been requested previously by the P*.

Definition:

Good aircrew coordination requires that each aviator maintain a peripheral awareness of the tasks being performed simultaneously by other crewmembers. Each crewmember also has the authority and obligation to question the pilot flying whenever it is apparent that the aircraft is about to enter a marginal or unauthorized flight condition. Failure to provide assistance or information, or failure to issue an appropriate challenge, leads to situations in which the overall performance of the aircrew is only as strong as the capacity of the weakest crewmember.

Examples:

5-1 The P* was attempting to maintain a 25 feet AGL hover in adverse weather over snow-covered terrain while awaiting the return of the mission's lead aircraft. Instead of offering assistance to the P* in maintaining their position in degraded visibility conditions, the PC concentrated his attention inside the aircraft. The P* fixed his attention on the returning aircraft and allowed the aircraft to enter a descending rearward drift. The aircraft subsequently struck the ground before either pilot could detect and correct the drift. [JUH-1H]

5-2 During the initial leg of a service mission to transport battalion staff members, the aircrew had encountered several hours of weather delay. During the return flight at night, the aircrew again began to encounter deteriorating weather while attempting to transit a mountain

pass. Weather was forecast to be below VFR minimums for the mountain passes, and soon the aircrew experienced reduced visibility in darkness, light rain, and decreasing ceilings. Despite these conditions, the IP* decided to continue the flight over the mountain pass and struck wires. The UC (flying in the rear of the aircraft as copilot) failed to challenge the IP*'s decision to continue the flight in below minimum weather. [UH-1H]

5-3 The UT* was conducting a mountain training mission. Of four attempted landings at a 10,000 feet MSL landing zone, two were successful and two were aborted due to excessive closure speed. An OGE hover check indicated that sufficient power was not available at this altitude. Despite the lack of power, the UT* elected to continue the training with attempted landings at a 12,300 feet MSL landing

zone. During the approach to the higher landing zone, the UT* lost directional control and the aircraft crashed. The P failed to challenge the UT*'s decision to proceed to a higher altitude after experiencing inadequate power at the lower altitude. [UH-1V]

5-4 Upon landing downwind to an upsloping terrain, the inexperienced P* failed to perform a required stability check before lowering the collective. As the aircraft settled off of the front portion of the skids, it rocked backwards. The P* reactively lowered the collective full down and applied full forward cyclic. This abrupt control input resulted in the main rotor blades striking the Upper Wire Protection System. The PC failed to challenge the less experienced P* in his selection of an approach direction and touchdown point. The PC also failed to

direct that a stability check be performed prior to lowering the collective to the full down position. [UH-1H]

5-5 Despite the fact that neither crew-member was mountain qualified, the PC* attempted to demonstrate mountain flying tactics on a training mission. In addition, the PC* failed to properly complete the PPC for the anticipated flight conditions. Finally, the PC* considered the OGE hover check conducted at 6,000 feet MSL to be adequate for predicting available power at the mission altitude of 9,180 feet MSL. While attempting an NOE masking/unmasking maneuver at this higher altitude, the PC* lost directional control of the aircraft and permitted it to crash into wooded terrain. The P failed to challenge any of the PC*'s actions or decisions during this mission. [UH-1H]

Crew Coordination Error 06

Failure of the P* to execute flight actions in proper sequence with the actions of other crewmembers.

Definition:

Good aircrew coordination requires crewmembers to direct and acknowledge tasks that require coordinated actions. It is equally important that crewmembers performing simultaneous actions allow for the proper sequencing and timing of those actions. A crewmember's impatience or disregard can destroy the required sequencing or timing of the actions. The most frequently observed example of this type of crew coordination error occurs with obstacle clearance responsibilities.

Examples:

6-1 The PC* (right seat) was attempting to hover taxi near a refueling point. A deployed ground guide noticed that the hovering aircraft was approaching too close to another parked aircraft; however, his signals to the PC* were obscured by blowing dust. The PC* directed the P (left seat) to clear the left side (nearest the parked aircraft). The P, however, waited until he realized they were about to strike the parked aircraft before attempting to locate the floor microphone switch for the ICS. Experiencing difficulty in finding the floor microphone switch, the P could not warn the PC* in time to avoid striking the parked aircraft with the aircraft's main rotor blades. [UH-1H]

6-2 The P was preparing to test the compatibility of NVGs with a new type of NBC mask during a night test flight. Only the P was wearing the NBC suit and was experiencing difficulty in climbing into the right seat. Without waiting for the P to be

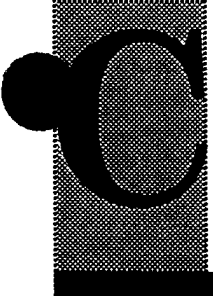
properly seated and in a position to assist with the engine start, the IP* attempted an engine start from the left seat, using the left collective throttle control and the right collective trigger. After an aborted start, the IP* failed to fully close the throttle. A second start attempt was initiated by the IP*, again before the P was connected to the ICS and in a position to assist in the start. The second start attempt resulted in a hot start and the subsequent destruction of the engine. [OH-58C]

6-3 After making a night landing to refuel at a small airfield with no taxiway markings, the PC* ground taxied the aircraft to a point near a hangar and became concerned that there was inadequate clearance. The FE provided the PC* with clearance to the right; however, the CE was unable to clear the left rear of the aircraft until he completed lowering the rear ramp. Without waiting for the CE to clear the left rear of the aircraft, the PC*

pivoted the aircraft and allowed the aft main rotor blades to move left and strike the hangar building. [CH-47C]

6-4 On an NVG mission to internally load an M102 howitzer, the PC* brought the aircraft to a 20 feet AGL hover facing away from the M102. The PC* requested clearance assistance and received left clearance. The CE (who was responsible for providing right and rear clearance)

requested the PC* to maintain the stationary hover until the CE could lower the rear ramp to provide rearward visibility. Instead of relying on the CE to provide rear clearance, the PC* focused his attention on a ground guide located to the front of the aircraft. When the ground guide signaled "down," the PC* (without waiting for the CE's clearance) lowered the aircraft directly onto the top of the M102. [CH-47D]



Selected Accidents by ATM Tasks

What you will find in this appendix:

- ☒ Examples of Army aviation accidents listed by ATM task

Selected Accidents by ATM Tasks

Task 1007: Perform Engine Start, Run-up, and Before-Takeoff Checks

OH-58 crew was preparing for a night test flight to determine the compatibility of NVGs with a new type of NBC mask. The P was wearing an NBC suit for test purposes. The P was experiencing difficulty ingressing the aircraft. Without waiting for the P to be properly seated and in a position to perform/assist in the engine start, the IP* initiated an unsuccessful engine start from the left seat using the throttle control on the left seat collective and the trigger on the right seat collective. The IP* failed to fully close the throttle after the initial start attempt. The IP* initiated a second start attempt before the P was connected to the IC and in a position to perform/assist in the engine start. The second attempt resulted in a hot start (due to the open throttle) and destruction of the OH-58 engine.

Task 1015: Perform Ground Taxi

1. CH-47C was landing at a small airfield (with no taxiway markings) for refueling. The PC* ground taxied the aircraft near a hangar and became concerned that the aircraft was too close. He received clearance to the right from the FE but failed to wait for left rear clearance from the CE who was lowering the ramp to clear. As a result, when the aircraft turned right, the rear swung left and the aft rotor struck the hangar.

2. UH-60A had ground-taxied to a maintenance hot spot when PC in right seat decided to reposition because they were blocking another aircraft parked closely to their left. PC directed P* to start forward but failed to direct the CE (seated behind the PC) to either switch seats or act as ground guide to assist P* in clearing aircraft on left. As a result, P* misjudged clearance and main rotor struck tail of parked aircraft.

3. UH-60A was performing ground taxi to a refueling point on left side of aircraft. P warned PC* that they were getting close. PC* acknowledged and improperly directed P to lock tail wheel. Thus, P's attention was focused inside and diverted from the primary task of clearing left. As a result, PC* misjudged clearance and main rotor struck a pole at the refueling point on left side of aircraft.

Note: PC was ground taxiing from right seat.*

4. UH-60A was ground taxiing to a refueling point on a civilian airfield. A fixed wing aircraft was parked to the front left with its tail extending into the taxiway. All four crewmembers of the UH-60A estimated three feet main rotor clearance to the fixed wing

aircraft. PC* in right seat elected to clear from inside the aircraft instead of dismounting the CE. During the right turn to the refueling point, the tail swung left, which brought the main rotor left (in turns, an additional 10 feet clearance is needed). As a result, the main rotor struck the tail of the fixed wing aircraft.

Task 1017: Perform Hovering Flight

1. UH-1V at end of an instrument evaluation mission was taxiing at 10 feet AGL and 18 knots across unmarked, snow-covered portion of the airfield to the refueling point. The P's attention was focused inside on radio tuning and making transmissions, and he failed to assist PC* in maintaining desired altitude through outside references. As a result, PC* allowed aircraft to descend into the snow; aircraft rolled over after impact.

2. UH-1H was Chalk 2 in a formation of four hovering downwind (9 knots quartering) along a taxiway. When Chalk 1 came to a stationary hover, P* began experiencing difficulty in halting forward motion and the aircraft continued closing on Chalk 1. P* failed to request assistance from PC in controlling the aircraft and instead made an abrupt cyclic climb over Chalk 1 to 40-50 feet AGL. Subsequently, aircraft control was lost to a point that the aircraft crashed.

Note: P's control problem was due to aircraft cyclic control being restricted by seat position being full forward and full up.

3. UH-1H was Chalk 2 in a formation of four hovering downwind (9 knots quartering) along a taxiway. When Chalk 1 came to a stationary hover, PC noticed P* experiencing difficulty in halting forward motion and the aircraft closing on Chalk 1. PC failed to query P* on need for assistance or offer guidance. After P* made an abrupt cyclic climb over Chalk 1 to 40-50 feet AGL, PC assumed control of the cyclic, unannounced; temporarily stabilized the aircraft; and then released cyclic control, unannounced. Subsequently, P* lost control and the aircraft crashed without the PC making any further attempt to assume control.

4. UH-1H on snow-covered airfield was taxiing at three feet AGL toward the takeoff point when whiteout conditions were experienced. PC directed P* to increase altitude. After attaining 20-25 feet AGL, whiteout conditions still persisted. PC then twice directed the P* to "move forward." The PC intended the P* to move forward faster to outpace the whiteout, but the P* did not understand the intent. Consequently, PC assumed the controls and overtorked the engine trying to escape whiteout.

5. UH-1H was hover taxiing to land close to an operating aircraft at a refueling point. Ground guide had noticed aircraft was too close and had signaled this; however, the guide was obscured from PC*'s vision by blowing dust. PC* had instructed P (left seat) to clear left where the operating aircraft was. P failed to provide constant clearing

communications to PC*. Instead, P waited until he realized they were too close; he then had difficulty finding floor mike switch to warn PC*. As a result, main rotor blades of the two aircraft hit.

6. OH-58A was on a day force-on-force mission. PC* had acquired a target and was attempting handoff to gunship. PC* was attempting to maintain stable low hover over 12-18 inch grass. Although P's attention was inside performing navigation duties, he noticed a drift to the right. P failed to notify PC* of the right drift. As a result, the right skid hit a 14 inch high stump and the aircraft rolled over.

7. AH-1S was hovering at three feet AGL. PC* decided to check the previously noticed low oil pressure. (*Note: Only oil pressure gauge is in pilot station and is difficult to see without leaning left and lowering head*). PC* failed to direct P to take controls while he checked oil pressure. As a result, when PC* diverted his attention inside, the aircraft drifted right, lost altitude, and struck the ground.

8. JUH-1H was on a cross-country mission over snow-covered terrain. P* was attempting to maintain a stationary 25 feet AGL OGE hover awaiting return of lead aircraft, which had turned around due to adverse weather. PC concentrated attention inside aircraft and failed to assist P* in maintaining attitude/altitude through outside references. As a result, P* fixed attention on returning aircraft and allowed aircraft to drift rearward and lose altitude until impact with ground.

9. UH-1H PC* selected an off-load site that was sloped to the extent that there was insufficient main rotor clearance to permit landing. PC* failed to advise CE that his constant attention was required to assist in maintaining clearance. As a result, CE stopped clearance assistance and started helping to off-load; main rotor struck the slope.

Note: There were sufficient personnel to off-load without CE's assistance.

10. UH-1H was at a low hover over sloping terrain. There was not enough main rotor clearance from the slope to land. While off-loading was underway, CE failed to announce that he was going to stop providing clearance and start to assist passengers with off-loading. As a result, PC* misjudged clearance and main rotor struck slope.

Note: There were sufficient personnel to off-load without CE's assistance.

11. OH-58D was attempting an NVG shipboard landing. The landing deck already contained another OH-58, which had just landed. The PC* of the landing aircraft attempted to maneuver onto the deck from a hover by means of a white reference line on the deck. The OH-58D drifted into the main rotor blades of the parked aircraft. The PC* was cited for failing to use either the P or the other aircraft for assisting in obstacle clearance.

12. OH-58D was attempting an NVG shipboard landing. The landing deck already contained another OH-58, which had just landed. The PC* of the landing aircraft attempted to maneuver onto the deck without assistance in obstacle clearance from the P. The aircraft drifted into the main rotor blades of the landed helicopter. The P should have assisted in obstacle clearance because he was in the left seat and the approach was being made to the left as the OH-58D hovered to the right of the ship. TC 1-204 states that the nonflying crewmember will assist the aviator on the controls in clearing obstacles during this type of approach.

Task 1028: Perform VMC Approach

1. UH-60A was on night unaided approach to a poorly illuminated LZ (Y lights obscured by background lights from town). Right seat P*, in right turn at 300 feet AGL, relinquished controls to PC due to problems in aligning approach. On taking controls, PC* failed to instruct P to monitor/call out airspeed and altitude. As a result, aircraft descended into trees. P advised PC*, "watch your closure," just before impact.
2. UH-1H on approach to a snow-covered LZ started experiencing whiteout. P* perceived a rearward drift, so added forward cyclic. PC perceived a nose-low condition and, unannounced, got on controls adding aft cyclic. The combined control action of both pilots caused the aircraft to rock back and forth several times, which caused the rotor blades to strike the upper wire protection system several times.
3. UH-1H was landing at a field POL point. At 40 feet AGL, the aircraft experienced compressor stall, and P* entered autorotation in response. The P* and P (PC) then recognized a loss of engine power. Unannounced, P got on the controls with the P*. Consequently, the autorotation was not successful, and the aircraft was damaged on impact.
4. UH-1H was on approach to insert an 8-member radiological team at a remote site. PC designated a landing site, but P* noticed 4 foot high stakes at the site. Without informing PC, P* decided to change the landing site. P* brought the aircraft to a 35 foot hover intending to land to the right and rear of the previously designated site. Unknown to the crew, the aircraft was over gross for OGE hover, lost directional control, and crashed. By not announcing his decision to land at a different site, P* disallowed PC to direct a different course of action (e.g., make a go-around).

Note: The crew had failed to correctly complete the PPC, which would have alerted them to the need to perform a hover OGE check to confirm adequate power for this mission.

5. UH-1H was transporting three passengers to the Brigade TOC. Just before touchdown, PC detected a slope at the touchdown point and announced, "Slope." P* gave the non-specific acknowledgement, "Roger," without understanding what the PC

intended. As a result, aircraft landed on skid toes, and P*'s subsequent reflexive control actions caused back and forth rocking action causing main rotor strikes to the upper wire strike protection system.

6. UH-1H was transporting three passengers to the Brigade TOC. Just before touchdown, PC detected a slope at the touchdown point and announced, "Slope." P* "rogered" the warning. PC failed to confirm correct understanding and simply accepted P*'s nonspecific, "Roger." As a result, P* did not understand this communication and landed on skid toes. Subsequent control actions caused back and forward rocking action and main rotor strikes to the upper wire strike protection system.

7. UH-1H crew was practicing night unaided landings to an inverted Y without landing lights. Several earlier landings involved excessive approach speeds. On the final landing, the P* hit the ground with the aft portion of the skids at an excessive rate of descent. The P* immediately attempted to increase collective to attempt another approach. The PC (without announcing his intentions to take the controls) attempted to lower the collective after hearing a loud noise. With no communication, the P* and PC struggled each other, unaware that both were on the collective. The P* suddenly released the collective, allowing the PC to move it to the fully lowered position. The aircraft struck the ground a second time, shearing off the aft cross brace.

8. UH-60A on a troop insertion was making an approach to a treeline at the edge of a large open field. P* was in right seat and treeline was on left. On short final, IP told P* they were getting too close but failed to confirm that P* understood the warning to take correction action. Instead, after giving the warning, IP started looking at his map. P* indicated that he did not hear IP's warning; he heard only a warning given by an FTX evaluator in the cargo compartment just before the main rotor struck the trees. Failure of the IP to monitor subsequent control actions by the P* (in response to his warning) contributed directly to this accident.

9. UH-60A was on night admin mission that was aborted shortly after takeoff due to dust storm. Aircraft hit trees on approach to open field. PC* failed to assign any duties to P during premission briefing or to request any assistance during the attempted approach. Just before impact, P recognized aircraft was too low and attempted to tell PC*, but it was too late.

Task 1031: Perform Confined Area Operations (6)

1. OH-58C was on approach to a confined area. PC* improperly directed P's attention by pointing out a number of obstacles on the approach to the confined area. As a result, the P failed to see a tree on his side and the aircraft struck it.

2. UH-1H was on approach to a confined area. PC in left seat saw a tree on left close to the line of approach. PC used misleading terms when he twice advised P*, "Don't turn left," instead of correctly identifying the tree hazard. As a result, the P* did not see the hazard and the main rotor struck the tree.

3. UH-1H was on a mission to extract troops from a confined area. P* in right seat elected to make an airspeed over altitude takeoff but drifted right and struck trees. PC, with intent to land, came on controls unannounced. P*, with intent to continue takeoff, stayed on controls. These cross-purpose control actions eventually led to the aircraft striking additional trees and eventually sliding into a large rock after touchdown.

4. UH-1H was on approach to a confined area too small for the aircraft (area = 70 feet diameter, rotor length = 57 feet) with 30-foot trees. While descending, PC* directed P to come inside and monitor torque. As a result of the P being directed away from his left clearance duties, the main rotor struck a tree on the aircraft's left side.

5. UH-1H was making a confined area approach to a built-up concrete pad. P* decided to shoot the approach to the pad to avoid creating brownout. Aircraft touched down short with skids hanging off rear of pad (CG was 16 inches off pad edge). CE noticed the situation and directed (over intercom) to "move forward." This direction was neither sufficient nor urgent enough to break through P*'s concentration. As a result, P* lowered collective, aircraft rocked back, and subsequent reactive control actions resulted in the crash.

Note: PC heard and understood CE's intent and was attempting to reiterate CE's message, but he was too late.

6. UH-1H was in a flight of three practicing confined area approaches. PC* failed to assign CE any clearance responsibilities during premission crew briefing. CE was tuning the LORAN-C nav radio during the approach when the accident occurred. As a result, the CE was out of position and focused inside the cockpit. This situation prevented the CE from assisting in clearing the tree that the main rotor struck.

Task 1053: Perform Simulated Engine Failure at Altitude

1. AH-1 was on a maintenance test flight to check autorotational RPM. MTP* initiated autorotation, and when he began power recovery, encountered abnormal vibrations. MTP* decided to continue the autorotation to touchdown. P (also an IP) was in front seat and was concerned that MTP* might pull too much collective during final deceleration. P placed his hand on the collective, unannounced, and thus restricted collective application by MTP*. As a result, not enough collective was pulled to keep the aircraft from falling through and landing hard.

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AH-1S was on an SIP qualification checkride. IP*, attempting a low-level autorotation, was cautioned by SIP that initial pitch pull was within limits but too much for existing density altitudes. IP* then applied cushioning pitch too early and excessive aft cyclic. SIP in front seat came on controls unannounced to apply corrective action, but he was unable to overcome IP* control inputs because of control force advantage of back seat control. As a result, aircraft experienced a hard landing.

3. OH-58A IP failed to announce type of recovery he wanted the P* to make (power recovery or terminate with power) before reaching 400 feet AGL during a simulated engine failure at altitude. This error did not cause/contribute to the ensuing accident.

CC principle: Always perform required communications. Do not assume understanding of intentions.

4. UH-1H was on a PC checkride mission. First attempt at simulated forced landing was unsuccessful and SIP counseled P* that maintaining proper rotor RPM was his (P*) responsibility. However, on four subsequent forced landing iterations, the SIP added collective to reduce RPM without announcing his action to P*. This created disharmony and distracted the P* to such an extent that on the last iteration he was late in decelerating and applied abrupt aft cyclic, which resulted in the tail rotor hitting the ground.

Task 1068: Describe or Perform Emergency Procedures

1. OH-58C P* on controls during a night NVG mission at 400 feet AGL interpreted warning lights as indications of engine failure. He failed to direct the PC to perform instrument checks to confirm engine failure before initiating autorotation. As a result, the aircraft eventually crashed with at least partial power (CCAD found nothing wrong with the engine).

2. OH-58C PC not on controls during a night NVG mission at 400 feet AGL responded to a perceived engine failure by deciding to revert to unaided flight. He removed his NVGs and turned on the landing and cockpit lights. However, he failed to announce his decision and intended actions. This error was not established by the investigation board as causing/contributing to the accident.

CC principle: Announce decisions that affect the duties that other crewmembers must perform, especially in abnormal/emergency situations.

Task 2009: Perform Multi-Aircraft Operations

1. UH-1H was flying abreast as "wing" in a two-aircraft flyby at 25 feet AGL at the end of a demonstration. PC* was in right seat and allowed his main rotor to underlap main rotor of lead aircraft. P advised PC* they were too close. PC*'s use of cyclic to move right caused his main rotor to elevate and mesh with the main rotor of the other aircraft. P failed to assist in maintaining clearance because he was watching the crowd, and PC* had failed to assign P any clearance responsibility during the crew briefing.

2. UH-60A, in a two-ship formation with another UH-60, was attempting a flight lead change under NVG conditions. During the attempted maneuver, the passing UH-60A drifted left and into the other aircraft, causing both aircraft to crash. Prior to initiating the maneuvers, the IP* of the passing aircraft failed to direct the CE to position himself and assist in providing obstacle clearance with the other aircraft. (NOTE: This accident occurred prior to the issuance of guidance regarding the positioning of CEs during multiship operations under NVG conditions.)

3. UH-60A on a multiship, night, NVG mission, was approaching a reporting point at 200 feet AGL. IP in right seat failed to announce his intention of coming inside and changing radio frequencies and to ensure that his responsibility for right-front obstacle clearance was assumed by another crewmember. As a result, while his attention was diverted inside, the aircraft struck a UH-60A that was on a single ship mission approaching the same reporting point from the right front.

CC principle: Announce decision to stop performing assigned duties and ensure these duties are assumed by another crewmember before taking action.

Note: The IP's obstacle clearance duty should have been assigned to a CE on right side. However, there was only one CE and he was required to be on left side in this formation flight. TC 1-204, para 7-16, advises use of two crewmembers in back to provide clearance on both sides of aircraft; however, it is not regulatory or spelled out that a crew of four is required under this situation.

4. UH-60A was Chalk 4 of seven in a staggered left formation on a night NVG mission. Formation had begun a left descending turn just past a ridgeline when P* in right seat announced, "I have lost the aircraft"—meaning Chalks 1 and 2; he still saw Chalk 3. PC misinterpreted this nonspecific announcement to mean P* had lost sight of Chalk 3. PC assumed controls, moved the aircraft left, but unknowingly lost altitude because he focused too much of his attention to helping reacquire sight of Chalks 1, 2, and 3. Consequently, the aircraft struck trees at 20 feet AGL.

Task 2081: Perform Terrain Flight

1. UH-1H was on a terrain flight mission to deliver troops and provide area orientation to P. During mission briefing or during mission, PC* failed to direct the P to provide any piloting assistance for the mission. The PC* assumed flying, clearance, and navigational duties and became task oversaturated. As a result, during a left turn with PC* in left seat, insufficient power was used to keep the aircraft from descending into the trees.
2. UH-1H was on a single ship NOE mission flying along a river. PC was navigating and was concerned that he had not yet located wires that were marked on the map. PC told P* to stop. At the same time, CE saw the wires ahead and announced, "Wires," without giving distance, clearance, or direction. The nonspecific nature of the communication led P* to overreact and improperly perform the deceleration; he applied abrupt aft cyclic with insufficient power to maintain tail rotor height above the terrain and, as a result, the tail rotor struck the water causing loss of tail rotor thrust.
3. OH-58C was making a left turn during an NOE flight. PC*'s vision to the left was obstructed by MILES system so he did not see tree in flight path. P decided to come inside and perform Battle Command duties but failed to advise PC* he would no longer be clearing left. As a result, the aircraft struck the tree.
4. UH-60A PC was on a night NVG rescue mission involving a CH-47 accident. More than two hours after beginning assistance, P at controls announced he was too tired to continue flying. PC took controls but failed to determine whether P was able to perform P duties (navigation and obstacle avoidance). Subsequently, aircraft struck high tension wires and crashed. Investigation board did not determine P error as a cause of this accident; PC's failure to determine P's ability to perform P duties was not established as a causal factor.
5. UH-60 was performing terrain flight with P* in left seat and CE in rear. P* initiated a right turn without announcing intention or requesting right front quadrant clearance. PC in right seat was inside with attention on map navigation. CE was not in correct seat and could not assist in clearing. Consequently, main rotor blades struck trees on right side of aircraft.
6. UH-60A, while performing terrain flight, struck trees because P* initiated a right turn without announcing intention or requesting clearance. PC failed to specifically address methods and types of crew communication and coordination. This failure led to the P's error and to the CE being in the wrong seat (left rear) and, thereby, unable to assist in clearing right.
7. MH-6H on night NVG mission over smooth ocean was descending from 1300 feet to a planned level-off at 50 feet. After leveling off, PC* instructed P to program the KNS 660 for home destination. PC* diverted his attention to check on P's programming task, noticed radar altimeter reading 38 feet, but continued watching P's actions. Instead of

directing P to assist in establishing a steady 50 feet altitude and then program the KNS 660, PC* elected to come inside and monitor P's actions knowing the desired altitude had not been stabilized. As a result, the aircraft continued descending until impact with the water.

8. UH-60A on a single ship night, NVG mission, was approaching a reporting point at 200 feet AGL. IP in left seat failed to announce his intention of coming inside and changing radio frequencies and to ensure that his responsibility for left-front obstacle clearance was assumed by another crewmember. As a result, while his attention was diverted inside, the aircraft struck another UH-60A that was approaching the same reporting point from the left front.

CC principle: Announce decision to stop performing assigned duties and ensure that these duties are assumed by another crewmember before taking action.

9. UH-60A was performing terrain flight over desert at 50 feet AGL and 90 knots. PC* noticed P's attention was focused into the rear cabin. PC* failed to use intercom to determine what the distraction was. Instead, PC* diverted his attention away from his primary duty of maintaining control and clearance and looked back into the rear cabin to determine what the distraction was. As a result, the aircraft lost altitude. When the PC* directed his attention back outside, he realized the loss of altitude and made aircraft cyclic input, which drove the tailwheel into the ground.

Note: The distraction was the CE who was passing a screwdriver to the AO. Attention of all four crewmembers was diverted inside.

ACRONYM LIST

AGL	Above Ground Level	NBC	Nuclear, Biological, and Chemical
AO	Aerial Observer	NOE	Nap of the Earth
ATM	Aircrew Training Manual	NVG	Night Vision Goggles
CC	Crew Coordination	OGE	Out of Ground Effect
CCAD	Corpus Christi Army Depot	P*	Pilot on the Controls
CE	Crew Chief/Engineer	PC	Pilot in Command
CG	Center of Gravity	POL	Petroleum, Oils, and Lubricants
FE	Flight Engineer	PPC	Performance Planning Card
FTX	Field Training Exercise	SIP	Standardization Instructor Pilot
IC	Intercommunications System	TC	Training Circular
IP	Instructor Pilot	TOC	Tactical Operations Center
KNS	King Navigation System	VMC	Visual Meteorological Conditions
LZ	Landing Zone		
MTP	Maintenance Test Pilot		

Any pilot or copilot duty position abbreviation followed by () indicates that person was on the controls, flying the aircraft.

Aircrew Coordination Case Studies

What you will find in this appendix:

- ☒ Aircrew coordination case studies grouped according to the five Crew Coordination Objectives

Aircrew Coordination Case Studies

1. General

- a. Aircrew coordination case studies in this appendix support the instruction provided in the Aircrew Coordination Course.
- b. Cases will be referred to by example number; e.g., Example 1-1. The analysis requested by the instructor will be to identify the Crew Coordination Objective involved in the case and then categorize the case according to the Basic Quality(ies) and ATM Crew Coordination Element(s) central to the crew's performance.
- c. The Basic Qualities used in case analyses are:
 - (1) Establish and maintain flight team leadership and crew climate
 - (2) Permission planning and rehearsal accomplished
 - (3) Application of appropriate decision making techniques
 - (4) Prioritize actions and distribute workload
 - (5) Management of unexpected events
 - (6) Statements and directives clear, timely, relevant, complete, and verified
 - (7) Maintenance of mission situational awareness
 - (8) Decisions and actions communicated and acknowledged
 - (9) Supporting information and actions sought from crew
 - (10) Crewmember actions mutually cross-monitored
 - (11) Supporting information and actions offered by crew
 - (12) Advocacy and assertion practiced
 - (13) Crew-level after-action reviews accomplished

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- d. The ATM Crew Coordination Elements that will be discussed are:
- (1) Communicate positively
 - (2) Direct assistance
 - (3) Announce actions
 - (4) Offer assistance
 - (5) Acknowledge actions
 - (6) Be explicit
 - (7) Provide aircraft control and obstacle advisories
 - (8) Coordinate action sequence and timing
- e. Be prepared to discuss your solution when called on to present the case study analysis to the class.
2. Aircrew coordination case studies are provided on the following pages in groups corresponding to Crew Coordination Objectives one through five.

GROUP #1: ESTABLISH AND MAINTAIN TEAM RELATIONSHIPS

Example 1-1: UH-1N NVG Training Flight (USMC)

During an NVG multi-aircraft operation (Army ATM Task 2009), a flight of two aircraft were practicing terrain flight navigation. The PC of the lead aircraft was under pressure from collateral duties within the unit. He was also known for his harsh treatment of subordinates. Three weeks earlier, he had a run-in with the CE of his aircraft, accusing him of sabotage when the aircraft had binding controls. The CE reported this to the unit commander who subsequently counseled the PC.

The unit had been bivouacked in harsh conditions and the OPTEMPO was intense for the last 4 months, resulting in evident fatigue among all members of the unit. Unit SOP required the crew of the wing ship of two ship flights to monitor lead's navigation and call a code word over the mission frequency if they detected that lead was deviating from the planned route. On a previous mission, the crew of the wing ship had done this several times to the PC of lead, only to have him reprimand them for breaking radio silence when the mission was over.

On this mission, the crew of the wing ship observed lead once again "flying off the top of the map." After watching lead make two course reversals, then fly off the map again, the crew of wing discussed calling the code word over the mission frequency. The PC of the wing ship said "he just chewed our ass for radio discipline,....let him continue for a few more minutes, then we'll call the code word." Approximately 45 seconds later, wing observed lead impact wires and crash.

Example 1-2: UH-60A NVG Troop Insertion Mission

The crew of a UH-60A was participating in a battalion-sized infantry insertion consisting of multiple-ship, multiple-sortie lifts to various LZs. The LZ selected for this insertion was a large, dusty field in which there was a large depression created by a dried-up lake bed.

The PC*, flying chalk #2 in a flight of three (ATM Task 2009), had attended the mission briefing but did not brief the rest of his crew on the mission. The PC* also conducted the preflight and performance planning by himself and didn't brief this information to the crew either. A subsequent interview conducted by the accident investigation board revealed the PC* considered the less experienced P as "virtually useless." This attitude also extended to the other members of the crew.

The flight was in a staggered left formation at 100 feet AGL and 70 knots as flight lead aligned the flight with the inverted "Y" illuminated by chemical lights. On short final,

lead browned out and called the flight informing them he was initiating a go-around. The PC* of chalk #2 didn't hear this call and continued an approach to the ground, unknowingly into the 20-foot-deep depression. The CE on the right side of the aircraft saw the rising terrain of the edge of the depression ahead and called, "Pull up! Pull up! Pull up!" three times in succession. The PC* did not immediately respond, and the front of the aircraft struck the terrain followed by the landing gear. The PC* abruptly pulled collective, which resulted in a tail-low ascent to approximately 50 feet AGL.

Thinking the tail rotor had hit the ground, and perceiving a right yaw, the PC* incorrectly diagnosed the aircraft's reaction to be the result of a tail rotor failure. The PC* rapidly lowered the collective, which resulted in a high rate of descent and a hard landing, injuring all 12 persons on board.

Example 1-3: U-8F Qualification Training Flight

During a U-8F qualification training flight, the crew was performing flight at minimum controllable airspeed in the landing configuration (ATM Task 3004). It is unknown whether the IP or RSP was on the controls. The IP and the RSP were of equal rank and experience, yet the IP was the RSP's supervisor within the unit.

Witness interviews conducted by the accident investigation board revealed that both the IP and the RSP had several discordant personality traits that isolated them from their peers. The RSP was described as "strong willed; quick to criticize the organization and the pilots in it; and an agitator who provoked arguments and conflicts with fellow pilots." The RSP was also considering divorce from a 10 month marriage. The IP was described as "having an explosive personality; a revengeful attitude; double standards; and an absolute authoritarian image who abhorred being challenged."

The board concluded that during the maneuver (ATM Task 3004), there probably was an aggressive and ongoing verbal exchange between the IP and the RSP that resulted in inadequate attention to the aircraft. The aircraft rolled over and yawed to the left, and entered a left spiral/spin with insufficient altitude to recover.

GROUP #2: MISSION PLANNING AND REHEARSAL

Example 2-1: AH-1G VFR Cross-Country Flight

The crew of an AH-1G was on a static display mission at a college homecoming celebration. During the day, the PC met a close female friend at the college and spent the afternoon with her. A subsequent interview conducted by the accident investigation board with the female friend indicated that her relationship with the PC was more than casual. The PC's female friend agreed to meet the PC later the same evening after the crew flew back to home base, approximately 100 miles away. The female friend departed for that city in her automobile shortly before the crew departed the college.

The crew had planned to depart the college and land at a nearby airport where they would refuel, file a flight plan for the return flight, and check the weather. During the mission briefing that morning, the weather was anticipated to deteriorate due to an approaching front. The operations officer emphasized the possibility of adverse weather to the crew and assured them that it was acceptable to remain overnight if the weather made the return flight unwise. By the time the crew arrived at the airport, a light rain was falling. The crew remained in the aircraft as it was refueled. Despite having the time available, the crew did not file a flight plan nor did they obtain a weather update, either in person or by radio with the Flight Service Station at the airport.

When the crew called for takeoff clearance, they were informed by the tower that the airfield had gone IFR. The crew requested and obtained a special VFR departure. A review of the radar flight path revealed the aircraft was flown at an initial altitude of 600 feet AGL, and the flight path followed an interstate highway. Because of gradually rising terrain and deteriorating weather conditions, the flight altitude eventually decreased to approximately 100 feet AGL.

While flying low level at approximately 120 knots (ATM Task 1035), the aircraft struck two 7-strand steel power lines and crashed, killing both crewmembers. The accident investigation board concluded that the PC's relationship with his female friend and the prearranged meeting with her later that evening were factors that impeded the PC's decision making process.

Example 2-2: CH-54 Support Mission

A CH-54 helicopter was supporting the US Forest Service near a Rocky Mountain resort area. Both the PC* and the P were RL 1, PC qualified aviators. On the morning of the mission, the PC* performed the pre-mission planning and the P performed the preflight. Takeoff was at 0715. During the morning, ten successful slingload sorties were completed. Prior to the return trip to home base, which required the lift of a pelletized

6000 pound load, another CE was manifested (resulting in a total crew of 4), and the main and auxiliary fuel tanks were topped off. The departure point was 9,730 feet MSL, the temperature was 81°F, and the DA was 12,187 feet.

Both pilots reviewed performance data, but because the PC* was confident in the aircraft's ability due to previous successful missions with similar loads, the performance data check was cursory. The aircraft weight actually exceeded maximum allowable gross weight limits for the conditions by over 4000 pounds. When external load operations requiring OGE hover power were attempted, (ATM Task 2016) the takeoff was unsuccessful and the aircraft crashed.

Example 2-3: OH-6A Static Display/Fly-over Mission

The crew of an OH-6A reported to the unit to participate in one of two Memorial Day static displays/fly-over missions approved by the unit commander. The PC* of one of the OH-6A aircraft outranked the AMC designated by the written mission briefing sheet and arbitrarily appointed himself as AMC. Additionally, the PC* combined the two separate missions into one mission, again countermanding the approved mission briefing. The P for the mishap aircraft was also current and PC qualified in the OH-6A but did not assist with the premission planning.

During the performance planning for the flight, the PC* failed to consider the additional drag and torque required when flying with the doors off (as stated in the aircraft operator's manual), and consequently underestimated en route fuel consumption by approximately 16-20%. While en route, neither the PC* nor the P completed accurate in-flight fuel consumption checks (ATM Task 1023).

On the final leg of the mission, while over an abandoned airfield but still 10 miles from home base, the low fuel warning light illuminated. The PC* elected to continue to home base; the P said nothing. On a 2-mile final for a straight-in approach, the engine flamed out from fuel starvation, after 3 hours and 10 minutes of logged flight time since initial takeoff. The ensuing autorotation was not entirely successful, resulting in Class C accident damage to the aircraft.

Subsequent examination of the aircraft revealed a total of 14 ounces of fuel remaining in the fuel tanks, with no fuel in the fuel lines or filters.

Example 2-4: UH-1H Troop Transport Formation Flight

The crew of a UH-1H was flying in Chalk #2 position of a flight of three on the return leg of a troop transport formation flight in day, VFR conditions. Shortly after takeoff, flight lead instructed the flight to change formation from a "V" of three to tactical trail

with no change in altitude. After the change of formation was directed, the PC* directed the P who had been flying to relinquish the controls. This was the last exchange of dialog in the cockpit until the accident.

The PC* then broke formation, descended to 50-75 feet AGL, and passed by a local recreational lake that was used heavily by water skiers and wind surfers. Without warning, the PC* executed a cyclic climb, described later by witnesses as "very steep." The P, who later admitted he was very concerned about both a wire strike while low level and the possibility of a mid-air with chalk #3, said nothing. At the top of the cyclic climb (altitude approximately 350-400 feet AGL), a return-to-target maneuver was initiated, followed by a 45-50° dive.

At approximately 100 feet AGL, the aircraft was pulled out of the dive and another steep climb was performed, followed by another return-to-target maneuver, and another 45-50° dive. However, during the attempted recovery, the aircraft was leveled but the PC* failed to arrest the aircraft's rate of descent quickly enough to prevent the aircraft from striking the ground. One passenger was killed and four persons were seriously injured as a result of the crash.

The aircraft investigation board discovered that the PC* had a history of "cowboying" the aircraft and had been counseled twice within the previous year for lack of flight discipline. The board concluded that the PC* had a need to take risks to impress others and that this hazardous attitude impeded the PC's* judgment and affected his decision-making process.

Example 2-5: UH-1H Support Mission

The crew of a UH-1H was on a routine support mission, in cruise flight at 4000 feet MSL and 100 knots. The P* was flying from the left seat, the PC was navigating. The crew and the passengers began to notice a burning odor, and shortly thereafter a loud crack-type noise was heard from the rear of the aircraft followed by a 10° right yaw and slight pitch-up movement.

The PC* quickly assumed the controls and, without discussing the yaw with the P who had experienced it, informed the crew that he was making an immediate landing. (A subsequent interview with the PC* revealed that he had been a P on a mission several months ago when aircraft problems were encountered. The PC of that flight did not land immediately after he had assessed the emergency. As the P on that flight, he'd felt very uncomfortable with that decision, but was overruled by the PC). The PC* began a descending right turn to an intended landing area while the P was making MAYDAY calls on all available guard frequencies.

The descent continued until approximately 200 feet AGL, when the PC* started a gradual deceleration and applied power to slow the rate of closure. When this was done, the

aircraft began a right turn that the PC* was unable to control with the application of left pedal. The PC* attempted to fly out of the spin by applying right cyclic, but was unsuccessful. The right spin accelerated as collective was applied at 40 feet AGL. After five or six complete right turns and still spinning, the aircraft impacted the ground in a near level attitude, rolled on its left side, and came to rest.

The accident investigation revealed that the aircraft tail rotor drive shaft severed in flight resulting in complete loss of tail rotor thrust. The board also concluded that the PC's* decision was affected by his overriding interest to land the aircraft immediately, even at the expense of correctly diagnosing the emergency (ATM Task 1068), and then applying the correct emergency procedure.

Example 2-6: UH-1H Rappelling Accident

The mission of the UH-1H crew was to conduct a rappelling demonstration. As the aircraft arrived and hovered over the drop zone area, the four rappellers threw out their rucksacks, which contained both of their ropes. They assumed the ready position, two on each side of the aircraft, and awaited the "Go" command from the rappel master. When the rucksack of the rappeller located in the left rear of the passenger compartment exited the aircraft, it was not thrown clear of the aircraft structure. Therefore, the rucksack slid down the side of the aircraft, struck the left skid and rolled off, leaving a looped section of the ropes caught over the rear ground-handling wheel mounting bracket on the left skid.

As the rucksack continued to the ground, both ropes deployed in a tangled condition, causing one or two entanglements to form approximately 20 feet below the aircraft. Upon receiving the "Go" command, all rappellers exited the aircraft, but the rappeller in the left rear position became hung up when he reached the point where the ropes were entangled. Ten seconds later, the rappel master checked to ensure that the two rappellers on the right side had reached the ground and began to cut their ropes. He also signaled the CE to do the same on the left side.

Before the mission, the rappel master briefed the CE that he was to cut the ropes on the left side after the rappelling was complete, but he did not tell the CE to look and be sure all rappellers had reached the ground. The CE had never participated in a rappelling mission before and was, in fact, a last minute replacement for another CE who had rehearsed this mission the day before. The PC did not clearly designate specific duties for the crew before the mission, and he did not ensure that the replacement CE was thoroughly briefed and familiar with the rappelling mission.

On the rappel master's signal, the CE proceeded to cut both sets of ropes on the left side of the aircraft without ensuring that the rappellers had reached the ground. The rappeller who was hung up on the entangled ropes fell over 50 feet to his death.

Example 2-7: UH-1V Night Emergency Medevac Mission

The crew of a UH-1V Medevac aircraft received a call from a hospital emergency room to respond to an automobile accident 8 miles northwest of the airfield. One of the victims was reported to have been thrown from the wreckage and in critical condition. Weather at the airfield was 200 feet scattered, 500 feet overcast, 3 miles visibility, with light rain and fog. Six minutes after receiving the call, the crew had received a special VFR clearance from the tower and departed to the northwest. The aircraft was observed by several witnesses on the ground as "flying very low, just over the treetops," with the searchlight on, at what appeared to be cruise airspeed.

Four minutes after takeoff, during low-level flight (ATM Task 2081), the aircraft struck a large pine tree 59 feet above the ground. Impact forces were estimated in excess of 75 Gs, thereby placing the estimated airspeed at approximately 100 knots. The accident investigation concluded that the PC's decision to fly too fast for the altitude and weather conditions was because of his perceived sense of urgency to accomplish the mission. This sense of urgency manifested itself in a hazardous attitude to get to the automobile accident site as quickly as possible, at any cost.

The board based this conclusion on the following evidence that indicated the crew's departure was rushed: 1) the P had left behind his survival vest and was flying in tennis shoes rather than regulation flight boots; 2) tools necessary to extract injured persons from wreckages were strewn on the hangar floor near the aircraft's parking spot; and 3) neither the PC's nor the P's pressure altimeter had been set to the correct altimeter setting even though the correct setting had been given to the crew by the tower.

Example 2-8: UH-60A NVG Air Assault Raid

During training for an NVG air assault raid, the crew of a UH-60A consisted of the PC*, the P, and the CE. The aircraft was chalk #2 in a flight of three, and the mission was to insert the raiding party via fast-rope rappelling (ATM Task 2010) into an urban environment. The PC* of the mishap aircraft was one of the unit's most experienced pilots, but the CE on the mishap aircraft was inexperienced, as was the AMC who planned the mission and was flying in Chalk #1.

The scenario called for the CE in Chalk #2 to fire live ammunition from his M60 machine gun just prior to the insertion, assist the pilots with obstacle clearance as they hovered in between two buildings, and ensure that the rappelling ropes on both sides of the aircraft were clear prior to departure. During the pre-mission briefing, the AMC did not comply with the unit SOP by requiring two persons on chalk #2 to clear the rappelling ropes. The PC* of chalk #2, who had co-written the SOP, did not call the AMC's attention to this oversight, nor did he adequately review detailed procedures the CE was to use to ensure that the rappellers were clear of the ropes before departure, even though he knew that the CE was inexperienced.

As a result, the CE became task saturated during the insertion, and in his rush to see if the rappellers were clear of both sides of the aircraft, he looked under the belly of the aircraft from the left side to clear the right side ropes. The CE failed to see that the last rappeller, who had departed the aircraft late, was still on one of the right side ropes. Consequently, the CE gave the clear signal to the PC* who began to depart the LZ. The rappeller eventually lost his grip and fell 130 feet to his death.

Example 2-9: UH-60A Fast-Rope Demonstration

A UH-60A was on a routine, day mission to perform a fast-rope rappelling (ATM Task 2010) demonstration. The crew received the mission four days in advance and had adequate time to plan the mission. On the day before the mission, the crew flew to the mission site; reconnoitered the jump area; and identified entry and exit routes, obstacles, and forced landing areas. This reconnaissance was performed in the same aircraft that would be used for the actual mission on the next day.

The aircraft had a long-term history of stabilator malfunctions in the automatic mode. During the reconnaissance flight, the crew experienced two stabilator failures, and in both cases, the automatic control switch was reset and the mission continued. On the day of the accident, the crew experienced two more stabilator failures during the flight to the mission site. Despite this history of stabilator failures, the IP* did not plan for a malfunction that could be reasonably expected; that is, he did not assign the P responsibility for assistance in case the stabilator failed during a critical portion of the mission.

During the demonstration, the IP* flying the aircraft from the left seat began a deceleration to the designated hover point. The stabilator caution light and warning horn activated but the P did not provide any assistance during the emergency. Because the IP* had not planned for this likely failure, and because he expected no help from the inexperienced P, he chose to attempt a forced landing within the confines of the field below him rather than terminate at a hover, or slew the stabilator and make a go-around. During the landing, the IP* did not apply adequate collective after the deceleration and the aircraft impacted tail low, rebounded forward, and struck trees with the main rotor system.

Example 2-10: UH-60A NVG Troop Pickup Mission

The P of the lead aircraft was appointed the AMC for the two-ship NVG troop pickup mission. Because it was the P's first occasion to plan a mission as the AMC, another pilot with only slightly more experience, but who had previously acted as an AMC, assisted the P during the mission planning. On the afternoon of the mission, the P and the other pilot visited the supported ground unit for the air mission briefing. During the briefing,

the supported unit requested the pickup at 1800 hours, during EENT. The unit also requested a southwesterly landing direction of 195°. Both these requests went unchallenged and were agreed to by both pilots.

After the briefing, the P and other pilot chose to recon the PZ by ground vehicle, even though there was an aircraft available to do the recon. While in the PZ, the pilots judged the PZ to be large enough to accommodate one UH-60A but, in fact, the PZ was 10 meters less in width than that required by FM 90-4. The flight of two aircraft departed on the mission at 1755 hours. The crews of both aircraft were having difficulty seeing with their AN/PVS 5 NVGs as they flew in a westerly direction, into the residual sunlight during EENT. Upon arrival at the PZ, the lead aircraft, with the P* flying, twice attempted a confined area approach (ATM Task 2003) in the briefed landing direction of 195° but was unable to complete the approach because the crew's NVGs shut down repeatedly due to residual sunlight.

An attempt was made to land in the opposite direction but was unsuccessful because of obstacles. A fourth attempt was made in the original direction with the crew looking under their NVGs and using the landing light. The P* was able to hover to approximately 10 feet AGL when he asked the PC to take the controls. The PC* continued the descent, clearing to the left with the assistance of the CE. The P was clearing the right. At 6 feet AGL, an impact was heard to the right rear of the aircraft. The PC* departed the PZ and made a precautionary landing at the base camp five kilometers away. All four rotor blades were damaged by the blade strike.

Example 2-11: UH-60 Night Administrative Flight

A UH-60 was conducting an unaided, night administrative flight. Shortly after takeoff, at approximately 300 feet AGL, the PC*, flying in the right seat, chose to turn and land the aircraft in a large, open field due to blowing dust that reduced visibility to less than 1.5 miles. While on approach (ATM Task 1028) to the open field, the aircraft hit trees.

The PC* did not assign any specific duties to the P during the premission planning as required in Chapter 5, TC 1-204, nor did he request assistance from the P during the approach. The P offered no assistance during the approach, waiting until the crash was inevitable before warning the PC* of danger.

GROUP #3: ESTABLISH AND MAINTAIN WORKLOAD LEVELS

Example 3-1: AH-1F Engine Failure

The crew of an AH-1F was returning from a surveillance mission at 800 feet AGL, 125 knots, when they noticed the aircraft was in an uncommanded descent. The PC* made an immediate cross-check of his instruments and noted N_1 , N_2 , and TGT were decreasing. He initiated an autorotation by applying aft cyclic, lowering the collective, and reducing the throttle. The crew then heard a "pop" from the engine compartment and saw N_1 was dropping through 20%. The low RPM audio sounded and the engine oil pressure, engine oil bypass, and engine fuel pump segment warning lights all came on as N_1 continued to drop to zero.

The P, who had been calling out instrument readings while the PC* maintained aircraft control, divided his scan between the instruments and outside the cockpit, in order to provide for obstacle clearance. As the P checked outside, he spotted wires at 12 o'clock and apprised the PC* of the impending hazard. The PC* then executed a 30° left turn, paralleling the wires, and began a deceleration at about 90 feet AGL. At 15 feet he applied collective and terminated the autorotation with minimal damage to the aircraft. During the descent, both pilots smelled smoke, and witnesses on the ground saw black smoke trailing from the engine area.

The emergency was caused by internal engine failure, probably resulting from failure of the No. 3 and 4 bearings.

Example 3-2: AH-6 Engine Failure

During NVG formation flight at 90 knots and about 30 feet above water, the crew of an AH-6 aircraft heard a "pop" from the rear of the aircraft. A few moments later, the engine chip detector light illuminated. The PC* called flight lead to inform him of the light's illumination and the decision was made for the flight to return to the point of origin. The AH-6, which had been chalk #3 in a flight of three, was maneuvered into the chalk #2 position. This would enable trail to follow chalk #2 down and rescue the crew should the troubled aircraft's engine fail.

After a few minutes of flight with the aircraft again established in free cruise formation, a gradual but constant rise in TOT was noted. The PC* climbed to an altitude of about 75 feet and adjusted the airspeed to 80 knots to give himself adequate time to react if the engine failed. After another 5 minutes, the TOT had risen to 722°C at 36% torque. Engine oil pressure dropped initially to 50 PSI, then continued to drop further. About 5 minutes after the oil pressure dropped, the engine failed.

The PC* responded to the aircraft's left yaw, change in engine noise, and decrease in N_2 and N_r by entering autorotation, knowing that the autorotation would terminate in 2-4 foot seas. While the PC* concentrated on flying the aircraft, the P kept him apprised of N_r , airspeed, and radar altitude. Assisted this way during the autorotation, the PC* flared the aircraft at the correct altitude, dissipating forward airspeed to zero. He applied cushioning pitch to arrive at 2 to 3 feet above the water with zero forward airspeed and low rotor RPM. The aircraft descended vertically into the sea, landing gently on a swell. The PC* applied right lateral cyclic and the rotor slapped the waves, quickly coming to a full stop. The crew immediately exited, swam clear of the sinking aircraft, and were rescued by the trail aircraft.

Example 3-3: CH-47D Combining Transmission Failure

The crew of a CH-47D was supporting a joint task force and had been flying for about 4.5 hours, slingloading equipment and transporting troops. The aircraft was in cruise flight at about 2,400 feet AGL during the return flight from a resupply mission when the crew chief reported smoke in the aft cabin area. The PC* immediately began a left descending turn to avoid a mountain in his flight path and began searching for a place to land. Within a few seconds, both the PC* and the P detected smoke in the cockpit. The PC* reported he had sighted a landing area. The P was examining the instruments for an indication of what was causing the smoke.

Finding no indication of a malfunction, the P turned and looked through the companionway of the aircraft to evaluate the situation. Seeing the entire cabin area was filled with thick smoke, he made two mayday calls, but received no response. The PC* continued a descending left spiral toward the landing area, a corn field one-quarter-mile square surrounded by steep foothills and mountains. The aircraft was still 1,000 feet AGL—only 30 seconds had passed since the smoke was first reported—and the cockpit was engulfed by smoke. Noticing the smoke smelled of rubber, and having found no instrument indications as to the source of the smoke, the pilots acted on the assumption that it was caused by some kind of electrical malfunction.

The P told the PC* that he was killing electrical power, and he turned off both main generators. This left the aircraft without the automatic flight control system, fuel pumps, gyros, and radios. Simultaneously, the PC* placed the aircraft in a left slip, which quickly cleared the cockpit of smoke and increased visibility. As the smoke decreased, both pilots noticed the transmission chip detector light had come on. The crew chief told the pilots the combining gearbox latch and both the left and right lower debris latches had tripped. These indications led the pilots to conclude the combining transmission was failing. The PC* reduced power to 15% to expedite emergency descent while maintaining a load on the transmission to prevent seizure. The P turned the No. 1 main generator on long enough to make distress calls, then turned it off again.

The aircraft was now about 200 feet above the emergency landing area. The P began calling radar altimeter and airspeed indications to the PC* who was banking the aircraft left to align it with the longest axis of the landing area. The aircraft was descending rapidly, and forward airspeed was about 100 knots. The PC* stated that he would have to begin deceleration or the aircraft would overfly the landing area. The P told the PC* to place the aircraft in a hard right sideslip to dissipate airspeed. When the aircraft was placed in a 40° sideslip, its speed rapidly decreased. At about 70 feet AGL, the aircraft was in a rapid vertical descent with less than 10 knots forward airspeed, and was properly aligned for landing.

The PC* began pulling cushioning power to slow the 1,550- to 1,700-foot rate of descent while the P told the crew and passenger to assume the crash position. As the PC* pulled cushioning power, the cockpit rapidly filled with smoke and the pilots heard a metallic grinding noise from the drive train area. The PC* continued to pull cushioning power while maintaining a landing attitude. Although visibility was reduced because of the smoke, both pilots could see the landing area.

The aircraft landed hard on all four wheels and bounced back into the air. The PC* continued to apply power as the aircraft landed a second time with its aft tires digging into the ground. Feeling the aft landing gear on the ground, the PC* reduced power to bring the forward landing wheels down. As the forward landing gear contacted the ground, the P placed the engine control levers in the full off position, bringing the aircraft to a stop. The enlisted crew and passenger got out of the aircraft, followed by the pilots after emergency shutdown had been completed. Aside from the failed combining gearbox, the only damage to the aircraft was a small puncture to the underside where the aircraft had hit a stump during landing.

Example 3-4: CH-47D Combining Transmission Failure

The crew of a CH-47D was transporting two external fuel blivets, five passengers, and internal cargo in support of a joint task force. The aircraft was in cruise flight at 2000 feet AGL when the PC* felt and heard a low, grumbling sound throughout the airframe. At the same time, the CE reported thick white smoke coming from the area of the combining transmission.

The PC* began an immediate descent into a valley bounded by steep, tree-covered slopes. Within seconds, smoke began entering the cockpit. The PC* continued his descent, with a 15% power setting, while searching for a suitable landing area. The P armed the cargo hook, turned the transponder to emergency, and made mayday calls on all available radio frequencies. The crew chief had taken a position with the fire extinguisher directly under the combining transmission. Despite the thick smoke and intense heat, he continued to advise the crew about the condition of the failing transmission. The flight engineer was watching the external load through the center cargo hole.

With the aircraft about 1,000 feet AGL, and thick smoke and intense heat permeating the entire aircraft, the PC* committed himself to landing in the valley. The external load was jettisoned, and the flight engineer repositioned himself at the right front cabin door while directing the passengers to prepare for a hard landing. The PC* continued his descent into the valley while performing 40° to 60° angles of bank to avoid intruding terrain where no landing areas were available. The pilots sighted a sloped clearing on the side of the valley that appeared large enough to permit landing. The PC* thought they were too high and too fast to make a landing in the area, but the P suggested sideslipping the aircraft to lose altitude and bleed off airspeed.

During this maneuver, the aircraft was rocked by an explosion from the rear of the fuselage. The transmission cooler fan shaft had sheared and was spinning out of control within the shaft housing. The onset of severe pitch and yaw transients forced both pilots onto the controls. Together, they managed to straighten the aircraft's attitude and pull cushioning pitch before the aircraft hit the ground. All four wheels impacted the sloping terrain, causing the aircraft to bounce about 4 feet into the air before settling to the ground. The pilots ordered everyone off the aircraft and completed an emergency shutdown.

The only damage to the aircraft other than the failed combining transmission was a small puncture of the rear ramp, caused when it was lowered so that the passengers and enlisted crewmembers could egress.

Example 3-5: OH-58C Night Tactical Mission

The P* of an OH-58C was flying unaided at night, 100 feet AGL over water (ATM Task 1035), in marginal weather, on a combat reconnaissance mission. As the aircraft approached a heavy rain shower, the P* began a left turn to circumnavigate the shower, but the PC directed the P* to turn right. At this time, the PC* assumed the controls, and without directing the P to assist with the instrument cross-check or other tasks, the PC* began to perform a number of tasks simultaneously.

As the PC* began a descent and reduced airspeed to penetrate the rain shower, he also attempted to make radio calls, reset the force trim, maintain visual contact with lights on the beach, and check the aircraft flight instruments. As a result, the PC* became task saturated and allowed the aircraft to descend unnoticed into the water.

Example 3-6: OH-58C NVG Formation Flight

The PC* of an OH-58C was chalk #1 in a formation of four aircraft flying a tactical terrain flight training mission with NVGs. Immediately after performing an NVG takeoff (ATM Task 2094), the platoon leader in the flight called the PC* of chalk #1 on the radio

and advised him to wait for the other aircraft to catch up. The PC* began a 360° turn and directed the P to clear them from the overtaking aircraft.

After completing the turn, the PC* added power to continue a climb to the pre-planned altitude of 200 feet AGL. At this time, the P heard unit operations trying unsuccessfully to contact the platoon leader, and without announcing his intentions to the PC*, he came inside the cockpit and began acting as a radio relay between unit operations and the platoon leader. Without the P to assist in navigating, monitoring instruments and obstacle clearance, the PC* inadvertently lost altitude and airspeed and struck wires.

Example 3-7: UH-1 Hovering Over Snow

At the completion of an instrument evaluation mission, the P* was hovering from the right seat (ATM Task 1017) at 10 feet AGL, and 18 knots across a large, unmarked snow covered portion of the airfield, en route to the refueling point. The CP was located in the left seat and the IP was in the jump seat, facing forward. The IP decided to tune the FM radio from the jump seat so he could talk to unit operations. The CP also focused his attention to the radios in order to switch from tower frequency to ground frequency.

Neither the CP nor the IP announced to the P* that their attention was inside the aircraft; thus the P* was completely responsible for maintaining the desired hover altitude with outside references when hovering through the blowing snow. The P* inadvertently misjudged his hover height and allowed the aircraft to descend, contact the ground, and rotate over the nose to an inverted position.

Example 3-8: UH-1H Terrain Flight Training Mission

IP* was flying a UH-1H on a day terrain flight training mission to deliver troops and also to provide a local area orientation to a newly assigned, inexperienced P. After picking up the troops at the designated PZ, the IP* proceeded to the LZ in the contour flight mode (ATM Task 2081). The IP* did not assign the P any responsibilities or duties during the pre-mission brief, nor did he direct the P to assist him during the mission. As a result, the IP* became task saturated when he attempted to fly the aircraft, provide obstacle clearance, navigate, and communicate with the supported unit.

Because of the task saturation, the IP failed to anticipate the additional power required when he entered a steep left turn. The aircraft lost altitude and crashed into the trees.

Example 3-9: UH-60 NVG Training Flight

The crew of a UH-60 was performing traffic pattern operations (ATM Task 1022) and was on climb-out after takeoff during an NVG proficiency training mission. On crosswind, the PC* noticed the master caution light illuminate and notified the P. He then activated the caution panel kill switch, bringing the panel illumination up to dim, from the NVG-dimmed mode. Both the PC* and the P noticed the number 2 primary servo caution light was illuminated.

As the PC* began a turn to downwind, both pilots came inside the cockpit, checked their collective servo switches, and found them centered. The P had previously expressed a lack of confidence in flying with NVGs, so the PC* continued to fly while he diverted his attention inside the aircraft and attempted to analyze and troubleshoot the emergency. This was in contradiction of the warning in the ATM task description stating that the P* must not allow himself to become fixated on the aircraft instruments because his primary focus should be outside the aircraft.

After an undetermined amount of time, the P noticed the barometric altimeter read 1000 feet MSL (field elevation was 990 feet MSL), told the PC* to "watch the altitude", looked outside the aircraft, and saw the ground illuminated by the aircraft position lights. The PC* looked outside, could see no visual horizon, and began to transition to instrument flight. The aircraft impacted the ground before the PC* could initiate a climb.

Example 3-10: UH-60A Terrain Flight Support Mission

The PC* of a UH-60A was conducting terrain flight (ATM Task 2081) and flying low level across the desert at 50 feet AGL, 90 knots. In the rear of the aircraft, the CE was attempting to pass a screwdriver to the AO. This distracted the P, who turned to the rear of the aircraft to see what was transpiring. When the P turned, this distracted the PC*, who likewise turned to the rear. Because no one was providing obstacle clearance, an uncommanded descent went unnoticed and the aircraft tailwheel struck the ground.

Example 3-11: UH-60 SAR Mission

As part of a daytime SAR mission, the crew of a UH-60 was ground taxiing (ATM Task 1015) to a refueling point, using no ground guide. The PC*, flying from the right seat, chose to park parallel to the refueling pumps, placing them on the left side of the aircraft. The P warned the PC* that the aircraft was getting close to a sign pole located at the pumps. The PC* acknowledged, stated that they would clear the pole, and told the P to lock the tailwheel, thus diverting the P's attention from his primary task of clearing the left side of the aircraft. As the P came inside the aircraft to lock the tailwheel, the main rotor system struck the pole.

GROUP #4: EXCHANGE MISSION INFORMATION

Example 4-1: AH-1F Inadvertent IMC

During a day cross-country training mission, the crew of an AH-1F entered inadvertent IMC. The PC*, flying from the back seat, continued looking outside the aircraft in an apparent attempt to fly the aircraft back into visual flight rules conditions. The enlisted CM in the front seat immediately focused his attention on the instruments. According to the attitude indicator, the PC* had placed the aircraft in a nose-down, left-bank attitude. The aircraft was descending at 2,500 feet per minute, and the PC* appeared to be in a state of fixation.

At 500 feet AGL, the enlisted CM informed the PC* they were in a dive. The PC* reacted by immediately jerking back the cyclic but was unable to control the aircraft with the use of the instruments. The enlisted CM began speaking calmly to the PC*, talking him through the necessary procedures to regain positive control of the aircraft. He continued talking to the PC*, pointing out deviations in attitude, altitude, and airspeed as they continued to fly IMC and until they were able to land at a nearby airfield. By becoming actively involved in the in-flight emergency, the enlisted CM helped the PC* regain aircraft control during an extremely stressful situation.

Example 4-2: AH-64 Night Currency Evaluation

An AH-64 IP* was flying NOE (ATM Task 1035) on a night systems currency evaluation. The IP* instructed the CPG to store target coordinates in the FCC (ATM Task 1106). The CPG complied, flipped up his HDU, and consulted his map for the target location. At this time, the aircraft crossed a ridgeline and was put into a slight descent in order to maintain NOE altitude. Concurrently, the PNVS video imagery deteriorated. The IP* came into the cockpit to evaluate the PNVS imagery without directing the CPG to provide obstacle clearance or take aircraft control. Before the IP* determined that the PNVS imagery was no longer suitable for NOE flight, a tree strike occurred.

Example 4-3: AH-64 Night Gunnery Training Mission

An AH-64 IP* on a night gunnery training mission was performing firing position operations (ATM Task 1119), hovering in excess of 100 feet AGL, using the HAS. The RSP was searching for and identifying targets on the range with the TADS (ATM Task 2049). The IP* attempted to confirm the aircraft heading but could not because the compass light was inoperative. The IP* then released the collective and transferred his left hand to the cyclic in order to free his right hand to check the compass with a

flashlight. He did this without communicating to the RSP to either take the controls or cross-monitor aircraft performance.

In so doing, the IP* did not remain focused outside the aircraft and did not announce any maneuver or movement prior to execution as required by the ATM task description for both tasks. As a result, both crewmembers' attention was directed inside the cockpit, away from visual or instrumented altitude cues. When the collective was released, the aircraft began an uncommanded descent. As the IP* was replacing the flashlight, he noticed indications of a descent in the HMD. The IP* immediately applied collective; however, the main rotor struck trees.

Example 4-4: AH-64 Tactical Night Movement to Contact

During a tactical night movement to contact mission, with the P* using the PNVs and the CPG using AN/AVS 6 NVGs, inadvertent IMC was encountered. The P* initiated VHIRP (ATM Task 1083) and a 500 FPM climb from an altitude of 250 feet AGL was begun. At that time, the P* removed his hand from the collective to first move the HDU from in front of his right eye. He then turned his head to the left rear to find the pilot's instrument light rheostat. He did this without directing the CPG to assist (i.e., to take the controls or to monitor the flight instruments).

Because of insufficient collective friction, the power began to decrease from 56% to 35%, which resulted in a rate of descent in excess of 1000 FPM. The P* returned his scan to the instrument panel at an altitude of 30 feet AGL, without enough time to reestablish a climb, and the aircraft struck the ground.

Example 4-5: MH-6B NVG Formation Flight

The crew of an MH-6B was performing NVG multi-aircraft operations (ATM Task 2009) and was chalk #2 in a flight of 2. The flight profile for this leg of the mission required traversing and then descending over a calm lake surrounded by higher terrain. Both pilots were wearing AN/PVS 5 goggles. There was 0% illumination. The UT*, who was concentrating on flying formation off the lead aircraft, began the planned descent from 350 feet AGL in preparation for the landing and instructed the P to announce when the radar altimeter indicated they were at 100 feet AGL.

As the aircraft descended below the surrounding terrain, the UT* lost visual contact with the silhouette of the lead aircraft but could still see its exhaust signature and position lights. The P announced that the radar altimeter indicated 100 feet AGL. The UT*, however, did not respond nor stop his descent. When the P next looked at the altimeter, it read 25 feet AGL and the P communicated this to the UT*. Before the UT* could respond, the aircraft impacted the surface of the lake.

Example 4-6: OH-58C NVG Training Flight

The crew of an OH-58C was conducting a tactical training flight. The illumination level was 7%, and both pilots were wearing NVGs. The PC* was flying from the left seat, maintaining 10-20 knots at about 20 feet AGL (ATM Task 1035) and was unable to maintain visual contact with the ground because of the lack of ambient light. The PC* perceived he was losing altitude, became very concerned with the situation, and wanted the infrared light on immediately to reacquire visual references.

The PC* erroneously thought it would be quicker to turn the light on himself rather than ask the P to assist. The PC* removed his left hand from the collective and placed it on the cyclic; then moved his right hand to the P's collective and began searching for the landing light switch. During this transfer of controls from one hand to the other, the aircraft entered an uncommanded descent. The crew did not see the ground until contact was unavoidable. Just prior to contact, the PC* increased the P's collective and repositioned both of his hands back to his controls. The PC* continued collective application as the aircraft impacted the ground with sufficient force to dislodge both crewmember's NVGs from their attaching points. The PC* was unable to judge aircraft attitude as the aircraft rebounded into the air. The aircraft impacted a second time in a tail-low, left roll attitude, causing major damage.

Example 4-7: OH-58 Day NOE Mission

An OH-58 on a day NOE mission was attempting to hover under high tension wires (ATM Task 1097). When the PC*, flying the aircraft from the right seat, advised the P of his intention to underfly the wires, the P said "OK" and returned his attention to his map. The PC* did not direct the P to provide obstacle clearance from the concrete power pole on the left side of the aircraft. The PC* positioned the aircraft close to the pole and proceeded under the wires. The main rotor system struck the pole, resulting in major damage to the aircraft.

Example 4-8: UH-1H Hydraulic System Failure

The crew of a UH-1H was on the final 20-minute leg of a 2-hour service mission at 500 feet AGL when the master caution and hydraulics caution panel segment warning lights illuminated. Recognizing the stiffness of the cyclic, collective, and tail rotor controls as a hydraulics failure, the PC* slowed the aircraft. The enlisted crewmember, occupying the other pilot's seat, realized that the PC's* attention was focused on controlling the aircraft, so he assisted by selecting the appropriate radio frequency and ICS position for the PC* to report the emergency. The PC* was directed to a nearby Air Force base to attempt a running landing. Moments later, two of the five passengers aboard reported what they believed to be a fire. The aircraft's cargo doors were closed, and a fine red mist was

forming inside the aircraft. The PC* realized the passengers were being sprayed with hydraulic fluid, which was causing a burning sensation in their eyes and on their skin.

Flight to the Air Force base would take about 20 minutes, and recognizing the high toxicity of the hydraulic mist, the PC* elected to attempt a running landing to an alkali lake bed. Because of the extreme stiffness in the controls, the PC* directed the enlisted CM to assist him in manipulating them. Together, they successfully accomplished the emergency landing, saving the aircraft and reducing their passengers' exposure to a chemical hazard.

Example 4-9: UH-60A NVG Interdiction Mission

A UH-60A was on an over-water, NVG interdiction mission, on a zero-illumination night. The crew was being vectored to a target boat at 60 knots and 50 feet AGL. While performing a climbing left turn to avoid over-flying the target, the PC* in the left seat experienced vertigo and announced to the P, "I've had it, you got the controls." The P* assumed the controls, leveled the aircraft, and stopped the climb at 300 feet AGL.

The P* did not interpret the PC's announcement to mean that the PC was incapacitated and, therefore, not able to provide any assistance in instrument cross-check or obstacle clearance. The PC was looking at the floor in an attempt to regain his orientation. The P* resumed the mission by initiating a left descending turn intending to level at 50 feet AGL. He made a power application at approximately 100 feet AGL in anticipation of reaching his desired altitude and continuing terrain flight (ATM Task 2081). The PC, still incapacitated, looked up and noticed the altimeter passing through first 50 feet AGL, then 38 feet. The PC announced each of these altitudes and then applied collective as the aircraft continued to rapidly descend through 28 feet, but the aircraft was descending too fast to avoid impact with the water.

Example 4-10: UH-60 NVG Formation Flight

The P* of a UH-60 was performing a night, multi-aircraft NVG mission (ATM Task 2009) and was approaching a reporting point at 200 feet AGL. The IP in the right seat did not announce his decision to cease his obstacle clearance responsibility on the right side of the aircraft and come inside the cockpit to change radio frequencies. As a result, no other crewmember assumed obstacle clearance responsibilities to the right front and the aircraft struck another UH-60** that was approaching the same reporting point from the right front.

**IP in left seat of second UH-60 committed similar crew coordination error.

Example 4-11: UH-60 NVG Formation Flight

A UH-60 P*, flying from the right seat, was performing multi-aircraft operations (ATM Task 2009) at night, using NVGs. The accident aircraft was chalk #4 in a staggered left trail formation of 7. The formation began a left descending turn just past a ridgeline when the P* announced, "I have lost the aircraft." The P* actually still saw chalk #3, but had lost visual contact with chawks #1 and #2, which passed behind the instrument panel.

The PC, who was inside the aircraft making a radio call, misinterpreted this non-specific announcement to mean that the P* had lost sight of chalk #3. Consequently, he took control of the aircraft, decelerating and sliding the aircraft to the left as he attempted to reacquire chalk #3. Because both pilots' attention was focused on reacquiring the other aircraft, no one was providing obstacle clearance as required in the ATM task description and the PC* unknowingly lost altitude, striking trees at 20 feet AGL.

GROUP #5: CROSS-MONITOR PERFORMANCE

Example 5-1: AH-1F Hydraulic System Failure

During an NVG training mission, two AH-1F helicopters departed a local heliport en route to an airfield. Because of threatening weather conditions, the pilots of both aircraft decided to return to base and conduct closed traffic pattern training. The lead aircraft gained spacing from the second aircraft, made a normal approach to the middle of the runway, and was beginning a takeoff as the second aircraft made its approach.

On climbout, the lead aircraft pilots heard a loud popping sound and saw the master caution and No. 1 hydraulic pressure segment warning lights illuminate. The P* transferred the controls to the PC, who leveled the aircraft and notified the tower of the emergency. The second aircraft cleared while the PC* and the P began executing dash 10 checklist procedures for a hydraulics failure below 40 knots. The PC* tried to circle to land, but due to loss of hydraulic pressure, the pedals became unmanageable. The PC* then decided to extend the downwind leg and attempt a run-on landing above 50 knots. Visibility was poor, and the PC* requested that the intensity of the runway lights be turned up; however, the tower was unable to comply.

On final, the PC* executed a run-on landing as the P continuously updated altitude, airspeed, and rate of descent. The team effort allowed the PC* and P to make a safe run-on landing at 50 knots.

Example 5-2: AH-1S NVG Training Flight

The crew of an AH-1S was conducting an NVG training flight. After a routine flight to the NVG training area, the P*, flying from the rear seat, performed several NVG confined area approaches (ATM Task 1031) with no difficulty. However, since take off, the ambient light level dropped from 17 millilux to 3.5 millilux because of increasing cloud cover. Additionally, the aircraft's infrared searchlight was inoperative. The P transferred the controls to the UT*, who then attempted to perform an approach into the same LZ, but terminated with a go-around when he lost visual reference with the ground.

The UT* chose to try the approach again. As the aircraft descended below the approach barriers, both the UT* and the P lost visual contact with the intended touchdown point. The aircraft had developed a high rate of descent and a steep approach angle that went undetected until both pilots regained visual contact with the ground at about 10 feet AGL. The P, rather than assist the UT* by monitoring and calling out airspeed, altitude, and torque during the approach, directed his scan out of the cockpit. The UT*, not knowing how much power was being used and concerned about overtorquing the

aircraft, was too restrained with collective application and did not arrest the descent adequately to avoid a hard landing.

Example 5-3: AH-1S NVG Training Mission

The PC* of an AH-1S was attempting a terrain flight approach (ATM Task 1038) using AN/AVS 6 NVGs, to a dusty landing area. During the first approach, the crew experienced a brown-out and a go-around was made. The PC encouraged the P* to try the approach again in order to build the P's confidence; however the PC did not offer any advice or information to the P* on techniques to avoid the brownout condition or what to do if it occurred again. On the second attempt, the brown-out was more severe, and the PC* assumed the controls too late and overtorqued the aircraft when flying out of the brown-out.

Example 5-4: CH-47 NVG Training Mission

During an NVG tactical training mission, a CH-47 IP* was making a terrain flight approach (ATM Task 2084) to the water with an intended level-off at 50 feet AGL. The crew was wearing AN/PVS 5 NVGs, and there was 0% moon illumination. The IP* stated "he wanted another set of eyes to monitor the altimeter" and the P assumed he was the object of the request because he was seated in the left seat and the only crew-member other than the IP* with access to a radar altimeter (another aviator receiving training was seated in the companionway). The P noticed the altimeter passing through 78 feet AGL but failed to notify the IP*. The IP* continued the descent until the aircraft contacted the water at approximately 70 knots.

Example 5-5: OH-58A Cross Country Training Mission

The PC* of an OH-58A was performing terrain flight (ATM Task 1035), flying approximately 5 feet above the surface of a lake at 90-100 knots. Because of a materiel problem, the A series of this helicopter design was restricted to 400 feet AGL minimum altitude.

The PC* had been the subject of 6 OHRs in the past year, all for hazardous or high risk flying techniques. The PC's* reputation in the unit was one of a "hot dog"; one that had, and would, deviate from standard practices whenever the opportunity presented itself. The PC* was also described as one who "did not take constructive criticism well; one who became very defensive when approached about his hazardous flying."

The P outranked the PC*, and was, in fact, the acting unit commander. The P told the PC* he was flying too low, but rather than increase the altitude, the PC* responded by

asking the P a question that directed his attention to the map. Seconds later, the aircraft impacted the water.

Example 5-6: OH-58D Night Shipboard Landing

An OH-58D was attempting a night NVG shipboard landing (ATM Task 1028) during a proficiency training mission. The landing deck already contained another OH-58 which had just landed, and which was on the left side of the approaching aircraft. The IP*, seated in the right seat, attempted to maneuver onto the deck without assistance in obstacle clearance from the P. The aircraft drifted into the main rotor blades of the parked aircraft. The P, in the left seat, failed to offer assistance in obstacle clearance, despite his location in the left seat, closest to the obstacle. TC 1-204 states that non-flying crewmembers should provide information to the pilot flying concerning obstacle avoidance, altitude, airspeed, and approach angle.

Example 5-7: UH-1H NVG Training Mission

The crew of a UH-1H was returning to an airfield to refuel following an NVG training mission. Because of communication problems between the aircraft and the tower, the crew was executing an expedited approach and an abbreviated traffic pattern that resulted in a steeper than normal approach angle. Because the NVG approach (ATM Task 2096) was being shot to an extremely dark area on the airfield, the PC* was using what he thought were the navigational lights of an OH-58 on the ground as a reference for the approach. The lights were actually those of the trail UH-60A of a two-ship formation that was sitting on the ground in the sod area waiting to enter the refuel point.

During the approach, the PC* became fixated on the lights and did not notice that the aircraft's rate of closure was excessive. The P was not performing P duties as required by the unit SOP (i.e., calling out airspeed, altitude, and power during the approach); rather, he was preoccupied by tuning the radio to the ground control frequency. On very short final, the PC* realized that his rate of closure was excessive and abruptly applied right aft cyclic in an attempt to decelerate and avoid the UH-60A on the ground. The maneuver was too late and the tail rotor of the UH-1H struck the main rotor system of the UH-60A causing major damage to both aircraft.

Example 5-8: UH-1H Service Mission

The P* of a UH-1H on a day service mission was hovering (ATM Task 1017) in a formation along a taxiway with a 9-knot tailwind. The aircraft was chalk #2 of a flight of four. When chalk #1 came to a stationary hover, the PC noticed the P* was experiencing difficulty in halting the forward motion of the aircraft, and the aircraft continued closing on chalk #1. The P*, thinking he had reached the aft cyclic stop, lost his composure and

applied an excessive amount of collective pitch that caused the aircraft to climb to a height of 40-50 feet.

During this maneuver, the PC did not offer assistance to P* and only when the maneuver became severe did the PC assume the aircraft controls (unannounced), but only briefly. After the PC released the controls (again unannounced), the P* once again lost control of the aircraft, and crashed without any further attempts by the PC to regain aircraft control.

Example 5-9: UH-1H Day Service Mission

The crew of a UH-1H was performing a day service mission to several outlying sites belonging to the supported unit. As the aircraft approached the field site, the P* initiated a confined area approach (ATM Task 1031) to the intended landing area, which was designated by four built-up concrete pads. The P* selected one of the pads for landing and planned the approach to terminate on the ground in anticipation of blowing dust.

The approach was terminated somewhat short, with the front portion of the landing skids on the pad, and the rear portion of the skids overhanging the aft edge of the pad. Calculations later proved that the aircraft CG was 16 inches to the rear of the aft edge of the concrete pad. The CE noticed this situation and directed the P* over the intercom to "move it forward," but did so in a tone of voice that did not break through the P's* concentration. The PC had intentionally not made a comment to the P* during the approach because he thought he had been offering too many suggestions to the P* during previous missions that day and didn't want the P* to think he was "riding" him.

When the P* abruptly lowered the collective, the aircraft rocked back over the 19 inch drop-off and the tail skid struck the ground. The P* then applied full forward cyclic and increased collective as the PC* came on the controls. The aircraft became airborne, yawed right then left, assumed a nose-low attitude and struck the ground hard, flattening the skids and skidding forward 14 feet.

Example 5-10: C-12 ASR Approach

A C-12 was initiating an instrument approach to an IFR airfield during a service mission. Because of thunderstorms near the ILS final approach course, approach control offered the crew an ASR approach (ATM Task 4510) instead. This approach was not published in DOD FLIP and, therefore, was not authorized for Army aircraft; however, the crew decided to accept the approach. The P*, flying from the left seat, had not flown an ASR approach for over a year, and when the MDA was given by approach control, he immediately began a gradual descent to that altitude. Additionally, the approach controller erroneously gave the crew an MDA that was 300 feet lower than the actual MDA.

Because the crew had no FLIP for this approach, they were unable to confirm the MDA and catch the controller's error. The PC knew the aircraft was descending, but because he was intent on looking for the airport environment, lost situational awareness and did not realize the P* was continuing his descent below the assigned altitude. The aircraft flew into trees approximately six miles from the runway, resulting in damage to the wings, horizontal stabilizer, and lower fuselage.

ACRONYM LIST

AA	Assembly Area	IFR	Instrument Flight Rules
ACE	Aircrew Coordination Evaluation	ILS	Instrument Landing System
AGL	Above Ground Level	IMC	Instrument Meteorological Conditions
AMC	Air Mission Commander	IP	Instructor Pilot
AO	Aerial Observer	LZ	Landing Zone
ASR	Area Surveillance Radar	MDA	Minimum Descent Altitude
ATM	Aircrew Training Manual	MSL	Mean Sea Level
CE	Crew Chief/Engineer	NOE	Nap Of the Earth
CG	Center of Gravity	OHR	Operational Hazard Report
CM	Crewmember	PC	Pilot in Command
CP	Copilot	PNVS	Pilot's Night Vision System
CPG	Copilot/Gunner	PSI	Pounds per Square Inch
DA	Density Altitude	PZ	Pickup Zone
DOD	Department of Defense	RL	Readiness Level
EENT	End Evening Nautical Twilight	RSP	Rated Student Pilot
FCC	Fire Control Computer	SAR	Search and Rescue
FE	Flight Engineer	SOP	Standing Operating Procedures
FLIP	Flight Information Publications	TADS	Target Acquisition/ Designation System
FM	Frequency Modulated; Field Manual	TGT	Turbine Gas Temperature
FPM	Feet Per Minute	TOT	Turbine Operating Temperature
G	Gravitational Force	UT	Unit Trainer
HAS	Hover Augmentation System	VFR	Visual Flight Rules
HDU	Helmet Display Unit	VHIRP	Vertical Helicopter Instrument Recovery Procedures
HMD	Helmet Mounted Display		
ICS	Intercommunication System (Intercom)		

Any pilot or copilot duty position abbreviation followed by () indicates that person was on the controls, flying the aircraft.



Aircrew Coordination Training Evaluation Guide

What you will find in this appendix:

- ☑ Aircrew Coordination Training Grade Slips
- ☑ Expanded Grading System
- ☑ Example Completed Grade Slips
- ☑ Rating Factors
- ☑ Rating Scale
- ☑ Basic Qualities and Behavioral Anchors

Aircrew Coordination Training Evaluation Guide

An important aspect of crew coordination training is the ability of IPs and UTs to assess crew coordination performance in an objective and reliable manner. This guide has been prepared to assist in making such evaluations.

..... Aircrew Coordination Training Grade Slips

The Battle-Rostered Crew Evaluation/Training Grade Slip (DA Form 7121-R) is used to record aircrew coordination training results and comments. Complete the form as instructed in the Aircrew Training Manual (ATM) with two exceptions:

- Substitute the Aircrew Coordination Training Grade Slip, described below, for the list of crew tasks.
- Use the expanded grading system, described below, to grade the overall flight as S+, S, S-, or U.

The Aircrew Coordination Training Grade Slip is a modification of the Maneuver/Procedure Grade Slip published in the ATM for each aircraft. Modifications include:

- Separate lines for each crewmember's name and duty position (for example, PC, PI, CPG, CE).
- More space in the grade block to permit multiple entries. *Note: For emergency procedures, enter the abnormal or emergency situation in the Aircrew Coordination Training Grade Slip (some emergency procedure ATM tasks are preprinted) and grade it the same as any task.*
- An expanded grading system using S+, S, S-, or U.
- A look-up table of Crew Coordination Basic Qualities (short titles) at the bottom of each page.
- Space for a summary rating for each Crew Coordination Basic Quality.

Identified as the Aircrew Coordination Training Grade Slip, this grade slip currently is to be used only for initial and refresher aircrew coordination training.

The grading system (letter grade) for aircrew coordination training is a modified version of the current Satisfactory (S) or Unsatisfactory (U) system. As always, the evaluator decides the grade. The grade should include both individual skill requirements and aircrew coordination aspects of each ATM task. To help identify aircrew coordination strengths and weaknesses, the satisfactory grade is further broken out into satisfactory plus (S+), satisfactory (S), and satisfactory minus (S-). Grading guidance for aircrew coordination training is as follows:

For the Aircrew Coordination Training Grade Slip:

- Enter the grade for the ATM task (S+, S, S-, or U) in the grade (GR) block.
- If the grade is S+, make an entry in the comment section of the Battle Rostered Crew Evaluation/Training Grade Slip.
- If the grade is S- or U *due to aircrew coordination*, enter the grade and the contributing Crew Coordination Basic Quality numbers (1, 2, . . . 13) in the grade block (for example, S- 2,5). Option: Include Basic Quality numbers for both positive and negative crew coordination behaviors by using a "+" or "-" sign next to each Basic Quality number (for example, S +7, +10).
- If aircrew coordination is not a contributor to the grade for the ATM task, enter the letter grade only (S+, S, S-, or U).
- Enter a summary rating (1, 2, . . . 7), described on page E-8, for each Crew Coordination Basic Quality in the grade block at the bottom of the last page of the Aircrew Coordination Training Grade Slip.

For the Battle-Rostered Crew Evaluation/Training Grade Slip:

- Enter an overall grade (S+, S, S-, or U) for the flight at the bottom of the Battle-Rostered Crew Evaluation/Training Grade Slip.
- Examples of completed Aircrew Coordination Training Grade Slips are at Figures E-1 to E-4.

Note: If a grade of "U" is given for unacceptable performance for a specific task, it does not render the entire flight unsatisfactory.

BATTLE-ROSTERED CREW EVALUATION/TRAINING GRADE SLIP					
For use of this form, see Aircraft ATM; the proponent agency is TRADOC					
BATTLE-ROSTERED CREW EXAMINEES/ TRAINEES	NAME		RANK		
	PC: <u>DORMAN, MARK A.</u>		<u>CW2</u>		
	PI: <u>PARKER, LLOYD R.</u>		<u>WO1</u>		
	NONRATED CREW MEMBERS				
	DUTY SYMBOL	NAME	RANK		
<u>CE</u>	<u>SULLIVAN, CLIFFORD P.</u>	<u>SGT</u>			
UNIT: <u>C CO, 5-101 AVN, FT. CAMPBELL, KY 42223</u>					
EVALUATOR/ INSTRUCTOR	NAME		RANK		
	<u>RICHARDS, JOHN G.</u>		<u>CW3</u>		
UNIT: <u>C CO, 5-101 AVN, FT. CAMPBELL, KY 42223</u>					
CREW DATA					
TOTAL BATTLE-ROSTERED CREW HOURS <u>6</u>			DATE DESIGNATED A BATTLE-ROSTERED CREW: <u>1 SEP 92</u>		
PURPOSE: EVALUATION <u>(TRAINING)</u>					
TIME TODAY: <u>2.0</u>			CUMULATIVE TIME:		
TYPE AIRCRAFT: <u>UH60FS</u>					
CREW TASK 1 _____		D/N/NVD		CREW TASK 6 _____	
CREW TASK 2 _____		D/N/NVD		CREW TASK 7 _____	
CREW TASK 3 _____		D/N/NVD		CREW TASK 8 _____	
CREW TASK 4 _____		D/N/NVD		CREW TASK 9 _____	
CREW TASK 5 _____		D/N/NVD		CREW TASK 10 _____	
DAY	NIGHT	WX	SIMULATOR	NVG	NVS
EVALUATOR/INSTRUCTOR RECOMMENDATIONS					
☐ (ISSUE) (VALIDATE) CREW QUALIFICATIONS					
☐ (SUSPEND) (REVOKE) CREW QUALIFICATIONS					
☐ REQUIRES ADDITIONAL (FLIGHT) (ACADEMIC) (SIMULATION DEVICE) TRAINING					
☒ SEE BACK FOR COMMENTS					
I HAVE DEBRIEFED THE EXAMINEES/TRAINEEES AND INFORMED THEM OF THEIR STATUS.					
EVALUATOR'S/INSTRUCTOR'S SIGNATURE: <u>John G. Richards</u>					
WE HAVE BEEN DEBRIEFED BY THE EVALUATOR/INSTRUCTOR AND UNDERSTAND OUR CURRENT STATUS.					
PC'S SIGNATURE: <u>Mark A. Dorman</u>					
PI'S SIGNATURE: <u>Lloyd R. Parker</u>					
NONRATED CREW MEMBER'S SIGNATURES: <u>Clifford P. Sullivan</u>					
OVERALL GRADE FOR THIS FLIGHT IS: ☒ S ☐ U ☐ NA					
DATE: <u>15 SEP 92</u>					

DA FORM 7121-R, MAR 92

Figure E-1. Example of Completed Battle-Rostered Crew Evaluation/Training Grade Slip (page 1)

PAGE 2, DA FORM 7121-R, MAR 92

E-4

MANEUVER/PROCEDURE GRADE SLIP FOR UH-60 RCM					
For use of this form, see Aircrew Coordination Exportable Training Package and TC 1-212					
PC <u>Dorman MARK A.</u>			Date <u>15 Sep 42</u>		
PI <u>Parker Lloyd R.</u>					
Instructor or evaluator will sign in the first unused block.					
NO	MANEUVER/PROCEDURE	GR	NO	MANEUVER/PROCEDURE	GR
1	CREW MISSION BRIEFING	S	27	EMERGENCY EGRESS	
2	VFR PLANNING		28	EMERGENCY PROCEDURES	ST
3	IFR FLIGHT PLANNING		29	HAND AND ARM SIGNALS	
4	DD FORM 306-4		30	FUEL SAMPLE	
5	DA FORM 5701-R	S	31	PASSENGER BRIEFING	
6	PREFLIGHT INSPECTION		32	INSTRUMENT TAKEOFF	
7	BEFORE-STARTING ENGINE THROUGH AIRCRAFT SHUTDOWN	5-411	33	RADIO NAVIGATION	S
8	ALSE OPERATION		34	HOLDING PROCEDURES	
9	GROUND TAXI	S	35	UNUSUAL ATTITUDE RECOVERY	
10	HOVER POWER CHECK	4,6,10	36	RADIO COMMUNICATION PROCEDURES	
11	HOVERING FLIGHT	S	37	PROCEDURE FOR TWO-WAY RADIO FAILURE	
12	VMC TAKEOFF	S	38	NONPRECISION APPROACH	S
13	TRAFFIC PATTERN FLIGHT	S	39	PRECISION APPROACH	
14	FUEL MANAGEMENT PROCEDURES	S	40	INADVERTENT IMC/VHIRP	S
15	PILOTAGE AND DEAD RECKONING	S	41	COMMAND INSTRUMENT SYSTEM OPERATIONS	
16	ELECTRONIC-AIDED NAVIGATION	S	42	A/C SURVIVABILITY EQUIPMENT	S
17	VMC APPROACH	S	43	MARK XII IFF SYSTEM	
18	ROLL-ON LANDING	S	44	CONFINED AREA OPERATIONS	
19	SLOPE OPERATIONS		45	PINNACLE OR RIDGELINE OPERATION	
20	AIRCRAFT REFUELING	S	46	FM RADIO HOMING	
21	POSTFLIGHT INSPECTION		47	EVASIVE MANEUVERS	5-57
22	SIMULATED ENGINE FAILURE AT ALT		48	MULTIAIRCRAFT OPERATIONS	S
23	SIMULATED ENGINE FAILURE AT		49	RAPPELLING OPERATIONS	
24	DEGRADED AFCS		50	INTERNAL RESCUE-HOIST OPERATIONS	
25	ECU LOCKOUT OPERATIONS		51	PARADROP OPERATIONS	
26	STABILATOR MALFUNCTION PROC		52	STABILITY OPERATIONS	
AIRCREW COORDINATION BASIC QUALITIES					
1. CREW CLIMATE	2. PLAN REHEARSE	3. DECISION TECH	4. WORK LOAD	5. UNEXP EVENTS	6. INFO XFER
7. SIT AWARE	8. COMM ACK	9. INFO SOUGHT	10. CROSS MONITOR	11. INFO OFFERED	12. ADVOC/ASSERT
					13. AAR

AIRCREW COORDINATION TRAINING GRADE SLIP

Figure E-3. Example of Completed Aircrew Coordination Training Grade Slip (page 1)

MANEUVER/PROCEDURE GRADE SLIP FOR UH-60 RCM												
NO	MANEUVER/PROCEDURE	GR	NO	MANEUVER/PROCEDURE	GR							
53	EXTERNAL LOAD OPERATIONS	S	79									
54	INTERNAL LOAD OPERATIONS		80									
55	AERIAL RADIO RELAY		81									
56	ACTIONS ON CONTACT		82									
57	TERRAIN FLIGHT MISSION PLANNING	S	83									
58	TERRAIN FLIGHT NAVIGATION	S	84									
59	TERRAIN FLIGHT	S	85									
60	WIRE OBSTACLES		86									
61	MASKING AND UNMASKING		87									
62	TERRAIN FLIGHT DECELERATION		88									
63	MAJOR US/ALLIED AND THREAT EQUIPMENT IDENTIFICATION		89									
64	TACTICAL COMMUNICATION PROCEDURES AND ECCM		90									
65	TACTICAL REPORT		91									
66	QUICK FIX MISSION		92									
67	FLAT TURN/VCALIBRATED FLIGHT		93									
68	ORAL EVALUATION		94									
69	<i>John G. Richards</i>		95									
70			96									
71			97									
72			98									
73			NOTES: ◇ NVD MANEUVER □ INSTRUMENT MANEUVER ○ STANDARDIZATION MANEUVER ENTER S+, S, S-, OR U IN GRADE BLOCK. IF GRADE IS S- OR U DUE TO AIRCREW COORDINATION INCLUDE UP TO TWO BASIC QUALITY NUMBERS. S- 2,5									
74												
75												
76												
77												
78												
AIRCREW COORDINATION BASIC QUALITIES												
1 CREW CLI- MATE	2. PLAN RE- HEARSE	3. DECI- SION TECH	4. WORK LOAD	5. UNEXP EVENTS	6. INFO XFER	7 SIT AWARE	8. COMM ACK	9 INFO SOUGHT	10. CROSS MON- ITOR	11. INFO OF- FERED	12. ADVOC/ ASSERT	13. AAR
G R A D E												

PAGE 2, AIRCREW COORDINATION TRAINING GRADE SLIP

Figure E-4. Example of Completed Aircrew Coordination Training Grade Slip (page 2)

Rating Factors

Objective and reliable assessment of crew coordination hinges on correctly identifying the Crew Coordination Basic Qualities (BQ) affecting a crew's performance. This section outlines rating factors to assist IPs and UTs in determining which BQ(s) contributed to an ATM task grade. These effectiveness factors are directly related to topics presented during the Classroom Instruction portion of the Aircrew Coordination Course.

BQ 1 Establish and maintain flight team leadership and crew climate

Leadership Style
Professional Respect
Resolution of Disagreements
Crewmember Attitudes

BQ 2 Prepermission planning and rehearsal accomplished

Prepermission Flight Planning
Prepermission Rehearsal
In-Flight Replanning and Rehearsal

BQ 3 Application of appropriate decision making techniques

High Time Stressed Decisions
Moderate/Low Time Stressed Decisions

BQ 4 Prioritize actions and distribute workload

Task Prioritization
Workload Distribution

BQ 5 Management of unexpected events

Crew Preparation and Composure
Resource Management

BQ 6 Statements and directives are clear, timely, relevant, complete, and verified

Adequacy and Timeliness
Clarity
Acknowledgement

BQ 7 Maintenance of mission situational awareness

Awareness Level of Crew
Awareness of Factors Inhibiting Attention

BQ 8 Decisions and actions communicated and acknowledged

Communication of Decisions and Actions
Clarification and Acknowledgement

BQ 9 Supporting information and actions sought from crew

Solicitation of Crew Input
Solicitation of Crew Assistance

BQ 10 Crewmember actions mutually cross-monitored

Scanning for Crew Error
Two-Challenge Rule

BQ 11 Supporting information and actions offered by crew

Anticipation and Offering of Required Information
Anticipation and Offering of Required Assistance

BQ 12 Advocacy and assertion practiced

Advocacy
Assertion

BQ 13 Crew-level after-action reviews accomplished

Critique and Improvement of Crew Performance

Rating Scale

The following numeric rating scale is used to assess the level of behavior that crews exhibit for each Basic Quality shown at the bottom of the Aircrew Coordination Training Grade Slip. Each Basic Quality is rated using a seven-point scale with values ranging from 1 (very poor) to 7 (superior):

Very Poor	Poor	Marginal	Accept- able	Good	Very Good	Superior
1	2	3	4	5	6	7

Written descriptions of the types of behaviors and levels of performance are shown for rating values 1, 4, and 7. These descriptions serve as behavioral "anchors" and are designed to assist you in determining how well a crew performs on each Basic Quality in relation to a well-defined set of behaviors. You should use the "anchors" as the standard for making ratings—don't fall into the trap of comparing one crew's performance with that of another crew's; rate a crew's performance in relation to the "anchors." To ensure reliable ratings, continue to refer to the anchors when making rating responses until you are *completely* confident that you *fully* understand how to rate each Basic Quality.

In completing a Basic Quality rating, you should decide whether the behaviors observed fall into the low end of the Basic Quality range (values 1 or 2), the middle of the range (values 3, 4, or 5), or the high end of the range (values 6 or 7). Once you have selected the general range of response, use the anchors to help select the final rating value. For example, if a crew did an adequate job of premission planning and rehearsal, the rating would come from the middle of the range (3, 4, or 5). After determining this, you would review the behavioral description (anchor) associated with value 4 to determine if crew performance resembled this description (4 value), was somewhat less than this description (3 value), or was a little better than this description (5 value). You use the end-point anchors similarly to help determine ratings that fall near the ends of the scale.

Army aviation crews that have little or no training in aircrew coordination techniques will score most frequently in the lower half of the scale. Most other crews, however, will fall into the middle area of the scale. Keep in mind that although Army aviators have well developed basic flying skills, as a group, their aircrew coordination skills will be much like the rest of the population. A few crews will have strong coordination and communication skills, a few will have weak skills, and a significant number will have moderate skills.

BASIC QUALITY 1. Establish and maintain flight team leadership and crew climate (Crew Climate)

Explanation:

This rating assesses the quality of relationships among the crew and the overall climate of the flight deck. Aircrews are teams with a designated leader and clear lines of authority and responsibility. The pilot-in-command sets the tone of the crew and maintains the working environment. Effective leaders use their authority but do not operate without the participation of other crewmembers. When crewmembers disagree on a course of action, rate the crew's effectiveness in resolving the disagreement. Note: Traditional leadership centralizes leadership in the leader with followers fully dependent on the leader. Functional leadership assigns leadership and followership roles as the situation evolves. Flight team leadership recognizes the impact of leadership style on the working environment. Regardless of leadership style, the pilot-in-command retains final decision and direction authority.

Superior Rating (7)

The crewmembers have very good interpersonal relationships. They respect each others' skills and appear to enjoy being with each other. The climate is very open; crewmembers freely talk and ask questions. Crewmembers encourage the individual with the most information about the situation-at-hand to participate. There is a genuine concern for good working relationships. No degrading comments or negative voice tones are used in interactions. Disagreements are perceived as a normal part of crew interactions, and the crew directly confronts the issues over which the disagreement began. Arguments or disagreements focus on behaviors or solutions rather than on personalities. Each crewmember carefully listens to others' comments. Senior crewmembers accept challenges from junior crewmembers. Alternative solutions are explored. The solution produced is a "win-win" situation in which all crewmembers' opinions are considered. The crewmembers have no hard feelings at the conclusion of the incident.

Acceptable Rating (4)

The crewmembers have sound interpersonal relationships and seem to respect each others' skills. The climate is an open one, and crewmembers are free to talk and ask mission questions. Regardless of rank or duty position, the individual with the most information about the situation-at-hand is allowed to participate. When disagreements arise, the crew directly confronts the issues over which the disagreements began. The primary focus is on behaviors or solutions, and no personal attacks are made in the heat of discussion. The solution is generally seen as reasonable. Problem resolution ends on a positive note with very little hostility or grumbling among crewmembers. Mutual respect is clearly intact.

Poor Rating (1)

Crew interactions are often awkward and uncomfortable. The crewmembers do not appear to like or respect each other. Crewmembers may be curt and impolite to each other. Requirements for assistance are made as commands rather than as requests for support. When disagreements arise, the crew fails to directly confront the issues. Personal attacks may arise. Senior crewmembers are resistant to recommendations from junior crewmembers. Crewmembers do not explore the range of possible solutions. They may shout and argue without finding a solution. One or more crewmembers may retreat and say nothing at all. A "win-lose" situation develops in which one crewmember is shown to be right and the other to be wrong. The crewmembers show little respect to one another except for deferring to formal rank.

BASIC QUALITY 2. Prepermission planning and rehearsal accomplished (Plan Rehearsal)

Explanation:

This rating assesses the prepermission planning and rehearsal activities that the crew performs upon receiving a mission order. Time available determines whether prepermission planning and rehearsal is completed prior to the flight or in the cockpit. During this period crews:

- Clarify the mission order and the commander's intent
- Assign actions, duties, and mission responsibilities
- Collect information (intelligence, communications, weather, flight planning) and develop the plan
- Identify potential problem areas and courses of action
- Assess risks
- Visualize and rehearse the mission
- Conduct crew briefing to review and discuss the plan

Although the pilot-in-command is responsible for leading this activity, evaluate the extent and manner in which the entire crew participates. Also, consider the time constraints on the crew. If there is insufficient time to conduct comprehensive planning and rehearsal, evaluate the crew on their planning and rehearsal of the most critical segments of the mission. That is, either prior to the flight or in the cockpit, did the crew address the most important issues given the time available? Note: The relationship among crew members should be observed during this period but the crew climate evaluation should be made on rating Basic Quality 1, Flight Team Leadership and Crew Climate.

Examples:

- UH-60 Task 2078 and AH-64 Task 1033, Perform terrain flight mission planning: The crew will analyze the mission in terms of METT-T and plan the flight as directed by the PC. The crew will rehearse important aspects of the mission.
- UH-60 and AH-64 Task 1000, Conduct crew mission briefing: Aircrew collectively visualizes and rehearses expected and unexpected events from takeoff to tie-down; all factors of the flight; and actions, duties, and responsibilities of each crewmember.
- AH-64 and UH-60 Task 1068, Perform or describe emergency procedures: PC will include in the crew briefing the general approach to all emergency procedures requiring immediate action.

Superior Rating (7)

The entire crew discusses a detailed description of the mission and the commander's intent. All actions, duties, and mission responsibilities are partitioned and clearly assigned to specific individuals. The crew acquires new and updated information and uses it to develop the mission plan from the aircrew mission briefing. Questions and discussion about the mission, commander's intent, and specific responsibilities are encouraged. Potential problems are noted and discussed in detail. Courses of action and individual responsibilities are established in the event that potential problems actually occur. All crewmembers speak out and acknowledge an understanding of the operational risks in the mission plan. The pilot-in-command leads the crew in mentally rehearsing the entire mission by visualizing and talking the crew through potential problems and contingencies. Crewmembers acknowledge understanding their assigned responsibilities and cues for actions. The tone of the interaction is friendly and professional.

Acceptable Rating (4)

A brief description of the mission is provided to the entire crew. The mission responsibilities are partitioned and assigned to specific individuals. Actions are taken to update current information that adds to the aircrew mission briefing and helps develop the mission plan. One or more crewmembers make comments during the course of developing the mission plan. Potential mission problems are only briefly discussed. There is adequate preparation for contingencies. Crewmembers briefly discuss the operational risks in the mission plan. Mental rehearsal is initiated by the pilot-in-command or another crewmember who talks through potential problems or contingencies for one or more mission segments. Some discussion takes place to clarify responsibilities in the event of unexpected problems or contingencies. The tone of the interaction is generally friendly and businesslike.

Very Poor Rating (1)

The pilot-in-command briefs the mission with little or no attendant explanation. There is little or no discussion of responsibilities or their assignments to specific crewmembers. The pilot-in-command develops the mission plan from the aircrew mission briefing and current information. Crewmembers tend not to ask questions about the mission. If asked, questions tend to be cut off, only briefly addressed, or ignored by the other crewmembers. Little or no mention is given to potential problems or complications. No crewmember says anything about operational risks or weaknesses in the plan. Any suggestion to talk through a potential problem or mentally rehearse responsibilities is rejected as unnecessary. The tone of the interaction is business-like, abrupt, and impersonal.

BASIC QUALITY 3. Application of appropriate decision-making techniques (Decision Tech)

Explanation:

This rating evaluates the manner and quality of the crew's problem solving and decision making performance throughout the planning and execution of the mission. Factors to consider in making this evaluation include (1) information available to the crewmembers, (2) time urgency of the decision, and (3) level of involvement and information exchange among the crewmembers. The time critical demands of tactical flying require many decisions to be made on an automatic, pattern-recognition basis with only a minimum level of information exchange. However, when adequate time and information are available, crewmembers are expected to engage in a more deliberate and interactive style of decision making. The evaluation of crew decision making performance should ask the following questions: (1) Did the crew use all of the available information? (2) Was the level of information exchange among crewmembers appropriate for the time available? (3) Was the type of decision process (deliberate versus automatic) appropriate for the time available?

Examples:

- UH-60 and AH-64 Task 2044, Perform actions on contact: Crew will discuss options for developing the situation, then choose a course of action that supports the intent of the unit commander's directives.
- AH-64 and UH-60 Task 2083, Negotiate wire obstacles: Crew will discuss the characteristics of the wires . . . to determine the method of crossing.

Superior Rating (7)

Crew decision making consistently reflects proper attention to available information throughout mission planning and execution. The level of crew participation and deliberate analysis of options is appropriate for the decision time available. Resulting decisions are timely and appropriate given the time urgency and level of information available in each situation. Crewmembers do not exhibit any of the known hazardous thought patterns (e.g., anti-authority, impulsivity, machoism, invulnerability, resignation, get-home-itis, overconfidence in other aviator) and appear motivated to seek the most mission effective and safe decision in each situation. The crew decides and implements a course of action before the situation jeopardizes crew performance or mission accomplishment.

Acceptable Rating (4)

Crew decisions occasionally reflect a reluctance to share or use available information. On limited occasions, crewmembers dwell too long on some issues while neglecting more time urgent requirements. Most decisions are timely, but crew performance begins to show signs of self-induced stress. Most decisions are appropriate for the situation, with the crew occasionally overlooking one or more factors or options. Occasionally, crewmembers do not recognize or exploit opportunities for additional planning or rehearsal, substituting instead *ad hoc* strategies or plans. Crewmembers do not exhibit any of the known hazardous thought patterns. The situation may worsen, without seriously degrading mission accomplishment, before the crew decides and implements a course of action.

Very Poor Rating (1)

Crew performance (both pre-flight and in-flight) reflects an inflexible style of decision making (either deliberate or automatic) regardless of time urgency. Crewmembers may engage in excessive deliberation, overlook the relative time urgency of competing decision requirements, or fall victim to inappropriate mind sets. As a result, decisions frequently lack timeliness, ignore important factors, or appear out of context. Information exchange and crewmember interaction is minimal, with the result that critical input is ignored or not sought. Crewmembers may display one or more of the known hazardous thought patterns (e.g., machoism, anti-authority, get-home-itis). The crew may be unable to decide or implement a course of action before a situation becomes critical.

BASIC QUALITY 4. Prioritize actions and distribute workload (Workload)

Explanation:

This is a rating of the effectiveness of time and work management. Rate the extent to which the crew as a team avoids being distracted from essential activities, distributes workload, and avoids individual crewmember overload.

Examples:

- AH-64 and UH-60 Task 1080, Perform procedures for two-way radio failure: P* will remain focused outside the aircraft or inside the cockpit on the instruments, as appropriate. He will not participate in troubleshooting the malfunction.
- UH-60 Task 2079 and AH-64 Task 1064, Perform terrain flight navigation: P will focus his attention primarily inside the cockpit; however, as workload permits, he will assist in clearing the aircraft and provide adequate warning of traffic and obstacles.

Superior Rating (7)

Virtually all distractions are avoided. Each crewmember understands precisely what information is relevant to the mission and what information is simply a distraction. If a crewmember becomes mildly distracted, other crewmembers remind him to focus on the mission task. Non-critical duties are prioritized and delayed until low workload periods or post-flight periods. Crewmembers are aware of workload build ups on others and readjust workload by assuming emerging, unassigned tasks appropriate for their duty station. Overloads do not occur. The crew's planning horizon is always "ahead of the aircraft."

Acceptable Rating (4)

Most distractions are avoided. The crew performs well in deciding what information and activities are essential to the mission. Most non-essential information is discarded or ignored. Non-critical duties are prioritized and delayed until low workload periods or post-flight periods. Crewmembers are aware of individual crewmember workloads during each phase of the mission. When an individual crewmember appears to be overloaded, other crewmembers take on part of the workload. The crew is always "in sync with the aircraft."

Poor Rating (1)

The crew is easily distracted. The crew is unable or unwilling to decide what is important and relevant to the immediate mission. There is little prioritizing of duties or actions. Time and energy may be wasted on low priority tasks. Risks to crew safety may occur as the crew focuses on minor tasks while critical tasks requiring immediate attention go unattended, (e.g., setting a radio frequency when attention should be focused on clearing an obstacle.). Neither the overloaded party nor other crewmembers takes voluntary actions to eliminate an overload condition. The crew makes little or no effort to redistribute task responsibilities as mission changes occur and new tasks arise. Individual crewmembers experience workload overloads. The crew's planning horizon is sometimes "behind the aircraft."

BASIC QUALITY 5. Management of unexpected events (Unexp Events)

Explanation:

This rating evaluates the crew's performance under unusual circumstances that may involve high levels of stress. This judgement includes the integration of technical and managerial aspects of contending with the situation. Note: Enter the abnormal or emergency situation in the Aircrew Coordination Training Grade Slip (some emergency procedure ATM tasks are preprinted) and grade it the same as any task.

Examples:

- AH-64 and UH-60 Task 2008, Perform evasive maneuvers: The most important consideration in an emergency is aircraft control—first assess aircraft controllability, check systems indicators, take evasive action.
- UH-60 Task 1068, Perform or describe emergency procedures: CE will keep communications to a minimum to allow the P* or P to attempt communications outside the aircraft.

Superior Rating (7)

The crew remains calm during the situation. Each crewmember seeks to understand the problem and provides the pilot-in-command with essential information. Each crewmember immediately takes on particular workload responsibilities based on prior discussions and rehearsal of potential problems and contingencies. The crew effectively communicates its actions and results to others and provides feedback to ensure complete coordination of efforts. Each crewmember handles his own responsibilities and seeks to support the crewmember with the greatest workload. The crew rapidly imposes the maximum amount of control possible over the situation given the available time and internal and external resources. A high level of situation awareness is maintained throughout the event.

Acceptable Rating (4)

The crew responds to the problem and the pilot-in-command's requests for information but does not overreact. The pilot-in-command's requests for information are met by feedback from the crew. The crew takes actions to reduce the pilot-in-command's work overload and provides information even if it is not specifically requested. The pilot and crew make good use of available resources. The crew is intense but not flustered by the situation. Adequate situation awareness is maintained throughout the event.

Very Poor Rating (1)

The crew becomes disorganized and flustered. The pilot-in-command's requests for information elicit inadequate responses. Crewmembers may focus on the wrong issues, thus delaying correct diagnosis of the problem. The crew focuses on only one solution to an event, does not consider other plausible alternatives, or chooses an inappropriate solution. Lack of coordinated actions adds to the confusion. The pilot and crewmembers make poor use of available resources to resolve the problem. Situation awareness appears to decay during the situation.

BASIC QUALITY 6. Statements and directives clear, timely, relevant, complete, and verified (Info Xfer)

Explanation:

Rate the completeness, timeliness, and quality of information transfer. Carefully consider the crew's feedback techniques to verify information transfer. In particular, evaluate the quality of instructions and statements associated with navigation activities, obstacle clearing activities, and instrument readouts.

Examples:

- AH-64 Task 1015, Perform ground taxi: The P will announce "Blocking" to acknowledge the P*'s announcement "Braking".
- UH-60 Task 2079, Perform terrain flight navigation: The P* will acknowledge commands issued by the P for heading and airspeed changes.

Superior Rating (7)

Crewmembers communicate frequently. Both senders and receivers use standard terminology for nearly all communications. Senders almost always provide clear, concise information. Receivers acknowledge nearly all messages in sufficient detail so that the sender can verify that the receiver understands the message. Receivers ask for clarification when they do not understand. Senders pursue feedback when no response is forthcoming. Whenever a workload shift or task responsibility transfer occurs, the change is communicated and acknowledged by the crew. All navigation, obstacle clearing, and "inside" or "outside" the cockpit information is stated, acknowledged, and updated.

Acceptable Rating (4)

Crewmembers communicate about the mission as required. Standard terminology is usually used. Receivers acknowledge most messages. Receivers ask questions when they do not understand. Senders usually pursue feedback when no response is forthcoming. Crewmembers are appraised of changes to responsibilities during the flight. "Inside" and "outside" the cockpit duties are specified and communicated to others.

Very Poor Rating (1)

Crewmembers may fail to make statements regarding critical information. Non-standard terminology is used or standard terminology is used inappropriately. Sender messages may be inappropriately delayed or irregular and may be confusing. Receivers usually do not verbally acknowledge the receipt of messages. Receivers do not ask questions. Senders do not pursue feedback when no response is forthcoming. Changes in responsibilities during the mission are often not communicated and may result in confusion over who has a task responsibility. Navigation instructions and obstacle location information may be incomplete or confusing. At times, "inside" or "outside" the cockpit responsibilities are not clearly communicated.

BASIC QUALITY 7. Maintenance of mission situation awareness (Sit Aware)

Explanation:

This rating assesses the extent to which crewmembers keep each other informed on the status of the aircraft and mission accomplishment. This reporting helps maintain a high level of situation awareness among the flight crew. Information reported includes:

- Aircraft position and orientation
- Equipment status
- Personnel status
- Environment and battlefield conditions
- Changes to mission objectives

Crew-wide situation awareness is an essential element of safe flying and effective crew performance.

Examples:

- UH-60 Task 2009, Perform multi-aircraft operations: P and CE will provide adequate warning to avoid traffic or obstacles.
- AH-64 Task 2008, Perform evasive maneuvers: When engaged by the enemy, crew will announce the nature and direction of the threat.

Superior Rating (7)

Crewmembers routinely provide each other with updates on the status of the elements of situation awareness and the status of the mission. Crewmembers anticipate the situation awareness needs of others and request needed information when it is not forthcoming. Crewmembers are aware of each others' mental and physical states and are not hesitant to alert others to personal problems that could undermine effective performance. Personnel status is voluntarily shared without fear of sanctions. All changes in the elements of situation awareness are verbalized and acknowledged. Crewmembers alert other crewmembers to the presence of obstacles.

Acceptable Rating (4)

Crewmembers usually provide updates on the status of most of the elements of situation awareness and the status of the mission. Changes to the situation awareness elements are verbalized. Obvious changes in personnel status are noted and acknowledged without fear of sanctions.

Very Poor Rating (1)

Crewmembers do not routinely provide updates on the status of the aircraft or the status of the mission. Generally, updates are provided only on request; they are not made voluntarily. Personnel problems such as fatigue or lack of attention are not mentioned.

BASIC QUALITY 8. Decisions and actions communicated and acknowledged (Comm/Ack)

Explanation:

Rate the extent to which decisions and actions are actually made and announced to the crewmembers after input is solicited from them. Crewmembers should respond verbally or with the appropriate adjustment to their behaviors, actions, or control inputs to clearly indicate that they understand when a decision has been made and what it is. Failure to do so may confuse crews and lead to uncoordinated operation. Note: Due to time constraints in certain situations, there is often little or no time for crews to make inputs to a decision. In such cases, raters should focus on the extent to which decisions are acknowledged verbally or through coordinated, pre-planned action.

Examples:

- UH-60 Task 2086, Perform masking and unmasking: P* will announce his intent to unmask. The P and CE will acknowledge that they are prepared to execute the maneuver.
- AH-64 Task 1038, Perform terrain flight approach: P* will announce intention of a go-around . . . whether approach will terminate to a hover or to the ground. P will acknowledge use of manual stabilator or any intent to deviate from the approach.

Superior Rating (7)

The pilot-in-command states decisions and actions and, time permitting, explains the reasons and intent. Crewmembers acknowledge the decisions with a clear verbal response and ask questions to clarify any confusion. The pilot-in-command answers all questions in a positive, straight-forward manner. Crewmembers keep the pilot-in-command informed of the results of their activities and changing responsibilities—especially visual area of responsibility or task focus. The crew clearly acknowledges results of actions, or changes, and then states its intended adjustments based on the information provided. If crewmembers do not acknowledge or adjust, the pilot-in-command requests acknowledgement. Crewmembers are particularly attentive to the communication of workload responsibilities. When assuming control of the aircraft or making control inputs, notification is always given and acknowledgement received.

Acceptable Rating (4)

The pilot-in-command states decisions and actions along with, time permitting, a brief explanation of the reasons and informs the crew of the adjustments they are expected to make. The crew acknowledges its awareness of the decisions and directions. Crewmembers may ask questions to clarify confusion. The pilot answers questions clearly and quickly and the crew adjusts to the new situation. When assuming control of the aircraft or making control inputs, notification is given and acknowledged.

Very Poor Rating (1)

Decisions and actions of a crewmember are often not passed on to the crew. The pilot-in-command takes unilateral action and does not explain or inform the crew of his intended purpose. The crew is often not aware that a decision has been made. The crew infrequently asks questions for clarification. The pilot-in-command may not acknowledge or respond to questions. The crew may not know how to react to changed circumstances. Crewmembers are often unsure what responsibilities have been assigned to them. Crewmembers may take uncoordinated actions without stating intentions or results. Two pilots may attempt to simultaneously take control of the aircraft when flight control authority is unclear.

BASIC QUALITY 9. Supporting information and actions sought from crew (Info Sought)

Explanation:

This is a rating of the extent to which crewmembers, usually the pilot-in-command, seek support information and support actions from the crew. Evaluate the degree to which crewmembers raise questions during the flight regarding plans, revisions to plans, actions to be taken, and the status of key mission information. Note: The extent to which crewmembers maintain situational awareness and contribute to decision making should be observed here but evaluated on Basic Qualities 7 and 4 respectively.

Examples:

- UH-60 Task 1032, Perform slope operations: P* will request assistance in setting the brakes.
- AH-64 Task 2044, Perform actions on contact: The crew will discuss options for developing the situation.

Superior Rating (7)

During the flight, crewmembers raise questions on plans or changes to plans and actions. Virtually all of these inquiries surface information that contributes to the mission decision making process. When the pilot-in-command realizes that a decision must be made during the flight, for which there is no clear standardized answer, he immediately alerts the crew to the situation and seeks suggestions on possible solutions and important information to consider. The pilot-in-command is open to all suggestions. Crewmembers respond to these inquiries with sound, task-focused discussions and clear answers that are provided in a timely manner. Crewmembers' inquiries are never ignored. All crewmembers encourage such questioning. When the pilot-in-command asks for assistance with actions he clearly states what assistance is required. He provides quick, clear feedback if the crewmember response is not what he expects. He asks for assistance before becoming overloaded.

Acceptable Rating (4)

During the flight, crewmembers occasionally raise questions on plans or actions when they are unclear on decisions being made. Most of these inquiries provide information that is relevant to the mission decision making process. The pilot alerts the crew to the need for decision input. Crewmembers usually respond to these inquiries with brief but reasonable answers. Crewmembers' inquiries are encouraged by other crewmembers

most of the time. The pilot-in-command listens to suggestions without interruption or criticism. He asks for clarification as necessary. He only asks for assistance when he becomes overloaded.

Very Poor Rating (1)

During the flight, crewmembers almost never raise questions about plans, actions, or changes to plans. The pilot-in-command makes mission decisions without seeking inputs from other crewmembers. The pilot-in-command does not alert the crew that a decision is required or is being made. Decision making and planning are done by one individual with little or no discussion—an observer will have difficulty noting this quality for "very poor" crews since it is hard to detect individual decision making. The few inquiries that are made are generally ignored or abruptly answered. Crewmembers may discourage others from asking questions by the tone of voice they use or by failing to respond. The pilot-in-command may not ask for crew assistance with tasks even when he is overloaded to the point of nearly failing to properly execute tasks.

BASIC QUALITY 10. Crewmember actions mutually cross-monitored (Cross-Monitor)

Explanation:

This rating captures the extent to which a crew uses cross-monitoring as a mechanism to avoid errors and improve future performance. Crewmembers are able to catch each other's errors. Such redundancy is particularly important when crews are fatigued or overly focused on critical task elements, and thus more prone to make errors. Included in this rating is the crew's use of aircraft technical manual checklists to perform required procedure checks and procedures (i.e., engine-start, run-up, before-takeoff, before- and after-landing, shutdown checks; HIT and emergency procedures). Note: This quality does not imply that task responsibilities are not clearly defined. It asks the question "To what extent do crewmembers help an individual assigned primary responsibility for a task or action by reviewing the quality of that individual's task execution and alerting him to any mistake noted?"

Examples:

- AH-64 Task 1094, Identify major US or allied equipment and major threat equipment: P* or P will announce the type and direction of the equipment detected. The other crewmember will confirm the type and direction of the equipment.
- UH-60 task 1023, Perform fuel management procedures: PC will confirm the results of the fuel check.

Superior Rating (7)

Each crewmember is concerned that all tasks are properly executed and checks both his tasks and those of others. When mistakes are noted, the crewmember making the error is quickly informed in a concise manner without excessive formality. The mistake maker accepts this review and feedback as a normal part of crew operations.

Acceptable Rating (4)

Crewmembers often check each other's task performance for errors. Mistake makers are informed and make the needed corrections. Only occasionally are mistake makers annoyed at being checked and corrected.

Very Poor Rating (1)

Crewmembers seldom, if ever, check each other's task execution. Crewmembers are insulted if they are corrected by another crewmember.

BASIC QUALITY 11. Supporting information and actions offered by crew (Info Offered)

Explanation:

This is a rating of the extent to which crewmembers anticipate and offer support information and support actions to the decision maker, usually the pilot-in-command, when it becomes apparent that a decision must be made or an action taken.

Examples:

- UH-60 Task 2016, Perform external load operations: All crewmembers will assist in clearing the aircraft and will provide adequate warning of obstacles, unusual drift, or altitude changes.
- UH-60 and AH-64 Task 1081, Perform nonprecision approach: P will call out the approach procedure to the P*.

Superior Rating (7)

The crew recognizes that a decision must be made and offers suggestions and information to the pilot-in-command. The crew checks for responses that indicate understanding. The information is repeated, as necessary, to ensure that the pilot-in-command understands the input. Pilot-in-command responses can be verbal or non-verbal actions. The crew seeks information and provides it to support decisions and actions. The crew frequently offers task execution support. The support offered always reflects the pilot-in-command's task needs. Crews are quick to offer support during particularly difficult tasks such as obstacle clearing.

Acceptable Rating (4)

The crew recognizes that a decision or action must be made and offers suggestions and information to the pilot-in-command. The crew sometimes offers task execution support. Crewmembers usually offer obstacle clearing support.

Very Poor Rating (1)

The crew does not offer suggestions and inputs to support decision making or actions. Moreover, it often appears that the crew does not even realize that a decision is being made. The crew generally does not offer its services to support task execution for other crewmembers. Crewmembers may fail to offer obstacle clearing support.

BASIC QUALITY 12. Advocacy and assertion practiced (Advoc/Assert)

Explanation:

This rating evaluates the extent to which crewmembers advocate a course of action they consider best, even when it may differ with the one being followed or proposed. Note: Except under extreme emergency conditions where time is absolutely critical, it is usually in the crew's best interest to hear the full range of viewpoints available.

Examples:

- UH-60 and AH-64 Task 2083, Negotiate wire obstacles: Crew will discuss the characteristics of the wires . . . to determine the method of crossing.
- AH-64 Task 2044, Perform actions on contact: Crew will discuss options for developing the situation.

Superior Rating (7)

Crewmembers state to the rest of the crew a course of action that they consider best. They clearly explain their reasons for believing this to be the best course. Other crewmembers listen to the argument before presenting any criticism or proposing alternate courses. Discussions focus on the strengths and weaknesses of the proposed course of action, not on the personality of the crewmember who proposed the action. Crewmembers call the crew's attention to changes in the situation and provide information that is essential to the proper execution of another crewmember's task. Crewmembers pursue feedback to ensure that their views are heard and understood. Other crewmembers expect such open comments and view them as positive contributions to mission performance.

Acceptable Rating (4)

Crewmembers state their support for a course of action or suggest improvements to other proposed actions. Each crewmember makes an effort to explain his position and convince others to concur with him on the course of action to be taken. Other crewmembers may interrupt with their views and alternatives. Crewmembers usually speak out when they recognize a departure from the mission plan or standard procedures or when they have a piece of information that is important to another's task execution. Crewmembers seek assurances that presented information has been received. Other crewmembers view such comments as constructive and not as a challenge to authority.

Very Poor Rating (1)

The crew almost never suggests a course of action. Crewmembers attempting to propose a course of action may be cut-off before they can propose the action or explain the rationale for that action. Crewmembers proposing courses of action may receive personal attacks. The crew raises few, if any concerns. Crewmembers may even fail to intervene when risks such as obstacles or poor visibility arise.

BASIC QUALITY 13. Crew-level after-action reviews accomplished (AAR)

Explanation:

This rating evaluates the extent to which the crew reviews and critiques its decisions and actions during or following a mission segment, during low workload periods, or during the post flight debrief. Evaluate the crew on their discussion of strengths and weaknesses (for example, what was done wrong, what might be done better, how improvements can be made, and what was done very well) in flight skills and aircrew coordination.

Superior Rating (7)

The entire crew reviews and critiques its decisions and actions throughout the mission, including the premission planning and rehearsal process. Crewmembers review factors considered in making their decisions, identify additional options or factors, including ways to "buy time," that should have been considered, and discuss different methods of weighting information in the decision process. All discussions focus on behaviors and information and carefully avoid any "finger-pointing" tones. The focus is clearly on education and understanding to improve individual and collective performance.

Acceptable Rating (4)

Senior crewmember(s) review and critique the crew's decisions and actions during problematic segments of the mission. They determine the major mistakes in the crew's actions or decisions and identify remedial actions or alternative options for future missions. Although the critiques are intended to educate the crew and to improve their performance during future missions, they may include some accountability for unsatisfactory performance.

Very Poor Rating (1)

The crew either fails to review and critique its mission performance or if a critique is performed, it is punitive or accusatory. That is, the critique is conducted primarily to assign blame for unsatisfactory performance. Little effort is made to identify lessons learned or to suggest constructive ways to improve future performance.

Simulator or Flight Mission Materials

What you will find in this appendix:

- ☒ List of Required Mission Materials

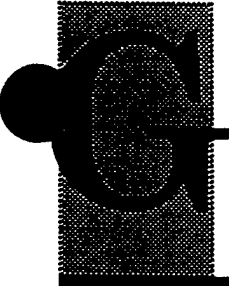
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Simulator or Flight Mission Materials

1. Instructors, IPs, or UTs will start with the unit's mission and develop realistic scenarios for the simulator or the flight phase of aircrew coordination training. Based on the scenarios, instructors will prepare, as necessary, and provide the written materials shown in Table F-1 to the student, IP, and simulator operator for each simulator or flight period.
2. Student materials provided by the instructor for premission planning and rehearsal, mission execution (simulator or aircraft), and crew-level after-action review include:
 - a. OPORD to include commander's concept and intent and/or air mission briefing per the unit's SOP.
 - b. Tactical map of the area of operations (to be returned to instructor for simulator periods).
 - c. Instrument approach plate(s) for fixed and/or tactical sites (to be returned to instructor for simulator periods).

Table F-1. Simulator or Flight Mission Materials

Mission Materials	Student	Instructor	Simulator Operator
OPORD and/or Air Mission Briefing ¹	X	X	X
Scenario Outline		X	X
Scenario Segment Info		X	X
Tactical Map	X	X	X
Approach Plate	X	X	X
Grade Slip		X ²	
Notes:			
1 Includes an instructor operator script for simulator scenarios			
2 Shared with students subsequent to the crew-level after-action review			



Background Reading

What you will find in this appendix:

- ☒ Articles related to the crew coordination topics discussed in this course.

Background Reading

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WARFIGHTER 6

Aircrew Coordination

Major General Dave Robinson

*Commander General, US Army Aviation Center and School
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For 50 years we have trained some of the best pilots in the world. In earlier times, aviators were trained mostly for single-pilot operations. Flying was somewhat easy; the L-19 Bird Dog and H-13 Sioux were forgiving aircraft, and the mostly daytime mission profiles were not too complex. Our standardization methods and checkride regimes were single-point oriented. We retained this orientation with the OH-58 Kiowa and the UH-1 Iroquois. As the fleet was modernized with AH-1 Cobra, OH-58D, AH-64 Apache, UH-60 Black Hawk, and CH-47 Chinook aircraft, single-point perspectives diminished. However, we had much to learn about crew operations in a modernized fleet. Today, a single pilot's mentality runs counter to the demand of complex, combined arms mission profiles and the high technology systems we operate and maintain.

Unfortunately, as tasks multiplied in the cockpit and environmental hazards increased, so did our accident rate. As early as 1973, the U.S. Army Safety Center identified problems in the ability of crewmembers to coordinate their actions. In a subsequent study of Class A aircraft accidents from 1983 to 1989, crew coordination failures steadily increased primarily because of more complex mission profiles and expanding night flying requirements.

A recent example of this phenomenon is Operation Desert Storm. Only 17 percent

of our flying was done at night, yet 68 percent of rotary-wing accidents occurred during the hours of darkness. Most of these accidents involved aircrew coordination failures. Why? There is strong evidence that peripheral vision is involved. During day operations, we have full vision capabilities. At night, our vision is limited peripherally, and important cues are missed. As we operate closer to the ground without sufficient visual cues, crew coordination becomes essential. When operating complex mission equipment packages in demanding operational environments, two sets of eyes and the brain power of two individuals is much better than one.

So how do we improve crew coordination? For many years, most military flight programs adopted civilian aviation's solution to the problem—Aircrew Coordination Training (ACT) and Cockpit Resource Management (CRM) training. The ACT and CRM programs were developed for civil aviation situations in which most of the mission profile was at high altitudes. Cooperation in the cockpit was based on using crew discussion in the decision making process. While this approach has value, it only partly addresses the Army's tactical flying needs.

Army Aviation's mission profiles are flown in the ground regime; obstacle hazards and the challenges of partial and

sometimes total obscurity confront even the most capable aviator. In flight, decisions must be made quickly, which calls for crew response to be nearly automatic.

Many aviation field commanders have been working on crew coordination matters for sometime. Battle rostering and special training programs have been used in units. However, the Army has not institutionalized its concern for the total crew concept. In response to this need, the U.S. Army Aviation Center has been drawing on field experience, our standardization personnel, and information from other services to revise completely the aircrew training program. We recognize that good crew coordination begins at the school house in primary training. Our training philosophy has moved from single-pilot operations to the total crew concept. This concept requires everyone to be responsible for specific tasks and share in the total operation of the aircraft.

To do this, crew coordination requirements are being integrated into the tasks, conditions, and standards of the aircrew training manuals. The goal is to take the guesswork out of duty assignment. Each crewmember is responsible for properly executing assigned duties while understanding the actions and directives of the other crewmembers. The new program also standardizes communication techniques to help eliminate ambiguity and confusion in the cockpit.

While a certain degree of flexibility is justified by the fluid nature of tactical flying, standardization is key to consistent behavior in the cockpit. We can no longer afford to assume that the other crewmembers know what to do and when to do it. Assumptions too often result in catastrophe.

Where do the subtle dimensions of human behavior fit into the cockpit team? We do not yet fully understand, nor do we have a vehicle to measure the impact of personality on mission accomplishment. We do know that to facilitate cooperation and coordination, commanders need to battle roster crews. While many of you probably just cringed, battle rostering does not mean a crew must fly together every flight. Keep in mind, however, familiarity with coworkers builds stronger team ties and opens channels of communication. Battle rostering also improves the crewmember's performance at a specific station.

As for risk management, a well-trained, cohesive crew will have a much lower risk factor than a newly formed or ad hoc crew, because communication breaks down the barriers that inhibit effective cockpit coordination. There will be risk tradeoffs to deal with along this road of individual, crew, and collective training. Commanders will need to consider the added risk involved when integrating new crewmembers during either complicated missions or adverse environmental conditions.

Challenging and innovative training is planned activity that focuses on team performance. Don't limit your concept of aircrew to just the aviators on board the aircraft. Crew chiefs, flight engineers, and aerial observers must be a part of the training process, if crew coordination is to be optimized. Crew coordination procedures must be implemented during day operations first to expedite safely positive habit transfer; this is the crawl, walk, run approach to training.

Establish creative simulator training programs to teach and confirm crew coordi-

nation skills. Skilled standardization instructors can learn much about a crew by watching crew drills in the simulator. Crew skills in day operations and in the flight simulator should be affirmed before taking on the more complex night environment.

I am proud that Army Aviation has consistently produced the best individual

helicopter pilots in the world. Without losing that individual advantage, it is now time to develop crews with the same skill and expertise needed to match the complex requirements of our mission profiles. Synergism is the key—combining individual elements to optimize their effectiveness. By implementing crew coordination training, we will become safer, more efficient, and more lethal warfighters.

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NEW DIRECTION FOR THE AIRCREW TRAINING PROGRAM

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Army Aviation's future direction for training aircrews departs from the current focus on individual training to place more emphasis on training and evaluating each crew's ability to work together as a team. The future changes affect crew training; battle rostering; crew evaluations; FAC 3 positions; risk assessment; NVG; and fratricide. Aviation unit commanders expect to make crew training as successful as individual training.

The new Training Circular (TC) 1-210, *Aircrew Training Program: Commander's Guide to Individual and Crew Training*, is the capstone manual for aviation commanders to use in developing their aircrew training programs (ATPs).

TC 1-210 is used with aircrew training manuals (ATMs) to meet individual, crew, and mission requirements. The ATMs are guides that give Army aviation a standard framework for individual and crew flight training programs after initial training. The Commander's Guide and the ATMs govern the ATP.

Several significant changes are projected for the ATP this year. The goal of the ATP is to develop cohesive, combat-ready aviation units. The direction of Army Aviation will help accomplish that goal.

By the end of this year, the Commander's Guide and all ATMs will be revised to reflect the new direction. The Commander's Guide, already sent to the U.S. Army Training and Doctrine Command, Fort Monroe, VA, is scheduled for fielding in June 1992. The ATMs should be fielded by the end of fiscal year (FY) 1992.

TC 1-210, the Commander's Guide for Individual and Crew Training

The new Commander's Guide refers to FM 25-100, *Training the Force*, and FM 25-101, *Battle Focused Training*. These manuals provide guidance on designing, implementing, and evaluating a training program. The guidance can be tailored to meet training requirements unique to aviation units.

The common denominator in all training techniques is training to meet the unit's mission essential task list. The training must link individual, crew, and collective training to accomplish the tasks in the mission essential task list.

Many commanders have already put some of the new concepts into their unit standing operating procedures. However, to provide a standard throughout the Army Aviation community, the revised commander's guide will include more spe-

cific guidance and regulatory requirements than did TC 1-210, *ATP: Commander's Guide*, published in 1986.

Along with a new title, significant changes will affect the way units are trained.

Major changes include the following—

Shift of focus from individual to crew training. The Commander's Guide published in 1986 and past ATMs have focused on the aviator. To complement the existing excellent individual training program, the next logical step is to focus on training the entire crew to work as a team.

This will bridge a long-standing gap between individual and collective training. TC 1-210 and revised ATMs will link the ATP with collective training found in field manuals, Army Training and Evaluation Program mission training plans, and other doctrinal material for combat training.

Crew coordination training. Crew coordination is the communication between crewmembers and actions taken in proper sequence to perform tasks efficiently, effectively, and safely. Lack of good crew coordination has contributed to fatalities and costs millions in damages during the last several years.

The goal in developing crew coordination is to increase mission accomplishment and reduce accidents. Beginning with TC 1-214, *ATM: Attack Helicopter, AH-64*, all ATMs will be revised to reflect this concept to increase mission accomplishment and decrease accidents.

The task descriptions in the ATMs will be rewritten to specify each crewmember's part in performing the tasks. TC 1-214 is

the first manual to be printed with the approved format for ATMs.

The emphasis on a coordinated team effort should satisfy both safety and training requirements for the ATMs. To help begin the new concept as soon as possible, the academic and flightline instruction syllabus at the U.S. Army Aviation Center, Fort Rucker, AL, is also being revised to include crew coordination training.

Battle rostering of crews. Crews who consistently fly together develop better cockpit coordination and are therefore less likely to have accidents. Battle-rostered crews include not only aviators, but also flight engineers, crew chiefs, aerial observers, aerial fire support observers, and medical observers.

Battle rostering does not mean these individuals must fly exclusively with each other on every flight. However, to be crew qualified, they must fly mandated crew iterations and pass evaluations as a battle-rostered crew.

Crew evaluations and tracking of commander-designated tasks. After progression to readiness level (RL) 1, the aviator begins crew progression from crew readiness level (CRL) 2 to CRL1 with the battle-rostered crew. Once designated CRL1, the crew must perform and track the prescribed iterations of the commander-designated crew tasks annually.

Aircrew Training Program

Besides the individual evaluations, an initial CRL1 evaluation is required. The battle-rostered crew will then be evaluated annually from the date it becomes CRL1.

Battle crew evaluations will focus on coordinated crew performance of selected commander-designated crew tasks.

Addition of flight activity category (FAC) 3 positions. It takes a staff officer about 5 hours away from normal duties to get 2 hours of flight time. A third FAC was created for key staff individuals who have duties so important that any frequent absence away from work hinders the unit mission.

FAC3 aviators have no aircraft hour requirements but must maintain simulator minimums, a current flight physical, current instrument qualification, and a current-10 exam.

Risk assessment. An intense training environment stresses both soldiers and equipment, creating a high potential for accidents. The potential for accidents increases as training realism increases. An accidental loss, whether from training or war, is no different than a combat loss. The asset is still gone.

With the risk assessment chapter included in TC 1-210, more emphasis is placed on assessing the risk associated with Army Aviation's highly realistic training environment. A work sheet is provided to help the commander assess risk based on individual, crew, weather, and mission variables. Battle-rostered crews will have a more favorable risk assessment than non-battle-rostered crews.

Night vision goggles (NVG). The publication of TC 1-210 and the revised TC 1-209, ATM: *Observation Helicopter, OH-58D*, means aviators will no longer use Field Circular (FC) 1-219, which is the ATM for NVG. TC 1-209 is scheduled for fielding in

FY 1992-93. Putting the NVG chapter in the new Commander's Guide fills the gap left by the outdated FC 1-219. This addition also puts numerous references and messages into a single source for NVG use.

Fratricide prevention. Two reasons have significantly increased the likelihood of fratricide: emergence of weapons that permit engagement of targets at extended distances and increased use of allied equipment by hostile nations. However, taking advantage of unique night and NVG skills, and ability to operate under reduced visibility, reduces the possibility of any adverse consequence that could occur from friendly fire.

For these and other reasons, antifratricide training should be one of our highest priorities in Army Aviation. As fratricide prevention doctrine evolves, changes will occur in TC 1-210.

Aircrew Training Manuals

Individual aircraft ATMs are being revised to include the new direction in the Commander's Guide. TC 1-214 is the first of the next generation of ATMs. In the coordinating draft stage, scheduled for fielding in June or July 1992, are TC 1-209; TC 1-212, ATM: *Utility Helicopter, UH-60*; TC 1-213, ATM: *Cargo Helicopter, CH-47*; and TC 1-218, ATM: *Utility Airplane*.

Several months after these TCs are fielded, TC 1-211, ATM: *Utility Helicopter, UH-1*; TC 1-213, ATM: *Attack Helicopter, AH-1*; TC 1-215, ATM: *Observation Helicopter, OH-58A/C*; 1-217, ATM: *Surveillance Airplane, OV-1*; and TC 1-XXX, ATM: *Transport Airplane*, will be fielded. The development

of crew coordination tasks, starting with TC 1-214, will be put in the other manuals.

The manuals are rewritten to delete information in the Commander's Guide, so only one source, the Commander's Guide itself, will give general information. We can thus avoid having manuals published at different times with conflicting guidance.

The focal point of the ATMs will be Chapter 6, Individual and Crew Tasks. The new focus describes crewmember duties to perform the crew's task successfully. The new generation of ATMs will reflect that aircrews fly aircraft and each crewmember has specific responsibilities to ensure safe and successful mission completion.

Revised Army Aviation Aircrew Training Manuals

TC 1-209, ATM: *Observation Helicopter, OH-58D*
TC 1-210, ATM: *Aircrew Training Program: Commander's Guide to Individual and Crew Training*
TC 1-211, ATM: *Utility Helicopter, UH-1*
TC 1-212, ATM: *Utility Helicopter, UH-60*
TC 1-213, ATM: *Attack Helicopter, AH-1*
TC 1-214, ATM: *Helicopter, AH-64*
TC 1-216, ATM: *Cargo Helicopter, CH-47*
TC 1-217, ATM: *Surveillance Airplane, OV-1*
TC 1-218, ATM: *Utility Airplane*
TC 1-XXX, ATM: *Transport Airplane*

Chapter 7, Maintenance Test Pilot Tasks, will also be added to each ATM. When the last ATM is revised, FM 1-544, *Standardized Maintenance Test Flight Procedures*, will be superseded.

Tomorrow's Challenge

The challenge to aviation unit commanders is to implement the revised ATP as smoothly and efficiently as possible. Changes in attitude, training, and equipment to meet the needs of aircrews and their missions will enhance unit readiness. Training crewmembers to perform their duties as an integral part of an aircrew will increase aviation operational capabilities.

Now commanders can tailor their training program to focus on mission proficiency. They can focus on the mission for several reasons: specific guidance for each crew to work together as a team, not individuals working separately, is being developed for each ATM; and the shift toward the evaluation of crew performance complements individual performance.

The U.S. Army aviator is one of the best trained aviators in the world. Once the new program tools are fielded, aviation unit commanders should be able to make crew training as successful as individual training. The challenge has been made—the rest is up to you.

AIRCREW COORDINATION TRAINING - A NEW APPROACH

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The purpose of the OH-58C mission was to conduct continuation training with night vision goggles (NVGs) and to provide familiarization of a maneuver site for an upcoming FTX. Normally, the OH-58 aircraft is crewed with a single pilot; however, the use of NVGs requires that two rated crewmembers occupy the cockpit. Both the Pilot in Command (PIC) and the pilot each had less than 65 hours of flying experience with the NVGs. The aircrew took off at dusk under visual flight rules and were joined by another aircraft for that evening's training. Normal NVG procedures call for the crewmember on the controls to be looking outside the cockpit, while the other crewmember is responsible for monitoring instruments and setting equipment inside the cockpit.

Upon reaching the maneuver area, the pilot lowered the OH-58C to approximately 400 feet AGL and flew it at 60 knots. The infrared search light normally used during NVG missions had been misaligned, creating a glare inside the cockpit, so the aircrew decided to land in order to make an adjustment to the light. Just at that time, the Low RPM audio signal and warning light came on, indicating a possible engine malfunction. The pilot lowered the collective momentarily, but within about two seconds, the Engine Out light came on and the aircraft yawed left.

According to the OH-58C operator's manual, the pilot is supposed to crosscheck other instruments to distinguish between an actual engine failure and a faulty warning signal. Under NVG conditions, this type of crosscheck would have to be performed by the other crewmember who is focused inside the cockpit (in this case, the PIC). Instead of requesting this crosscheck, the pilot immediately lowered the collective to the full down position and entered autorotation.

Acting on his own (and with the possible intention of taking over the controls for a non-NVG autorotation), the PIC removed his goggles and turned on the normal landing light. This light flashed, but immediately burned out. The PIC continued, however, by switching the instrument lighting from the special NVG setting to the normal setting - thus, creating visual problems for the pilot who was still wearing NVGs and who was still controlling autorotation maneuver.

The pilot began to put the OH-58C into a decelerative attitude at about 100 feet AGL; but the aircraft impacted the ground at an excessive rate of descent. The aircraft bounced, became airborne in a right roll, and struck the ground a second time with the transmission tearing loose from the fuselage. The aircraft came to rest on its side; however, both injured crewmembers were able to egress the aircraft under their own power.

While many factors came together to produce this type of accident, one message seems clear: the individuals were not performing as a crew! Lack of communication during the final seconds of this flight resulted in (1) a failure to properly confirm an engine failure and (2) a counterproductive sequence of actions which possibly degraded the pilot's vision through

the goggles and reduced his ability to successfully complete the intended autorotation under NVG conditions.

Analysis of Army Aviation Accidents

In a recent review of Army aviation accidents, the U.S. Army Research Institute Aviation R&D Activity (USARIARDA) has found that approximately 40% of all of the human error accidents involve crew coordination failures of some type (based upon an independent review of Class A-C rotary wing accidents during FY84-89). This estimate is significantly higher than the 11 percent figure reported in a 1973 Army study.¹ One reason for this increase is that reporting of Army accidents has not always adequately identified or highlighted crew coordination as a specific causal factor - a deficiency now being remedied by the U.S. Army Safety Center (USASC).

A review of over 125 Army aviation accidents involving crew coordination failures reveals many of the same patterns identified in previous research by the Federal Aviation Administration (FAA)². Among these are

- failure to communicate critical information
- poor management of crew resources
- ambiguity over task assignments and task priorities
- lack of assertiveness by junior crewmembers

However, a striking feature about Army rotary wing accidents is that they typically involve degraded environmental conditions and very short reaction times, as compared with the commercial transport accidents studied by the FAA and NASA. This is not surprising, given the high percentage of Army helicopter flying done

at extremely low altitudes (e.g., nap-of-the-earth), under tactical conditions (e.g., night), and over terrain with marginal visual contrast (e.g., water, desert, snow). Thus, where commercial pilots fly routine flight profiles over highly controlled air lanes, Army helicopter pilots are flying at low altitude, under goggles, and over marginally familiar terrain hazards. Where a commercial transport crew may have minutes or tens of minutes to identify and manage an emergency, the typical Army helicopter crew has but a few seconds to, react before entering into an unrecoverable condition (i.e., the majority of crew coordination accidents examined by USARIARDA involved less than 20-30 seconds from time of initial flight anomaly to ground impact).

Crew Coordination Training in the Army

In a related effort, USARIARDA has reviewed current training of crew coordination skills as part of the Army's overall aviation training program. Relevant training in this regard is provided in two ways. During Initial Entry Rotary Wing (IERW) training, Army aviation students are introduced to the principles of crew coordination as part of a course entitled "Dynamics of Aircrew Communication." In addition, Aviation Safety Officers (ASO) receive a 21-hour block of training in crew coordination principles as part of continuation training under the auspices of USASC. Both of these programs are based on training concepts and materials adapted from the civilian airline industry. They introduce the aviator to general principles of

effective communication, small group dynamics, personality, and managerial skills. Classroom examples are typically drawn from commercial aviation accidents. In both cases, training is limited to classroom lectures and small group discussions. Training materials typically cite examples that are drawn from commercial aviation; hence, they often lack relevance to the specific equipment or missions of interest to Army aviators. Similarly, use of a flight simulator to demonstrate and reinforce crew coordination principles—a technique heavily used in the civilian aviation community—is not currently considered in either the IERW training or ASO training.

It is noteworthy to mention that the Army has neither mandated nor provided for standardized crew coordination training at the unit level. Army aviation units are left to their own discretion as to whether or how crew coordination training will be taught within each unit. Likewise, there does not exist a common definition across the Army as to what crew coordination is or how it will be assessed. As a result, there currently exists a disparate collection of training programs across the Army aviation community. Materials found at the local level (where they exist) typically include a collection of lectures, handouts, and exercises that have been informally "bootlegged" from other units or training programs. This is not to imply that crew coordination training isn't taken seriously in many Army aviation units. The situation is simply that the Army lacks standardization in this area of aviator performance.

Based on this review, USARIARDA concluded that the Army's implementation of crew coordination training is weak, at

best. In this regard, a number of specific deficiencies can be summarized:

- a. Crew coordination training during IERW is offered at a time when students are coping with basic 'stick and rudder' skills. In addition, crew coordination concepts are difficult to demonstrate during the IERW training phase because of role constraints imposed by the student - instructor pilot relationship. As a result, IERW training offers little realistic opportunity for introducing, demonstrating, reinforcing, and evaluating crew coordination skills.
- b. Current approaches to training crew coordination lack specificity in their emphasis of the "soft" concepts of management theory, group dynamics, and interpersonal relations. Many aviators have difficulty applying such concepts since they are not expressed in the familiar "task condition - standards" format which characterizes Army aviation training and operations. As a result, current approaches to training crew coordination skills are met with negative or defensive reactions.
- c. The collegial principles emphasized in current training programs are not supported by Army regulations that prescribe crewmembers authorities and responsibilities (e.g., the notion that subordinate crewmembers have the right and obligation to challenge the Pilot in Command when the flight is not proceeding according to established procedures). The lack of precise authorities and responsibilities leaves the problem of interpretation to the individual aviator - and

clearly creates a dilemma in many instances. Until such concepts are clearly reconciled with Army regulations and interpreted in terms of Aviation Training Manual (ATM) task standards, Army aviators will be reluctant to modify traditional military attitudes in favor of the more collegial or democratic concepts of operation.

- d. Army rotary wing flying is clearly different from commercial transport flying, with special emphasis on night operations and low altitude. As a result, crew coordination training in the Army must respond to the highly time-stressed environment which provides less margin for error. Such an environment suggests greater reliance upon standardized procedures and specific crew responsibilities, rather than upon the vague introduction of broad management or socialization principles. Attitudinal changes in aircrew members are important, but they must be reinforced with habit responses that are developed through drilled or "over learned" procedures.

- e. Crew coordination training in the Army is currently confined to classroom instruction and small group discussions. In contrast, comparable training in the civilian aviation industry emphasizes the use of flight simulators to place aircrews in realistic mission settings in order to demonstrate and reinforce critical training points. While a variety of flight simulators exist for many of the Army's tactical aircraft, such simulators have not been used in any formal manner to support crew

coordination training - either during IERW or as part of unit level training.

- f. Crew coordination receives low visibility in much of the Army today simply because Army aviators are not held explicitly accountable for this aspect of performance. This lack of accountability is not surprising, given the vague manner in which crew coordination has been currently defined in ATM task standards point noted recently by MG Ostovich, Chief, Aviation Branch³. If crew coordination is an important aspect of crew performance, then it must be measurable in terms of specific, observable standards. Such standards must then be met as part of aviator progression to higher Readiness Levels (RL) and maintained through the Annual Proficiency and Readiness Test (APART) hands-on performance tests given to RL 1 aviators. In short, the Army must formally and explicitly address crew performance (in addition to individual aviator performance) as part of its Aircrew Training Program.

**USARIARDA Response:
Simulator- Based, Task-Specific
Aircrew Coordination Training**

Beginning in mid-1989, USARIARDA embarked upon research designed to provide the Army with an improved approach to aircrew coordination training - an approach which would respond uniquely to the needs of Army aviators. By virtue of the Army's flying regime, this research has focused heavily on rotary wing aviation and, more specifically, has emphasized

tactical operations under night or Night Vision Goggle (NVG) aided conditions.

Unlike previous training which has been limited to classroom discussions of communication principles, management theory, group dynamics, and interpersonal relations, this new training will be ATM task-oriented and make specific use of Army flight simulators. Specific goals of this training development research can be summarized as follows:

- Identify specific procedures for managing aircrew workload, assigning aircrew task priorities, and specifying crew member communication requirements for specific aircraft, flight tasks, and environmental conditions (e.g., UH-60 confined area operations under NVG conditions). Ultimately, such procedures would be incorporated into ATM task standards that emphasize *crew* responsibilities, rather than individual aviator responsibilities.
- Develop specific methods for training and evaluating aircrew coordination skills in the flight simulator. Specifically, develop flight simulator training scenarios that are keyed to certain "events" or "conditions" that have been repeatedly associated with crew coordination errors in Army aviation accidents. In addition, develop rating scales and procedures for grading aircrew performance and providing meaningful feedback to aircrews after training flights.

The need for specific procedures for managing aircrew workload, assigning aircrew task priorities, and specifying crew member communication requirements has

become apparent from a recent in-depth review of aircrew coordination failures in Army aviation accidents by USARIARDA and USASC. During this joint review, several recurring classes of aircrew coordination failures have been noted:

- a. Inappropriate or inadequate use of "nonflying" crewmembers during high workload task conditions⁴
 - failure of the pilot-in-command to provide clear tasking
 - assignment of a conflicting, but lower priority task
- b. Inadequate or misleading communication of essential information
 - failure to provide situational awareness information
 - failure to inform other crewmembers of actions taken
 - ambiguous tasking of another crewmember
 - failure to acknowledge a communication or resolve conflicting interpretations
- c. Lack of assertiveness by a subordinate crewmember to question a flight anomaly or the situational awareness of the "flying" aviator
 - failure to question tactics or flight plans which violate FAA or Army regulations, standard operating procedures, aircraft limitations, or prudent air discipline

- failure to take control of the aircraft when it is apparent that the "flying" aviator is not able to safely control the aircraft

As one aspect of its on-going research, USARIARDA (through a research contract with Dynamics Research Corporation) has begun to develop proposed revisions to the ATM task standards that would provide specific guidance regarding the use of "non-flying" crewmembers and task priorities for certain high workload task conditions. Current efforts have focused on the UH-60 Black Hawk ATM, with subsequent expansion to other aircraft types. In addition, USARIARDA and USASC plan to convene (April-May 1990) a panel of subject matter experts from across the U.S. Army Aviation Center to review relevant ATM task standards and propose specific procedures for eliminating each type of coordination error identified in the recent joint review of aviation accidents. This panel will be asked to consider a broader range of ATMs covering the UH-1, UH-60, OH-58, OH-6, CH-47, AH-1, and AH-64 aircraft. The combined product of each of these efforts will be a set of proposed ATM revisions that will specify standards of crew proficiency.

In a second area of training development research, USARIARDA (through a contract with ANACAPA Sciences, Incorporated) has begun to translate the conditions associated with recurring types of aircrew coordination failures into specific training scenarios for the UH-60 Blackhawk Flight Simulator. That is, each mission scenario is designed to include event probes which have been known to induce aircrew coordination errors under conditions of high workload or extreme time stress. Versions

of the scenarios are being developed for both day and NVG flight environments.

Development of these "accident-oriented" scenarios is one step in the process of building an objective training and evaluation system for assessing the coordination proficiency of aircrews under tactical conditions. While the UH-60 was selected as the demonstration system for these scenarios, the ultimate goal is to expand this work to other Army aircraft types.

Coincident with the demonstration of these training and evaluation scenarios is the development of objective rating instruments for scoring aircrew proficiency. In developing these rating instruments, USARIARDA realizes that an assessment of aircrew coordination proficiency must be explicitly anchored with observable and measurable standards. In this regard, two approaches are being explored at the present time. In one approach, the Dynamics Research Corporation has modified a version of NASA's Line/LOFT Check Airmen Worksheet⁵ for specific use with UH-60 Blackhawk aircrews. This instrument is intended for use by Instructor Pilots who are positioned to observe aircrew performance in the UH-60 Flight Simulator, and to conduct post-flight interviews with the crewmembers. While details of this rating instrument (now known as the Aircrew Coordination Evaluation (ACE) Checklist) are still being refined, it generally provides for a set of ratings (or other indicators) concerning the following aspects of aircrew coordination:

- Common experience of each crewmember (by seat position) with other crewmembers

- Specific dimensions of aircrew communication and coordination

- The management of abnormal or emergency situations
- Conflict resolution among crewmembers

In a second approach, ANACAPA Sciences, Incorporated, is exploring the development of specific rating instruments keyed to the individual event probes that are included in the flight simulator mission scenarios. This more focused approach is designed to provide a method for assessing crew responses to each type of high workload or time stressed situation. While more difficult and time consuming to develop, this detailed approach offers a more in-depth method, for assessing crew proficiency and providing training feedback.

Coupled with the development of specific rating instruments is an effort to provide for other forms of training feedback. Specifically, USARIARDA is exploring the use of low light level and/or near-IR video cameras for recording crew interactions during simulated missions (this type of camera is required for compatibility with the NVG mode of the UH-60 Flight Simulator). Playback of mission recordings has already been demonstrated in the civilian aviation industry as an effective feedback device for debriefing aircrews.

Fort Campbell Demonstration

Current planning calls for USARIARDA to take the UH-60 training and evaluation scenarios, rating instruments, and video recording equipment to Fort Campbell

during April-June 1990. Using participating aircrews from the 101st Airborne Division and Special Operations Task Force 160, USARIARDA will validate and refine the scenarios in the UH-60 Flight Simulator at Fort Campbell. In addition, unit Instructor Pilots and UH-60 Flight Simulator Trainer/Operators will be trained in the administration of the crew coordination rating instruments. From this initial demonstration, USARIARDA will determine if (1) the scenarios appropriately recreate conditions known to stress crew coordination skills and (2) provide an objective and reliable method for assessing crew proficiency.

For the Future

Over the remainder of FY90, USARIARDA will be engaged in developing a prototype program of instruction (POI) for training task-specific, procedures-driven UH-60 crew coordination in both the classroom and the flight simulator. For the classroom, the training POI will emphasize findings from the recent review of Army aviation accidents involving aircrew coordination failures. Combined with this material will be the teaching of specific coordination strategies or procedures for the cockpit, task responsibilities, and task priorities.

In addition to a revised classroom POI, USARIARDA will develop a prototype three-hour block of training for the UH-60 Flight Simulator. This block of training will serve to reinforce ideas introduced in the classroom and to demonstrate techniques and procedures under tactical conditions.

Returning to Fort Campbell in the November-December 1990 timeframe, USARIARDA will conduct a controlled experiment to determine the effectiveness of this new training. Using a sample population of aircrews from the 101st Airborne Division and Special Operations Task Force 160, the experiment will compare the resulting proficiency of the trained aircrews with that of a control group of aircrews. Again, mission scenarios and rating instruments similar to those used during the Spring evaluation will be used to measure aircrew coordination proficiency.

For 1991 and beyond, USARIARDA plans to expand the current training development effort to address additional Army helicopter models. Specifically, there is interest in exploring the unique requirements associated with tandem crew seating in either the AH-1 or AH-64 helicopters, and in expanding the training to address non-rated crewmembers in such aircraft as the CH-47 and OH-58. In regard to this last system, plans are being developed to investigate training requirements and techniques associated with aircraft for which there is not an available flight simulator.

Summary

In summary, USARIARDA has embarked upon the development of aircrew coordination training which is specifically tailored to the unique demands of Army rotary wing aviators. The use of advanced flight simulators, combined with an in-depth understanding of Army aviation accident data, promises to make this training both relevant and interesting for the Army aviator.

In a related sense, this research begins to move the Army beyond its current focus on individual aviator skills and toward MG Ostovich's goal of assessing *crew* proficiency.

Finally, this research begins to acknowledge that training for the complex aviation weapon systems of tomorrow's battlefield must increasingly address total system performance, with special emphasis on the demanding environments unique to the Army aviator.

For further information on this research program, contact USARIARDA at Fort Rucker, Alabama, Autovon 358-4404 or 4204.

Notes

- 1 Ricketson, D.S., Johnson S.A., Branham, L.B., and Dean, R.K. (1973) Incidence, Cost and Factor Analysis of Pilot-Error Accidents in U.S. Army Aviation, U.S. Army Agency for Aviation Safety
- 2 Jensen, R.S. (1989) Aeronautical Decision Making - Cockpit Resource Management DOT/FAA/PM-86/46, Federal Aviation Administration
- 3 Ostovich, MG R., III "The 1989 Aviation Brigade Commanders' Conference" in Army Aviation, Army Aviation Association of America, Vol 39, Number 2, Feb. 28, 1990
- 4 In this context, "flying" or "non-flying" crewmember distinguishes the aviator actually on the flight controls.

THE CREW COORDINATION MODEL

Robert Simon
Dynamics Research Corporation

Basic Flying Responsibilities

Aviators undertake several major categories of behavior in all flying situations. Figure 1 shows the categories of the Basic Model of operator functions in their simplest forms. These elements include:

1. Planning and plan revision (PLAN)
2. Situation Awareness (ASSESS)
3. Problem Solving/Decision Making (RESOLVE)
4. Operational Task Execution (EXECUTE)

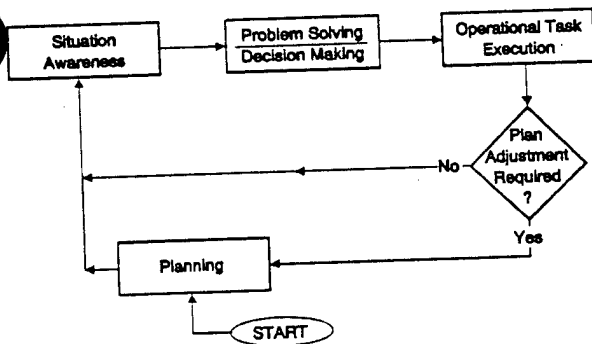


Figure 1. The Basic Model

All missions start with premission planning (PLAN). Throughout a mission, aviators continuously cycle through Situation Awareness (ASSESS), Problem Solving/Decision Making (RESOLVE), and Operational Task Execution (EXECUTE). When significant unforeseen events occur, the aviator may be forced back into the planning stage, where the plan developed

during the premission planning stage is revised to accommodate new conditions. Note that some part of the aviator's attention must always remain focused on Situation Awareness. Specifically, the aviator must always maintain awareness of the status of key factors that can influence the mission. This emphasis on ASSESS is one of the unique features of the model. It is an especially important issue in the area of safety because numerous aviation mishaps have been attributed to the failure of crews and individual pilots to maintain adequate Situation Awareness as they sought solutions to relatively minor problems.

The model holds true whether a single aviator or a crew controls an aircraft. In the next section, the Basic Model will be expanded to incorporate crew coordination and resource integration considerations within the framework. The major aviator control functions within the Basic Model are described below:

Planning (PLAN) comprises two phases depending on when the planning takes place. The first phase occurs during the premission planning stage. Essential considerations of premission planning include:

1. Mission objectives,
2. Aircraft status,
3. Current and predicted environmental conditions,

4. External support and interfaces,
5. Personnel status, and
6. Team member responsibilities (if crewed aircraft).

The second planning phase occurs during the mission. This phase combines the above factors in a dynamic fashion and consists of modifying and refining the initial plan. These revisions to the plan occur intermittently as required by mission events.

The key outcome of Planning is a clear and shared understanding among the entire crew of the basic mission objectives, the implementing actions needed to attain those objectives, mission limits and constraints, and the functional responsibilities assigned to each crewmember during the mission.

Situation Awareness (ASSESS) is defined as an aircrew's understanding of flight factors that impact on the success of the mission and the safety of the crew and aircraft at any given point in time. An operator who demonstrates Situational Awareness is cognizant of each of the dynamic Situational Awareness elements and its synergistic effect on other factors. Simultaneously monitoring all of these factors is a sophisticated integration activity. The six factors monitored in Situation Awareness include:

1. *Mission objectives* - The flight plan, purpose of the flight, standing operating procedures for mission accomplishment and flight safety
2. *Orientation in space* - Altitude, air-speed, heading, geographical location,

and mission time expended and remaining

3. *Environmental conditions* - All relevant current and predicted weather information, status and location of other air traffic, and status and location of threats to the aircraft and personnel
4. *External support* - The condition and readiness of external resources to support the mission, including, for example, air traffic control, refueling points, navigational aids, ground guides, other aircraft in the flight, and ground support equipment
5. *Equipment status* - Current and expected status of all mission equipment
6. *Personnel capabilities status* - Numerous human-related considerations including stress, fatigue, arousal level, workload, and individual skill and experience

Problem Solving and Decision Making (RESOLVE) synthesizes the elements of Situation Awareness to influence action. In the context of this discussion, the terms Problem Solving and Decision Making are used almost synonymously. A review of the literature did not reveal a sharp distinction between the two activities. However, we believe that Decision Making can best be conceptualized as a Problem Solving method. Consequently, whatever distinction might be made between the two holds little value in our model. Decisions must be made on a nearly continual basis when operating an aircraft. Decisions range from trivial and virtually automatic (e.g., how often one checks fuel consumption), to complex and deliberate (e.g., the choice of an alternate destination or an

other-than-planned target due to mitigating circumstances). In the latter two examples, operators perform Problem Solving.

The literature review yielded several Decision Making models, one being the DECIDE model. The Federal Aviation Administration (FAA) of the US Department of Transportation sponsored the development of a series of six curricula now in the public domain entitled "Aeronautical Decision Making for BLANK" where BLANK is 1) "Student and Private," 2) "Commercial," 3) "Instrument," 4) "Instructor," 5) "Helicopter," and 6) "Multi-Crew" (Jensen, 1989). The FAA emphasizes the DECIDE model (depicted in Table 1) in its training curricula.

Table 1. Elements of the DECIDE Model

D - Detect:	The decision maker detects the fact that a change has occurred that requires attention.
E - Estimate:	The decision maker estimates the significance of the change to the flight.
C - Choose:	The decision maker chooses the desirable outcome for the flight.
I - Identify:	The decision maker identifies plausible actions to control the change.
D - Do:	The decision maker acts on the best option.
E - Evaluate:	The decision maker evaluates the effect of the action on the change and on the progress of the flight.

In our model, DECIDE breaks Decision Making into three components: Estimate, Choose, and Identify. Instead of proposing that decision-making be the key notion in aircrew coordination, as is suggested in the FAA series, we treat Decision Making as only one activity of several others involved in aircrew coordination.

Our review of the literature on decision making surfaced two other important concepts: "recognition - primed decision making" (takes into account the experience level of the decision maker) and "coupling" (takes into account the environment in which decision making takes place). With respect to the former (experience of the decision maker), Klein (1989) presents a cogent discussion of a new perspective on Decision Making; he argues that research on decision making has relied too heavily on analytical Decision Making processes and suggests a "recognition model."

The recognition model postulates that proficient decision makers use their experience to recognize a situation as familiar, which gives them a sense of what goals are feasible, what cues are important, what to expect next, and what actions are typical in that situation. Experienced decision makers do not perform concurrent deliberation (i.e., they do not use an analytical Decision Making model in which the decision maker surfaces several decision options and compares them to arrive at the best alternative). Recognition decision makers recognize patterns and understand the appropriate actions for each particular pattern.

Decision making processes differ depending on the experience base of the decision maker and whether decision making is an individual or group process. Regardless of the decision making process employed, either analytical or recognition, the three elements of the DECIDE model, Estimate, Choose, and Identify, remain important.

The second (new) element of decision making that the model addresses is the concept of "coupling." Coupling refers to

the amount of time available between an error and a response that could correct the error. Coupling also refers to the environment in which an event takes place. Coupling is dependent on flight phase or flight profile and involves the potential hazard that may be present and the probability of an event causing an accident. Central to the notion of coupling is whether an event occurs in a forgiving or unforgiving environment, which directly defines the potential for safe recovery. Events can be either "loosely" or "tightly" coupled. When an event is loosely coupled, it occurs in a relatively forgiving environment with a relatively large amount of time to recover. Conversely, an event is tightly coupled when there is relatively little time to recover and the environment is unforgiving.

In relation to the Problem Solving and Decision Making processes, an event is loosely coupled when a relatively generous amount of time is available to institute the Decision Making process and the mission is in no immediate danger. An example of a loosely coupled flight event could involve the following scenario: the crew of an eastbound VFR flight in low traffic conditions descends from 6,500 feet Mean Sea Level (MSL) to 4,500 feet MSL but unintentionally commands the aircraft beyond the desired altitude to 4,300 feet MSL. The crew recognizes the mistake and makes a correction, thus allowing them to continue their flight without mishap.

Conversely, a tightly coupled event exists when there is relatively little time to institute an analytical decision making process or to act. An example of a tightly coupled

event might entail a similar altitude error (i.e., overshoot by 200 feet). However, in this instance, the situation is "unforgiving" such as could be expected during final approach, flight in mountainous terrain, or flying nap-of-the-earth (NOE). A catastrophic event is more likely to follow because the event occurs in a tightly coupled situation.

The issue of coupling is critical in considering Army aircrew coordination because a large percentage of Army flying is "tightly coupled" (e.g., NOE flight), as compared with the commercial aviation and transportation sector.

Operational Task Execution (EXECUTE) concerns itself with decision implementation. At this stage of the model, the aviator executes a specific action resulting in a change to one or more of the six elements composing Situation Awareness. In this framework, "doing nothing" could possibly result in a change to one of the Situation Awareness factors because the aviator does not control all of the Situation Awareness elements. Examples of EXECUTE include changing altitude or attitude, switching to auxiliary fuel, firing a weapon, informing the crew or ground control of events, flying a precision approach, etc. The essential element of EXECUTE is that the aviator engages in purposeful action. After EXECUTE, the aviator reassesses the elements of Situation Awareness to determine whether the action produced the change he intended. When the preceding decisions and actions disrupt the mission plan, the plan must undergo revision to accommodate the changes.

Beyond the Basics - A Model for Crewed Systems

The Basic Model applies to all flying situations; it describes the major categories of behavior required of aviators. In this section, we overlay crew coordination on the Basic Model to incorporate additional activities essential to a crewed aircraft. Before factoring aircrew coordination into the model, a broader notion of aircrew coordination should be introduced. Cockpit Resource Management (CRM) was defined by John Lauber of the National Transportation Safety Board as the "effective utilization of all available resources—hardware, software, and liveware—to achieve safe, efficient flight operations." Figure 2 shows a model of cockpit resource management. As the figure shows, we modified Lauber's definition to include additional factors. First, we include external resources such as air traffic control (ATC) procedures, ATC capabilities, other aircraft in formation, etc. Second, although the notion of aircraft resources was accepted at face value (i.e., hardware and software assets), we refined the notion of liveware to include three categories: personnel (the crew); individual aviator flying skills; and the crew's skills, knowledge, and attitudes on aircrew coordination. Two points can now be emphasized regarding the model of cockpit resource management: (1) CRM and aircrew coordination are *not* synonymous, and (2) aircrew coordination is the cornerstone of CRM for crewed weapon systems. Furthermore, if one excludes the aircrew coordination techniques element in the CRM model, the model is equally applicable to single-operator weapon systems.

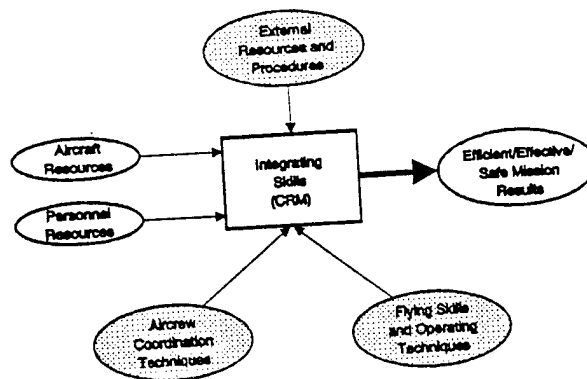


Figure 2. Extending the Model of Cockpit Resource Management

Figure 3 depicts the Crew Coordination Model (CCM). A central concern in the development of the CCM was to maintain the integrity of the Basic Model while introducing and highlighting important elements of crew coordination.

Like the Basic Model of Operator Functions (Figure 1), the flow of action in the CCM (Figure 3) is clockwise with several feedback loops. Unlike the Basic Model, crew factors are now incorporated within each of the major elements: PLAN, ASSESS, RESOLVE, AND EXECUTE. For example, Situation Awareness responsibilities are assigned and continuously maintained throughout the mission cycle by at least one crewmember. Situation Awareness maintenance is critical to mission performance and safety. The notion of "coupling" is introduced by including a "time to respond" factor within the ASSESS portion of the model directly effecting the RESOLVE pathway that follows. The pilot-in-command may or may not have time to confer with his crew. In the event of the latter (i.e., a tightly coupled event), he must decide and act immediate-

ly, which introduces the recognition-primed decision making concept discussed earlier.

The five crew coordination objectives placed in the center of the CCM are crew coordination management and implemen-

tation activities permeating all four major elements of the CCM (PLAN, ASSESS, RESOLVE, and EXECUTE). The exact nature of the crew coordination objectives are discussed thoroughly in the Army crew coordination training course.

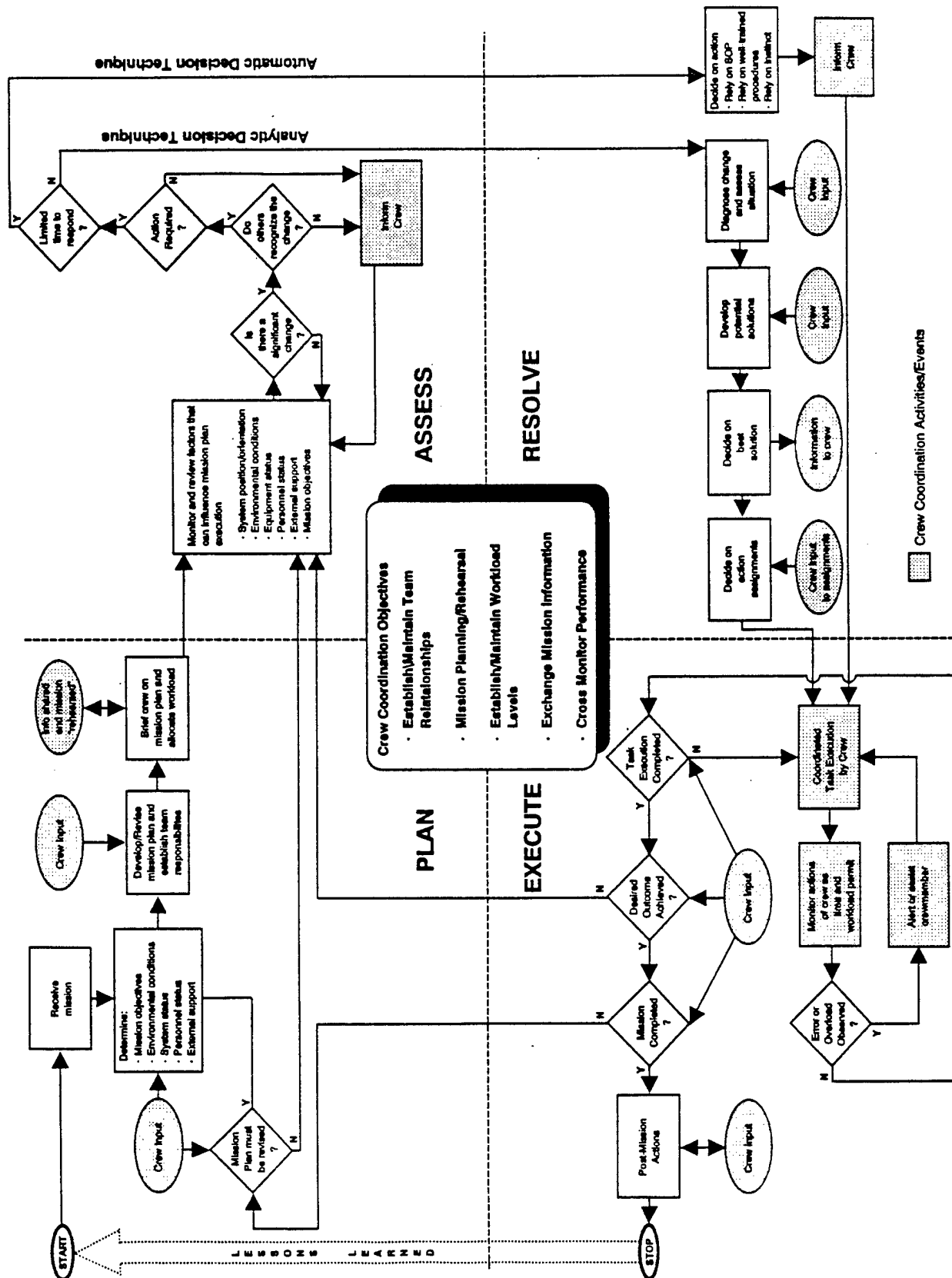


Figure 3. The Crew Coordination Model (CCM)



THE BIG PICTURE ON HUMAN ERROR

by CW3 Alfred L. Rice

Much has been said about *Human Error* as the major cause of aviation mishaps. Human error mishaps are caused by one or more of four failures—training, leadership, standards, or individual. Most of us who read *Flightfax* often read it with these questions in mind: who *failed*, what, where, when, and why.

It is understandable why, as pilots, we sometimes become defensive when we hear the term human error. Most of us sometimes feel events happen that seem beyond our control. Can we really have control over events? Can we stop human error mishaps? We have established the fact that, if there is aircraft damage, personal injury, or a fatality, human failure probably was involved. We have met the enemy, and we are the enemy. Fortunately, many human failures do not result in mishaps. Often, only luck or providence separates us from being a statistic. If we were all perfect, we could reduce our accident rates to near zero—the dream of every commander and safety officer.

The great strides we have made in aircrew coordination and risk management are due to noble efforts of concerned stewardship over our material and human warfighting capabilities. Both programs help check and control human failures. To understand our human failings, we need to look no further than the data from our civilian counterparts in the Federal Aviation Administration. A few years ago, the chairman of the National Transportation Safety Board admitted that "with existing data ... we do not know why pilots make

errors." The following predictable factors are common causes of most human error mishaps:

- **Judgment.** Pilots continuously make decisions about the safe operation of their aircraft. Some pilots do not exercise good judgment at well as others. Some have no qualms about doing a steep approach into a confined area while others would go around the area. This quality represents common sense and maturity. Gun-runs on recreation boats and other friendly vehicles are considered an exercise in poor judgment. Good judgment is a quality that sometimes can be developed with good mentorship.
- **Preoccupation.** Preoccupation is the lack of alertness. A safety message by Major General Rudolph Ostovich III, in December 1990, described this factor as, "not focusing on the task at hand." This description is true and is not limited to daydreaming. A pilot preoccupied with a zone reconnaissance or a call-for-fire that allows his aircraft to drift into the same airspace with hardwood trees generally is considered distracted. Having a close call or seeing other pilots have mishaps can help stimulate one's focus.
- **Personality.** Pilots have personalities. Our cultural background often influences our personality. A pilot's intentional disregard for procedures may be considered an act of defiance. In a profession in which pride and confi-

dence are prized character traits, there is often a fine line between the gung-ho soldier and the risk taker. Pilots with risk-taker personalities often have recurring mishaps. A risk taker may try to fly nap-of-the-earth 1 inch above the trees when 3 feet will do as well. Some risk takers are considered to be bored individuals who subconsciously seek excitement in an otherwise mundane and routine existence. A risk management and a leadership climate, in which macho aerial cowboys are not encouraged, can sometimes keep this factor in check.

- **Training and experience.** Many flight tasks develop perishable, poorly developed skills. This factor often is the cause of hard landings. The recency during which a pilot practices nonstandard maneuvers often is a factor in his ability to perform these skills when it counts. During Operation Desert Shield and Operation Desert Storm, lack of training and experience in desert operations caused night vision device (NVD) mishaps. Flying in new situations often presents different operating characteristics that are unfamiliar to the pilot. When faced with crises situations, we often revert to previous training. This factor is influenced best by a good crew mix, continuation training, and basic pilot skills.
- **Sensory inputs.** Encounters with spatial disorientation are deadly while flying aircraft. Visual and vestibular illusions affect our actions during the undesirable situations we may encounter while flying. Verbal communication with copilots, controllers, and flight engineers is sometimes confusing or unclear. Sensory overloads cause errors

and difficulty in making decisions. Good communication is essential. Often the lack of verbal communication from copilots causes us to make wrong decisions. Pilots need to remember safe flying is based on aircraft control. Reconfirming sensory inputs by other verbal and visual means is essential.

- **Stress and fatigue.** Stresses that are psychological or physiological can affect our performance and prevent us from operating at our maximum potential. Impulsive actions and hasty decisions are often the result of stress. Unintentional omission of critical tasks results from fatigue. The underlying problem of stress and fatigue may lead to errors in preoccupation and poor judgment. A well-established circadian rhythm, proper rest, good diet, and good physical fitness assist in managing stress and fatigue. Avoiding the self-imposed stresses and proper crew endurance remain the effective countermeasures against this enemy.
- **Planning.** Careful and detailed planning of weather, altitudes, headings, routes, fuel requirements, frequencies, appropriate modes of terrain flight, and the alternatives for these considerations reduces the variables of unexpected circumstances. Many errors in the cockpit are the result of hasty and poorly thought out decisions. If most decisions for the flight are made at the planning table, the errors in the decision-making process while flying are reduced dramatically.

When accidents occur, normally more than one of these factors is present. A pilot with financial problems, 3 hours of sleep, experiencing vertigo while completing a

steep confined-area approach under NVDs with a 20-minute fuel light, and flying on the last night before he goes noncurrent has stacked the cards against his favor. Will this joker have a mishap? The wild card in this equation is the other pilot—the copilot. If this joker is paired with an ace, he may live to play another day.

It is easy to count the number of mishaps that occur. However, it is almost impossible to count the number of accidents that have been prevented because of vocal, alert, and knowledgeable copilots—the person not on the controls. The pilot not on the controls may fail to realize the hazardous situation. He may realize the hazardous situation, but fail to respond (sometimes because of intimidation), or he may respond to the situation inadequately (poor timing).

The challenge for all Army aviators is to develop professional pilot qualities of good planning, judgment, and an alertness to hazardous situations. We must be constantly aware that our psychological and physiological limitations will continue to result in human errors. We must continue to reassess how aviation systems such as leadership, training, and publications play roles that allow human errors. We must discover new and innovative ways of improving system inadequacy. As leaders and trainers, we may not be able to eliminate all hazards completely. We should address these factors as we apply the principles of aircrew coordination and risk management as methods of reducing human error mishaps.

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REDUCING ARMY ACCIDENT RATES IN AVIATION AND GROUND OPERATIONS

*U.S. Army Research Institute for the
Behavioral and Social Sciences*

Introduction

This paper briefly describes an exploratory research and development project being conducted by the Systems Research laboratory within the U.S. Army Research Institute (ARI).

Army Need: The Reduction of Materiel and Personnel Losses Due to Accidents

Army losses of materiel and personnel due to peacetime accidents are currently estimated to be nearly \$250 million per year: losses that directly reduce Army readiness and combat power. Included in this figure is the Class A loss of nearly 40 combat aircraft per year, plus the damage of many more due to Class B-C accidents. Historically, about 70 percent of these accidents are attributable to human error (as opposed to materiel failure, environment, etc.). Thus, research leading to even modest reductions in human error causes of accidents has tremendous potential for a cost-effective payback.

Identify Strategies for Reducing Human Error Causes of Accidents

ARI's FY89-95 objectives for this research and development effort include (1) the detailed diagnosis of specific human error factors prevalent in Army aviation and ground operation accidents and (2) the identification of promising strategies for reducing these accident causes through

improved soldier selection, training, leadership, and organization. At the same time, this research and development effort responds to the Army's growing introduction of high-technology weapon systems into its combat force structure and the impact of this materiel trend on human error accidents.

Understanding the Antecedents of Human Error Accidents

A review of current research on human error, coupled with a review of accident research by the military services, other Federal agencies, and the civilian sector suggests a dual approach to reducing operational accidents within Army. On the one hand, the Army nominally trains its pilots, weapon systems operators, and maintainers to perform mission essential tasks according to specific conditions and standards. Various factors within each individual, however, serve to modify or reduce the performance capability of these soldiers: physiological state; temperament and attitudes; cognitive and psychomotor ability level; technical skill acquisition and retention; and interpersonal skill, to name but a few. On the other hand, task demands are influenced by a variety of factors external to the individual soldier: operating environment (e.g., night vision goggles); mission demands; command attitudes and organizational climate; crew matching and familiarity; equipment design; and so forth.

Thus, despite training standards, combinations of these internal and external factors will occasionally place soldiers in situations where performance capabilities are temporarily exceeded by task demands. The result can be seen in a variety of vigilance and perception errors, information processing and judgement errors, and sensorimotor control errors. Accidents occur when (1) such errors are not detected and corrected in a timely manner and (2) the operational circumstances are unforgiving of the error.

When an accident occurs, the natural tendency has been to focus attention upon the immediate causes of the mishap. Yet a more productive research approach is one which addresses the important antecedents of human error. Accordingly, this research program examines in depth a number of important issues regarding crew selection, training, and performance measurement. Given the current level and cost of Army aircraft losses, much of this research initially focuses upon Army aviation operations. As the research base matures, however, findings and methods will be expanded to address ground combat systems.

Identifying and Managing the High-Risk Aviator

In support of the U.S. Army Aviation Center (USAAVNC), ARI is developing and validating an Army-wide system for tracking aviator performance and indicators of high-risk behavior. Earlier Army initiatives to implement such a system have failed largely because of their narrow focus on "willful and knowing violations of rules and procedures," a label which ignores other potential deficiencies in aviator

selection and training. In contract, ARI has proposed a system which provides for the identification of at least five specific high-risk profiles:

1. The aviator with marginal technical knowledge and flying skills
2. The aviator who exhibits poor judgment and decision making
3. The aviator who displays one of several known hazardous attitudes regarding prudent air discipline
4. The aviator who lacks requisite aircrew coordination and communication skills
5. The aviator who is distracted by external (non-mission) stressors.

Working with the Director of Evaluation and Standards, USAAVNC, ARI is developing a comprehensive tracking system which includes (a) flight school records, (b) operational unit records, and (c) specific accident and award records. Based upon an analysis of these records over several years, ARI will identify specific criteria for alerting aviation commanders to potentially high-risk aviators within their units. In conjunction with this effort, ARI is also conducting an experimental evaluation of aviator peer assessments and their potential use by aviation commanders in managing high-risk pilots. In a third area, ARI is developing an experimental questionnaire for assessing specific indicators of safety climate within each aviation unit. As this questionnaire is refined, it will provide an enhanced basis for accident investigation by the U.S. Army Safety Center (USASC), as well as for the ongoing monitoring of safety climate within operational Army units.

Selection of Aviator Candidates

In a related area, ARI is conducting an experimental investigation to determine if the potential for specific types of pilot error can be predicted in individuals prior to their entry into flight training. As part of this research, candidates entering into the Army basic flight training program are given a battery of cognitive, psychomotor, temperament, and attitude tests. In an initial phase of this investigation, test score profiles are matched against evaluations of student pilot error, as provided by instructor pilots during scheduled check flights. In a subsequent phase of research, the same pilots will be tracked into their initial operational assignment. Here, original test scores will be matched against indicators of performance, advancement, and safety, as obtained from the aviator performance tracking system described earlier. Through both of these validation efforts, ARI will seek to determine if meaningful and reliable criteria can be developed for selecting a safer and more capable population of aviator candidates.

Flight Training Standards

Two investigations are currently addressing different aspects of flight training standards and their relationship to aviation accidents. In one area, ARI is developing a set of objective standards and criteria for assessing aircrew coordination and communication. Through a review of Army accident files, ARI has implicated aircrew coordination (sometimes referred to as cockpit resource management) as a causal factor in a large number of aviation mishaps. At the same time, it has been noted that the aviation community generally lacks adequate standards for evaluat-

ing training programs and pilot proficiency in this area. In response, ARI is developing a set of behaviorally anchored rating scales for assessing specific aspects of aircrew coordination and resource management. Refined versions of these scales will then be evaluated for application to both USAAVNC pilot training and USASC accident investigation. As a byproduct of this research effort, ARI is identifying appropriate additions to selected Army training manuals, standard operating procedures, and related materials.

In a second area dealing with flight training standards, ARI is working in conjunction with USASC in the investigation of training setbacks during initial flight training and their potential relationship to subsequent accidents. The focus of this research is on student pilots who have been set back in the training curriculum for reasons relating to flight skill deficiency. Flight school records from the past five years will be compared against the subsequent involvement of these pilots in human error-induced Class A-C aviation accidents. If a significant and positive relationship is found, the research will be extended to develop criteria for diagnosing specific flight skill deficiencies and eliminating marginal aviator candidates from initial flight training.

Night Vision Devices: Enhanced Training Strategies and Methods

As part of ARI safety research program, attention is being devoted to the development of emergency scenario training methods. This research looks beyond the Army's current training of pilots in emergency procedures toward simulator-based training designed to prepare the aviator to

(a) specifically recognize onset cues associated with recurring accident scenarios, (b) to better understand system performance and handling characteristics under specific high-risk situations, and (c) to develop strategies for safely recovering the aircraft under emergency conditions. During the initial phase of this research, Army accident files are being reviewed and reassessed to identify frequently recurring accident scenarios and potential training objectives. From this research base, work will then proceed toward the development of simulator training exercises that are designed to teach specific recognition and control skills.

As part of this general research effort, considerable attention is being devoted to accidents and training related to the increased use of night vision goggles (NVGs) by rotary wing aviators. NVG usage has become increasingly implicated in a significant number of Army aviation accidents. A preliminary investigation by ARI has identified the loss of spatial orientation and motion cues as a major contributor to human error in these accidents. In cooperation with both USASC and the U.S. Army Aeromedical Research Laboratory, ARI is investigating (a) specific psychophysiological degradations associated with NVG flying; (b) the effect of these degradations on aircrew workload, habit patterns and interactions; and (c) the resulting impact on aircrew performance. Through this research, ARI will assist USAAVNC in developing refinements to the Army's training programs and standard operating procedures used in association with NVG flying.

For the Future

Considerable research has been accomplished within ARI over the past several years regarding the development of computer techniques for modeling crew workload. As an extension of this work, attention within the safety research program will be devoted to refining these modeling techniques in several areas: (a) representing specific levels of cognitive processing (e.g., habit responses, rule-based reasoning, knowledge-based reasoning); (b) representing the effects of stress, fatigue, and other hypoxia effects on psychomotor and cognitive processes; (c) representing specific types of aircrew interactions and coordination; and (d) the prediction of specific types of human errors. The ultimate goal of this research will be to refine crew workload modeling techniques to the point where they can be used (along with equipment simulators and actual field experience) as a tool for accident prevention.

Summary

In summary, ARI is engaged in a comprehensive program of research designed to better understand the various antecedents of human error-induced accidents within the Army's aviation and ground combat operations. Translation of these research findings into accident-prevention strategies and countermeasures is already underway and will continue throughout the next six years. It is expected that the modest investments being made in this research during FY89-95 will pay large dividends through the saving of materiel and soldier costs normally lost through operational accidents.

For information regarding this research program, contact Dr. Dennis K. Leedom, U.S. Army Research Institute Aviation

R&D Activity, PERI-IR, Fort Rucker, Alabama. Autovon 558-3915, Commercial (205) 255-3915.



GROUP-LEVEL ISSUES IN THE DESIGN AND TRAINING OF COCKPIT CREWS¹

*Prof. J. Richard Hackman
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One way that Cockpit Resource Management (CRM) training can foster crew effectiveness is by building the knowledge and skill of individual crew members. This application of CRM training has just been discussed most informatively by Robert Helmreich, and there is much value in such training. Yet, as Bob notes, the overall task of successfully completing a flying mission is always a team task. Even though only one person is manipulating the flight controls at any moment, others may be simultaneously operating radios, making fuel calculations, and performing the multitude of other duties involved in flying a large and complex aircraft. Moreover, cockpit crews always operate in an organizational context, and the transactions between the crew and representatives of that context (e.g., organizational managers, air traffic controllers) are consequential for any crew's performance.

For a complete understanding of crew performance, then, we must look beyond our traditional focus on individual pilots to see how team- and organization-level factors can enhance (or impede) the ability of even well-trained individuals to work together effectively. This way of thinking about cockpit crews (that is, viewing them as teams that operate in organizations) offers some potentially useful avenues for thinking about next steps in the development of CRM training programs. I will explore those possibilities today, emphasizing how they can enrich (not replace) individually-focussed CRM training.

Cockpit Crews as Teams

We often think of flying, even in multi-engine aircraft with multi-person crews, in individualistic terms. This is understandable, given that the selection, training, and assessment of pilots all focus squarely on the individual. No pilot forgets his or her first solo flight, when one experiences for the first time what it is like to have a flight depend wholly on one's own capabilities. The individualistic orientation of flight training is reinforced continuously throughout a professional pilot's career, both formally (in individual training and proficiency checks) and informally (through a culture that accords the highest respect to great individual pilots).²

Viewed in this light, the work of a cockpit crew is akin to the performance of a ballet: while the ballet is an ensemble performance, each member of the company has his or her own part to play, and those parts are carefully choreographed beforehand. Consider, for example, a Category II approach (as practiced by most commercial airlines): each crew member has individual duties to perform at specified times, and when all members play their parts well, the approach unfolds beautifully. While improvisation may be required under unusual circumstances, all that normally is required is for each crewmember to execute his or her own responsibilities precisely in accord with the script.

Flying an aircraft is, of course, much more complicated and interesting than the above paragraph suggests, particularly when things happen that were not anticipated by those who wrote the manuals. But pilots rarely use the language of groups or teams in talking about flying. Let me illustrate with a story about an approach that did not go well. I'd like you to listen carefully to two versions of this story. The first version is as the events were related to me by a pilot (although I have altered some details). The second version is a different way of telling the same story. See what differences you notice between the two. Here is the first version:

"...so there was this flock of geese having a tea party right over the end of 22 Left, and the tower switched them to 31 just when Charlie was getting lined up on the ILS. Well, the weather was a mess, they were vectoring old Charlie all over the place, and he got confused and got behind. Three times Phil had to remind him about something, and eventually Phil just took the airplane and landed the damn thing himself."

And here is the second version:

"...so after they got ATIS they just assumed it would be a routine ILS approach to 22 Left and they started chewing the fat. They didn't hear the talk on the radio about the geese over the runway, so when the tower switched runways at the last minute it was scramble time. Charlie was flying, and he had his hands full because of weather and the new vectors he was getting. Phil started changing the

radios to set up for the new approach, but didn't tell Charlie what he was doing—and Charlie couldn't figure out what the hell was going on. Nobody really got things organized, everybody got confused, and eventually Phil got so frustrated that he took the airplane and landed the damn thing himself."

Do you see the difference? In the first version, the one most likely to be heard, Charlie has a problem—he let a situation that was not all that demanding get the better of him, and he had to be bailed out by Phil, his Captain. The attributions made are all to individuals. The second account invites a group-level interpretation: the crew got itself into trouble, by not paying attention to changing situational demands, by not planning and organizing the work (either contingently beforehand, in real time when other exchanges on the radio suggested complications, or after the runway change was announced), and by poor between-member communication and coordination. Indeed, if someone is to be blamed in this situation, it might most appropriately be the Captain for not managing his cockpit well—an interpretation unlikely to be made based on the first account, in which Phil is implicitly viewed as the savior.

One does not often hear stories about pilots and flying that view the crew as a whole as the performing unit. Indeed, because most of us are so accustomed to talking about the performance of individual pilots, it would take a change of mindset to tell a story in which a team is the central character. Yet on occasion it may be useful to think this way. I invite you to join me in doing so now, as we attempt to identify some new ways that

CRM training can be used to foster cockpit crew effectiveness.³

Crew Effectiveness

The first issue we must address has to do with the criterion, what we mean by an "effective" cockpit crew. Statements of criteria always have, at their root, statements of values—that is, some specification (even if implicit) of what is ultimately viewed as "good" by those who choose the criteria. So let me be explicit about ours. We ask three questions about each crew we study in our NASA research, questions that make operational our values about line flying. What I have to say later about CRM training is intended to help crews behave in ways that generate positive answers to these questions.

1. Does the performance of the crew fully meet (or, better, exceed) the standards and expectations of others who have a legitimate stake in how the crew performs? The most obvious stakeholders are the clients of a flight—such as airline passengers, or customers to whom freight is being transported by a cargo flight, or analysts who will use data being collected by a reconnaissance flight. But clients are not the only legitimate stakeholders. Others include airline or unit managers, the crews of aircraft that share airspace with the flight, and representatives of the public (such as airport and FAA personnel). Each of these groups has a legitimate stake in how a crew performs, because each of their interests is affected by the crew's behavior. And because the expectations of various

stakeholders often conflict with one another, it can be quite a challenge for a crew to attempt to meet them all simultaneously. An effective crew generally succeeds in doing so. A less effective crew may focus its efforts on a single set of expectations and sacrifice all others—in effect converting a multidimensional performance problem into a unidimensional one. And an ineffective crew may fail to meet any group's expectations for its performance.⁴

2. As crewmembers gain experience with one another over time, do they become increasingly expert in working as a team? Many crews do so: by the time they have flown their last leg together, they are operating as a well-oiled machine. Observing such crews is like watching a fine basketball team or jazz ensemble. Members are ahead of the game, anticipating one another's moves, constantly adjusting their own behaviors to help their teammates to the greatest extent possible—and usually having great fun in the process. For other crews, the first leg may be the best leg. The longer members work together, the more problems they have in doing so. Tension and conflict can even build to the point that members actively undermine one another (as when the pilot not flying observes that the pilot flying is about to make an error, and sits back and lets the error happen; or when one crewmember has elaborate, deliberate difficulty understanding what another is asking or saying).

There is evidence that crews generally do become better at working together as they

spend more time together (Foushee, Lauber, Baetge & Acomb, 1986), which is good news. Yet I would argue that this does not happen automatically, and I count as one component of team effectiveness the degree to which members are able to build their capabilities as a performing unit over time.

3. Does the experience of being in the crew contribute positively to the personal learning and satisfaction of each individual member? The first of my three criteria focuses on performance outcomes, and the second on the capabilities of the crew as a performing unit. The final criterion addresses the impact of the overall experience of flying with a crew on the learning and satisfaction of individual members. In an effective crew, each member comes away from the crew generally happy with the experience, and more knowledgeable or competent than he or she was when the crew initially formed. In an ineffective crew, the experience of working together may serve mainly to frustrate or upset everyone, and even to diminish the confidence that individuals have in their own competence. Even if a crew's mission is completed satisfactorily, I do not consider it effective if members depart frustrated and alienated by their experiences in the team.

In sum, I am arguing that there is no single criterion of crew effectiveness. Instead, we must examine what happens on three different (although obviously related) dimensions: one having to do with the task, one with the capability of the group as a performing unit, and one

with the learning and satisfaction of individual crewmembers. Can cockpit resource management help crews achieve a high standing on these three dimensions? As will be seen, my answer is affirmative—but with some qualifications that depend on what the training is about, and when in the life of a crew it is expected to be used.

Four Critical Times in the Crew Life Cycle

There are certain times in the life of a crew when CRM skills can be very helpful in achieving the criteria I just discussed, and other times when such training will be less relevant. Let me explain my thinking about this by identifying four critical times in the life cycle of a crew, and then identifying the points in that cycle at which I believe resource management training can have the greatest leverage on crew effectiveness.

Pre-Arrival: The "Shell." Many features that significantly influence the life of a cockpit crew are already in place before crewmembers meet prior to their first leg. Arriving for work is something like walking into a room in a hotel where you have stayed before. The room is already furnished and the familiar layout shapes your behavior to a greater extent than you realize. (For example, recall your behavior in the last hotel you visited that had a television remote control switch at bedside but no desk or worktable, and compare that to your behavior in a room where the opposite was true.) You also know ahead of time how to relate to hotel staff you encounter—the van driver who picks you up at the airport, the desk clerk, the room service waiter—even though you have not

met any of these specific people before. And you have a clear understanding about the behaviors that are and are not appropriate for hotel guests. (It is perfectly acceptable, for example, to take the little container of shampoo that appears on each day of a multi-day stay, even if you have not used up the first day's supply; but it is never acceptable to walk off with one of the hotel's blankets.) You have great latitude in how you can behave in a hotel. Yet that latitude is restricted in ways you rarely think about—restricted by how the room is outfitted, certainly, but also by your own knowledge about how one is supposed to relate to hotel staff and by general norms of conduct for hotel guests that you accepted long ago. As will be seen, the same kind of phenomenon occurs in cockpits.

I call the collection of features that are already in place prior to the first meeting of the crew the cockpit "shell." The shell is the overall structure within which the crew works, and it consists of things that are accepted as givens by crewmembers or that they assume to be true without questioning. Among the most significant features of a shell are:

- *The basic flying task and cockpit technology.* For an airline crew, the core task (flying a set of passengers from point A to point B as safely and expeditiously as possible) and the technology (the general configuration and instrumentation of the type of aircraft flown) are taken as given by crewmembers, without need for personal reflection or group discussion. If behavior is affected by how the core task has been designed by the airline, or by the technology installed on the aircraft, that influence is mostly hidden from view.

- *The roles of crewmembers, and the general characteristics of the people who occupy those roles.* On Boeing 727s operated by a certain carrier, for example, there always will be (a) a Captain, First Officer, and Flight Engineer in the cockpit, and (b) a team of four flight attendants in the cabin, one of whom will serve as lead. The general duties associated with each role are well-known by all, and each individual is assumed to have the knowledge and skill needed to execute his or her role competently.

- *The basic norms of conduct that regulate crewmember behavior.* While these norms can vary greatly from organization to organization, there typically is substantial agreement about them within a given airline or military unit. Crew members know what is expected and valued on flight-decks in their organization, and they also know what behaviors are unacceptable. Because individuals "import" their understanding of such matters to new crews they join, there is no need for basic group norms to be explicitly discussed or recreated each time a crew forms. Such norms are simply part of the common cockpit "shell" of that organization.

In sum, the cockpit shell exists even before members of any given crew first meet. Shaped over time by technology, policy, and collective experience, the shell frames the crew's work and shapes how that work unfolds. Yet its impact often goes unnoticed—precisely because it is so generally accepted as "the way things are" in a given organization.

Team Creation. When people occupy a shell, they breathe life into it and become

a team.⁵ Previously an abstraction, the shell now becomes a real working environment. The abstract task of flying a 727 from point A to point B safely and expeditiously, for example, now becomes specific: it is flying aircraft 802 (which has one autopilot inoperative) with 92 people on board from Seattle to Denver (where thunderstorms are predicted), and then going on to St. Louis and finally overnighing in Detroit. The standard crew roles (i.e., Captain, First Officer, and Flight Engineer, working with a team of four cabin crew) are now filled with real people: it is Phil and Charlie and Linda, working with Bob (who is new), Mary Sue (who is funny), Alphonse (who is the lead attendant), and Willa (who doesn't say much). And the general norms of conduct that guide crew behavior in the organization (for example, that the Captain and First Officer will fly alternate legs) are tailored and applied to present circumstances: Phil is a management pilot who needs some landings, so he will take both the first and last leg; moreover, since he has not been on the line for a few weeks, he wants Charlie and Linda to be especially quick to point out anything that concerns them.

The shell becomes a team very quickly, and very early in the life of a crew. Indeed, the team creation process begins the instant crew members first see one another—when they immediately and automatically begin to size one another up. The process continues at full tilt (even if subtly) as ground preparations for the flight are completed. By the time taxi begins, members have become a full-fledged team, and a great many things have been established that will shape behavior in the crew throughout its life (for example: that the

Captain is a real stickler for following company procedures; that the cabin attendants are experienced and can be counted on to do the right thing; and that this will be a crew that has lots of fun).

Task Execution. The crew now proceeds to do its work: planning, solving problems, manipulating controls, communicating endlessly (with other team members, but also with passengers, ATC, and support staff from the organization), and so on. These activities have been well-documented and well-studied, so I will not go over them again here.

Most that has been written about the execution of the flying task focusses on how the crew functions during high workload times: the critical moments that surround takeoff and landing, plus other times when things are so busy and demanding that the safety of flight requires focussed, competent team behavior.

It also is true, however, that a great deal happens during those times when nothing seems to be happening—at 35,000 feet over Kansas, or at the hotel over dinner. Such low workload-times are occasions for people to learn from one another, and for the team to evolve and mature as a performing unit. There is no guarantee, of course, that what is learned will help performance or strengthen the team; we have all seen people learn things that impede subsequent performance, and dinner outings that nearly destroy members' ability to work together the next day. The point is that things are happening during seemingly task-irrelevant times, and those things are worth attending to because they can powerfully shape subsequent team behavior and performance.

Team Termination. The aircraft has been shut down and the paperwork completed. The work has been performed, whether well or poorly, and individuals are preparing to go their separate ways, whether better or worse for their experience working together. The team ceases to exist.

A given crew may or may not take time to debrief on their time together, depending on organization policy, the Captain's preferences, and (perhaps most of all) how late it is and how tired crewmembers are. But whether or not team members reflect systematically on their collective experiences, people have learned and been changed by their experience in the team.

There is, in effect, a residue left behind each time a crew terminates—and that residue is one means by which the cockpit shell for a given organization evolves over time. "Well," the First Officer reflects while driving home, "all that stuff they were saying in training about being assertive with the Captain certainly turned out to be hogwash. Next time I'm flying with one of the old codgers he can start down as late as he damn well pleases; if he misses a restriction, too bad. But I'm not about to stick my neck out again and get it chopped off the way I did coming into DFW...." The shell has changed. It changed only a tiny bit, and in this case not in a way that would please a CRM instructor. But it has changed, and the cumulative effect of thousands of small lessons such as this can be powerful indeed in redefining the shell that will be occupied by crews in the future.

Points of Leverage for Resource Management Training

CRM training can yield benefits at all four of the times in the crew life cycle I have been discussing: prior to arrival (i.e., by affecting the cockpit shell), at the time the cockpit team first forms, during execution of the work, and when the crew terminates. I will discuss these times in order of their amenability to change through CRM training, starting with the time of team creation—which I view as having the greatest promise. Then I examine, in turn, the impact of CRM training on behaviors during task execution, on crew termination processes, and on the pre-arrival shell.

Team Creation

As part of our NASA research project, Lt. Col. Robert Ginnett of the USAF Academy has recently completed a study of team formation in a large U.S. carrier that requires Captains to brief cockpit and cabin crewmembers as a group before they board the aircraft (Ginnett, 1986). Ginnett found that the briefing—indeed, the very first moments of the briefing—shaped what happened in the crew throughout much of its life history. Apparently the initial framework established by a team has great momentum over time, a finding also true for other types of task-performing groups (Gersick, 1986).

While a given Captain tended to conduct briefings in essentially the same way on different occasions and with different crews, there was considerable variation among Captains in how they managed the first moments of their crews. Ginnett found that different Captains' briefings could be neatly categorized in terms of

their impact on the pre-existing shell—specifically, on crew members' imported expectations and assumptions about how crews in that airline operate.

The best Captains creatively elaborated the shell. That is, they accepted and affirmed the positive expectations shared by pilots in the airline about how crews should function, and then tailored those expectations to fit as well as possible with the special circumstances of this particular flight and with the Captain's own preferred leadership style. By the end of the briefing, these Captains had built a strong sense of team identity, a commitment to excellent performance, and a set of norms that encouraged all crew members to share in the leadership of the team under the Captain's overall direction. In sum, these Captains actively shaped the team that they were to lead, and did so in a way that strengthened and elaborated the positive features of the pre-existing shell.

More typical were Captains who affirmed the shell. These individuals ensured that members were clear about the boundaries of the team, about any special requirements in the work that was about to commence, about the roles of all members (including how the cockpit and cabin crews would coordinate their activities), and about the way the crew would manage its relations with external groups such as ATC, ramp personnel, and operations staff. But these Captains did not take initiatives to build the team beyond normal company expectations.

A third group of Captains abdicated responsibility for building the team. They typically would go through the motions of conducting a briefing, but seemed to do so

mainly to comply with company policy. Little real work was accomplished in these sessions, and crewmembers usually left the briefing room with their pre-arrival expectations and assumptions augmented only by factual data such as the names of others in the crew, dispatch information, and so on. These Captains reported that they saw little value in even having a briefing, often describing the process as "going through the motions," or as "the social hour."

A fourth (and very small) group of Captains actively undermined the pre-existing shell. Positive features of the shell were systematically dismantled through comments like I know they want us to do such and so, but I think we'll just overlook that..." or by blatant behavioral violations of normal expectations (such as making a joking comment about how "the First Officer will have to run the cockpit because I'm tired and am just going along for the ride").

One would predict that teams briefed by these four groups of captains would differ substantially in their ability to work well together, and that prediction was affirmed by Ginnett's on-board observations throughout the lives of the crews. It appears, then, that the process by which a Captain creates a team is well worth attending to in CRM training. The consequences of the team creation process are significant, and they endure for a surprisingly long time. Moreover, skills in forming a team and conducting an affirmative briefing should be readily trainable; they do not require Captains to change their personalities or to exhibit behaviors that are inherently difficult to master.⁶

Task Execution

Beyond the enduring effects of the team creation process, how much impact can CRM training have on the way crewmembers interact as they work their way through a multi-day trip? I have two opposing responses to this question. One type of training appears to have limited impact in the short term (but may yield significant long-term benefits); a second type can have immediate constructive effects on team performance.

I am pessimistic about the short-term payoff of training that seeks to alter how crewmembers (particularly the Captain) behave in periods of high stress. How are crewmembers likely to act when hit with an engine fire, followed by numerous secondary problems? Is that a time when they will draw heavily on their CRM training? It is very unlikely. Psychological research shows that under periods of high arousal, people revert to well-learned behaviors, exhibiting whatever response is most dominant for them for the present situation (Zajonc, 1965). Training in resource management is not going to result in an immediate change of these dominant responses; they are too well-learned for that. And therefore there will be no immediate change in how crewmembers act under highly stressful flight conditions.

Only over the long term, when appropriate responses also become the dominant responses, will the benefits of such training be seen. Consider, for example, the behavior of Captains during emergencies in Line Oriented Flight Training (LOFT) scenarios. According to Clayton Foushee (personal communication), Captains in the early years of LOFT training tended to

become autocratic in emergency situations, firing off orders and taking personal control of the aircraft if they were the pilot not flying. Now it is becoming more common for the Captain to delegate flying to the First Officer, and then go to work on the problem with the Flight Engineer (if present), soliciting the input of other crewmembers along the way and taking the time needed to consider various strategies for managing the problem. According to Foushee, CRM training probably has been instrumental in achieving this gradual but fundamental change in Captains' dominant responses to emergency situations.⁷

A second type of training can result in immediate improvements in crew performance during task execution. This training defers consideration of behavior under stressful conditions, and focuses instead on what happens when things are relaxed—for example, during low workload periods in flight, or when crewmembers are together outside the cockpit (such as on overnight or while waiting for an aircraft to arrive). Our data show great variation in how Captains use such times. A few use them destructively, perhaps by harping on personal complaints about the organization or starting an argument with other crewmembers about some task-irrelevant issue. Such behavior diverts members' attention from their flying responsibilities and may even undermine the Captain's credibility as a leader. Other Captains appear not to be aware of the leadership opportunities such times offer, and essentially squander them by letting conversation and attention wander in whatever direction it happens to go.

Some Captains, however, use low workload times to "tune" the team as a performing unit. Examples that might take place in flight include:

- Taking an initiative to re-focus attention on the flying task if it has been straying, perhaps through a comment as simple as "Well, let's take a minute and see how we're doing here..."
- Fostering crewmembers' learning from one another, perhaps by encouraging someone who has just returned from recurrent training to comment on what new things he or she learned that the rest of the crew ought to know about, or by initiating an exchange of experiences among crew members who have different backgrounds (e.g., corporate vs. military).
- Encouraging members to project how their situation may change as the flight progresses, and to do some contingent strategy planning based on that assessment (e.g., asking the Flight Engineer to find out what is happening to a line of thunderstorms that was supposed to be moving across Pennsylvania, and then engaging the crew in conversation about alternatives for managing the approach to New York based on those data).

Beyond such "tuning" interventions, a Captain can use low workload times (or out-of-cockpit times) to continue the team-building process that was begun when the crew first formed. He or she might, for example, initiate a conversation that is explicitly about cockpit leadership—helping crewmembers see that they all have leadership responsibilities, that everyone needs to watch for leadership functions

that need to be performed and to make sure that they actually are accomplished. If successful, this intervention should increase the frequency with which crewmembers other than the Captain take initiatives (such as those listed above) to "tune" the crew's performance. Another example of a team-building intervention might be to use the first evening of a multi-day trip to do an informal team self-assessment, seeking members' views about how the crew is functioning and inviting their ideas for improvements.

There are, of course, many other things that a Captain can choose to do to build a team over the course of a trip. What will be appropriate depends heavily on both the situation the crew finds itself in and on the personal styles of the crewmembers. The point is that an effective team leader does not merely create the team and then keep hands off; instead, he or she is constantly on the alert for appropriate occasions to strengthen the team and fine-tune its performance.

Like training in how to competently create a team, training in performance tuning and team building are intended for use during relatively relaxed times in the life of a crew. For that reason alone, it may have a greater impact on behavior during line flying than training that aspires to directly change how people behave in challenging, high workload situations. Still, training in team-oriented leadership is sure to require repetition and frequent opportunities for practice, since many Captains will find the behaviors they need to exhibit unfamiliar and awkward when they first try them out.

The potential payoff of team-oriented leadership training is great. The ultimate benefit, of course, is that when the Captain really does need to have all resources focused on a serious problem, the chances are greater that they will be available and deployed. Even if the Captain slips into an ineffective style of leadership during a crisis, help may still be forthcoming from his or her colleagues—precisely because the Captain previously took the trouble to build the crew into a strong performing unit whose members share responsibility for getting critical leadership functions fulfilled (Hackman & Walton, 1986). Moreover, such training contributes directly to achieving the second and third criteria of team effectiveness I specified earlier: namely, that the team grows in competence as a performing unit over time, and that experiences in the team contribute positively to the personal learning and satisfaction of each member.

Team Termination

The termination of a cockpit crew can be an excellent time to apply resource management training. I can only speculate on this because we have collected no data specifically about crew termination. Research on other types of teams, however, suggests that the end of a group provides a unique opportunity for members to explore what can be learned from their time together. Because the team has finished its work and has no future, members may be relatively comfortable reflecting on what has transpired and more open to learning from those reflections than they would have been previously. Just as some of the most significant lessons from LOFT exercises come after the simulation is over, so

can learning from line flying be harvested at the end of a crew's time together.

For debriefings to become commonplace in commercial air carriers would require a significant culture change; in all carriers I have observed, crews generally disperse as soon as possible after the flying is completed. Because regular debriefings are so contrary to usual practice in commercial aviation, it is likely that any attempt to institute them would be met with strong resistance. Yet there are flying organizations in which end-of-mission debriefings are conducted routinely—such as military units during combat operations (Robert Ginnett, personal communication). So it is at least possible to conduct learning-oriented debriefings after a crew's flying work is finished.

If such debriefings were to become common practice in an organization, pilots in that organization would, over time, become more and more skilled at working in teams. The "people" part of the cockpit shell would become increasingly conducive to excellent team performance, and crews would find that they are able to get off to a faster start than previously was the case—bypassing much of the trial-and-error learning that typically occurs early in the life of a crew as members are learning how to work together. Training to help Captains become skilled at leading good termination-time debriefings might, over the long haul, be almost as valuable as teaching them how to form a new team and get it started off on the right foot.

Pre-Arrival

Sometimes CRM training is intended to directly improve the core culture of an

organization, thereby immediately strengthening the cockpit shell. The theory is that people who have been trained will thereafter arrive for work with attitudes and skills that foster effective utilization of cockpit resources, and that this learning will be exhibited in how crew members interact.

I believe that aspiration is unrealistic. It is next to impossible to engineer the culture of an organization. Instead, culture emerges from the multitude of little things that affect peoples' experiences at work, as a product of how the work is designed and managed. Culture is more useful as an indicator of how things stand than as a point of intervention for change. As CRM training pervades an organization and affects what happens in crew after crew, the culture will indeed change—but slowly and incrementally, as the result of improved crew functioning, not as its cause.

Summary

So far, I have identified some times in the lives of cockpit crews when CRM skills may be particularly useful, giving special emphasis to crew formation and termination, and to low workload and out-of-cockpit times during task execution. I also have pointed to some leadership behaviors that can strengthen the team at each of those times. Throughout, I have focused on team management skills that are high in potential impact, that are trainable, and that are likely to be used on the line once learned. Training in these skills, most of which are fairly specific, contrasts with training that would seek to change the personality or interpersonal style of pilots (which I doubt can be accomplished, and am not sure is a good idea even if it could

be), or to alter the overall culture of the organization through massive changes in pilot attitudes (which I do not believe to be a feasible objective for a training program).

The kind of CRM training I have been discussing, then, is relatively specific and modest in scope. Even so it presents a major training challenge, mainly because of its emphatic focus on teams. Such training simply does not fit well with the individualistic orientation that characterizes pilot technical training, flight standards, and flight operations management in most air transport organizations—not to mention the FAA. So there would be a strong temptation, in designing and executing team-focused CRM training, to slip back to a more familiar and culturally agreeable emphasis on the attitudes and skills of individual pilots. It will be hard to conduct training for pilots that is mainly about teams.

Yet the occasions for such training are readily available. LOFT technology, for example, is ideally suited to what I have been talking about, particularly when crews as whole units review videotapes of a scenario they have just flown. The potential of LOFT for team-focused training is enormous, and so far we have barely begun to tap it. Captain upgrade and recurrent training also offer excellent opportunities for education about team functioning, and for teaching the skills needed to be a superb team leader. The coaching done in many organizations by flight standards personnel offers additional occasions for such training.

The ultimate impact of CRM training, however, may depend as much on other

features of the organization as it does on the content of training courses. In our NASA research, Bob Ginnett and I have been working to identify those organizational conditions that most powerfully foster cockpit crew effectiveness. Let me close by providing a quick overview of some of the factors that appear to be most critical in providing a supportive organizational context for the use of CRM skills.

Organizational Influences on Cockpit Crew Effectiveness

Two classes of factors have emerged in our research as especially significant in creating conditions for team effectiveness: (a) the design of the cockpit shell, and (b) the supportiveness of the broader organizational context. As will be seen, both can either reinforce or seriously undermine the impact of CRM training.

Design of the Shell

Three design features that appear to be key to team performance are: (a) the design of the team task and the supporting technology, (b) the composition of the crew, and (c) core norms of conduct that are specified and enforced by organizational and regulatory authorities.

A well-designed task puts the crew in control of a whole and meaningful piece of work, provides the crew ample authority to execute that work, and generates regular, trustworthy feedback about how well the crew is performing (Hackman & Oldham, 1980). Within an air transport organization, those who design missions and create schedules have considerable influence on the degree to which these

conditions are met. More broadly, the engineers and manufacturers who design aircraft and cockpits are stacking the deck through the technology and automated systems they provide—sometimes in ways that enrich the crew's task, other times in ways that undermine the crew's ability or motivation to manage the work (Wiener, 1985).

A well-composed crew first of all means that each member individually has sufficient technical skill to perform his or her part of the work competently, and enough interpersonal skill to work cooperatively with other crew members (Helmreich, 1986). Beyond those basics, the mix of crew members (in level of experience, for example, and perhaps in personality as well) should be appropriate for the work to be done, and members should be rostered together for a long enough time that they can develop into a mature, smoothly-functioning performing unit (Foushee et al., 1986). Organizational recruitment practices obviously have much to do with the degree to which these conditions are met. But the adequacy of crew composition is affected as well by scheduling policies, rostering practices, and labor agreements that specify how individuals are matched to lines of flight. Indeed, many organizational practices that superficially appear relevant only to the quality of life of individual pilots (such as bidding procedures) turn out to be highly consequential for quality of crew composition.

Finally, norms of conduct that foster team effectiveness are those that explicitly reinforce crewmembers' collective responsibility for actively managing their flight. This means that both organizational authorities

(such as training and flight standards staff and regulatory authorities (such as the FAA) must explicitly reinforce the view that crewmembers are responsible as a team for the safe conduct of a flight, and that the team is expected to scan its environment and update its performance strategies continuously.⁸

One could argue that the above message is exactly what is routinely communicated to flight crews by organizational and regulatory authorities. Close examination of the actual communications received by pilots, however, suggests that this is not always the case. At least in some organizations, communications from above give primary emphasis to the responsibility of individual crewmembers to execute their duties competently and cooperatively, under the immediate supervision of the Captain. And, in those organizations, I have heard crew members report that their main interest is in "doing my own job right and staying out of trouble," a comment that reflects an individual rather than team mindset, and a more reactive than proactive stance toward the work. I have observed few communications from organizational authorities that emphasized instead the responsibility of the team as a whole for active situation scanning and strategy planning—even though CRM training in some of those same organizations seeks to foster precisely these norms.

Supportiveness of the Organizational Context

The design features listed above, when present, should set a crew nicely on its way toward effectiveness. But if a crew is to take full advantage of a good design, it also requires on-going support from the

surrounding organization. Although I cannot review them in detail here (for that, see Hackman, 1986), we have found the following organizational features to be particularly helpful to task-performing teams:

- A reward system that provides positive consequences for excellent team performance, thereby countering the tendency in the flying community to assign all consequences to individuals.
- An information system that provides the data crewmembers need to invent and modify team performance strategies as circumstances change, so that their strategy is always appropriate to the task and situation at hand.
- A technical support system that makes available to the crew the technical expertise and consultation that are needed when problems arise that exceed members' own knowledge and skill.
- Adequate material resources (ranging from cockpit supplies to a fuel truck at the ready) so that the work will not be unnecessarily impeded by the absence of the wherewithal needed to carry it out.

Summary

Imagine, if you will, a beautifully designed and professionally executed CRM program that helps crewmembers learn and practice precisely the skills that they need to operate well as a team in a demanding flying environment. Now place that program in an organization where lines of flight are badly constructed and constantly changing at the last minute, crews are poorly composed and

short-lived, norms of conduct reinforce individual order giving and taking rather than team-level planning, excellent crew performance goes wholly unrecognized, and crews often are unable to obtain information, technical assistance, or material resources when they need them to proceed with the work.

What would you predict about the impact, and indeed the longevity, of a CRM program in such circumstances? Probably all the training will do is frustrate the trainees, because it gives them some new and interesting ways of operating that they are unable to use well on the line. To complete a good CRM course in an organization that has a badly flawed cockpit shell and an unsupportive organizational context is like getting all dressed up for a dance and having the car break down halfway there. Cockpit resource management simply cannot take root and thrive unless organizational conditions also foster and support effective teamwork.

What ultimately is needed are multiple, diverse, redundant organizational conditions all pulling in the same direction—ranging from pilot selection and initial training, to the design of crews and their tasks, to the very structure of air transport organizations and the regulatory environments in which they operate. Factors such as these are the context within which CRM training takes place, and because that context is extraordinarily powerful we must be careful not to design and execute training programs without taking careful account of it. Indeed, there may be occasions when the wise course of action is to defer CRM training, and spend energy first ensuring that the cockpit shell and

organizational context will support what eventually is to be taught.

Conclusion

Many of us are trained as engineers or scientists, and are most comfortable when we can say "do X and Y will happen." We like tightly-linked cause-effect relations. Flying reinforces this preference: it would make life both more interesting and less pleasant if one could not count on the fact that when you push the thrust levers forward additional power will follow shortly thereafter.

Social systems do not operate the way mechanical systems do. Cause-effect relations are not tightly linked in social systems, and there often are multiple and diverse ways to achieve any given outcome. For this reason, there can be no one best way to be a good Captain or crewmember, nor will we ever discover the optimal way for crew members to relate to one another. Just as there are many different ways to get from New York to Chicago (an agreeable fact if you discover a line of thunderstorms crossing your planned route), there are many ways to achieve a state of team effectiveness.

What are the implications of this way of thinking for the design and management of cockpit crews? The approach we are taking in our NASA research is to identify the several conditions that together increase the likelihood that a crew will come up with a way of operating that is uniquely suited to its performance situation (including what is going on inside the cockpit as well as outside, and what may happen in the future as well as what is

happening at this moment). Rather than seeking single powerful causes of team effectiveness that can be directly manipulated, we favor putting in place multiple and redundant conditions that act in concert to build constructive momentum. Among those conditions (but certainly not the only one or even the major one) are the skills of crewmembers in cockpit resource management.

If we do give serious attention to the impact of group and organizational factors on cockpit crew performance, then we must also begin to broaden the focus of CRM training activities. We need to determine who has responsibility for (or the opportunity to influence) those conditions that are most potent in fostering crew effectiveness, and make those people prime targets for training in resource management concepts.

Consider, for example, flight standards staff. How can they be helped to understand (and then model and teach) that it is important to attend to group relations in the cockpit as well as to individual performance, and that crew effectiveness may have as much to do with the quality of group information exchange and decision making as it does with stick and rudder flying? How about airline managers, military officers, FAA policy-makers and inspectors, and the leaders of pilots' unions? How can we help them explore the ways their decisions affect the conditions needed for crew effectiveness? How can they be encouraged to think creatively about ways they might provide better cockpit shells and more supportive organizational contexts for flight crews?

We load too much on the Captain. He or she can do many things to promote crew effectiveness, but not everything. It may be time to get serious about bringing the resource management message to others in the flying community who have the leverage to affect the kinds of conditions I have been discussing in this talk. If that is not done, continuing to promote CRM training in traditional air transport organizations may ultimately turn out to be like swimming upstream against a strong current.

A wonderful foundation for the continued development of CRM training has been built over the last five years, largely by those of you present at this conference. Perhaps it is now appropriate to step back and reflect on ways that CRM training can be broadened and increased even more in impact. Let me close by emphasizing three directions that strike me as particularly promising in this regard. One is to orient CRM training increasingly toward crew-as-a-whole performance, rather than using powerful devices such as LOFT mainly as vehicles for getting at the performance of individual crew members. A second is to highlight things that Captains (and other crew members) can do outside the cockpit to increase the chances that in-cockpit behavior will be as competent as possible during those challenging times when there is little opportunity for reflection and planning. And a third is to start bringing key actors in organizational and regulatory contexts under the CRM tent—specifically, helping those who have authority and responsibility for the design, management, and regulation of crews learn how to create performance environments that will actively support the kinds of behaviors and attitudes that are taught in CRM courses.

Notes

1. Delivered at the NASA/MAC Workshop on Cockpit Resource Management Training, San Francisco, May 6-8, 1986. Preparation of this paper was supported by Cooperative Agreement NCC 2-324 between NASA and Yale University. Helpful comments on an earlier draft of the paper were provided by Clayton Foushee, Robert Ginnett, Robert Helmreich, Phyllis Kayten, and Linda Orlady.
2. For further discussion of the historical roots, current manifestations, and possible implications of this individualistic orientation, see Hackman and Helmreich (1987).
3. For the theory of team performance on which the material that follows is based, see Hackman (1986).
4. This approach requires us to think about effectiveness in line flying very differently from the way performance typically is assessed in check rides and in research on pilot performance. For one thing, demonstrated proficiency in executing an established set of procedures and maneuvers merely affirms that a pilot has the competence to execute well the technical aspects of the work; it does not address how that competence is used to achieve performance objectives. Also, simple unidimensional measures of performance (such as fuel burn, actual versus scheduled block time, or number of deviations from prescribed cockpit procedures) are not sufficient to assess overall performance in the operations—even though many such

measures may be useful as components of a summary assessment. Finally, traditional check procedures focus almost exclusively on the behavior of individual pilots; here, we are asking how the crew as a whole does in meeting others' legitimate expectations and standards.

5. By "team," I mean a small social system in which (a) membership is clearly defined (i.e., one can readily distinguish members from nonmembers), (b) members have differentiated roles to play in pursuit of some common purpose, and (c) the team as a whole manages transactions with other individuals and groups as it goes about its work (adapted from Alderfer, 1977). A cockpit crew clearly meets these criteria.
6. Despite the considerable potential of well-conducted briefings for promoting crew effectiveness, there is great variation in the policy of air transport organizations regarding them. At one extreme, some military units require Captains to conduct an extensive and highly structured briefing for all working members of the crew (not just the cockpit crew); crewmembers report two and one-half hours before scheduled departure to allow ample time for the briefing and other flight preparations. Other organizations require a briefing, but cabin crew members are not included because their schedules are not yoked to those of the cockpit crew. In still other carriers, normal practice is that no briefing is conducted—and crewmembers sometimes are observed introducing themselves to one another even as

they are running the pre-flight checklist.

7. Robert Helmreich (personal communication) reports that gradual changes in pilot behavior also are appearing in response to two other types of CRM programs: those that seek to change pilots' attitudes about flightdeck management, and those intended to help pilots understand how stress affects their personal capabilities.
8. This perspective raises some interesting and thorny questions—for example, about the appropriateness of violating an entire crew for busting an altitude, or of having assessments of individual pilots depend in part on the overall performance of crews with whom they fly.
9. It is possible that the FGC's were contrasting alternatives (but at an unconscious level), or possibly the FGC's were unreliable in their reports. We have no way of demonstrating that the FGC's were not contrasting alternative options, but the burden of proof is not on us. There is no way to prove that something is not happening. The burden of proof is on those who wish to claim that somehow, at some level, option comparison was going on anyway. The reasons we believe that the FGC's were rarely contrasting options are because it seems unlikely that people can apply analytical strategies in less than a minute (see [10]), because each FGC argued forcefully that she/he was not contrasting options and because they described an alternative strategy that seemed to make more sense.

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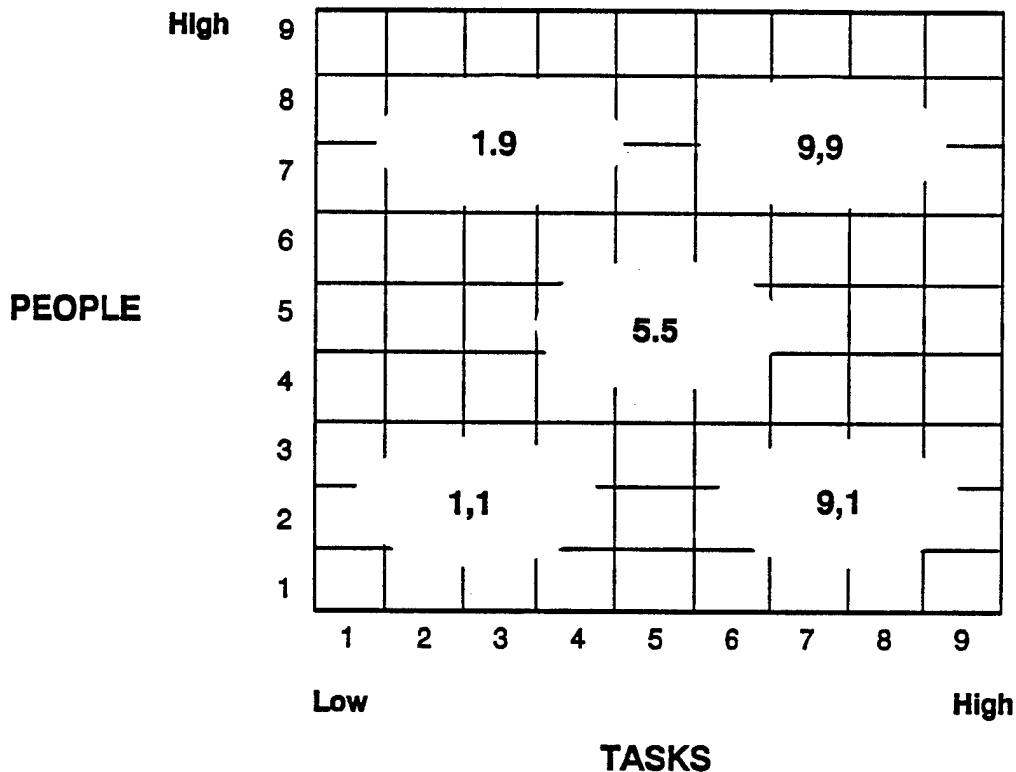
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LEADERSHIP/FOLLOWERSHIP

Blake and Mouton's Management Grid

The management grid is used to show management styles. As you can see, the grid is arranged with a high concern for people along one axis and a high concern for performance along the other.



A 1/1 would have a minimum response to both people and performance. He is only on the job to reach some private goal, maybe retirement. He is a coaster. He is visible and looks occupied without actually doing anything, contributes as little as possible without getting into trouble.

A 1/9 would place emphasis on people ensuring crewmembers are happy, contented, and feel a sense of warmth and acceptance. He will want to cooperate to ensure efficient flight performance.

A 5/5 is a balancer. He adjusts to the tempo that others have come to adopt. He will not push for more even though the results obtained are less than what might have been accomplished by a different approach. In this way, some progress is made and everyone feels that something has been done. When conflict arises, he adjusts by splitting the difference in ways that include compromise, accommodation, and adjustment.

LEADERSHIP/FOLLOWERSHIP

Examples of Team Management Problems in the Aircraft

Lack of Support - Where one crew-member fails to back up another, during high workload situations.

Standard Operational Procedures Ignored - The HAC and crew fail to complete a checklist under time or other pressures.

Stress Problems - A crew experiences difficulty in adapting to unusual emergency situations.

Judgment Problems - Management of priorities and distractions distort the judgment process.

Emotional Problems - Aggression or extreme submissiveness in the aircraft affect personal relations, or where there is a carry over of domestic worries and conflict to the job.

Get-Home-Itis - Failure "to divert" or "go around" in a high risk situation.

Management Pressure - A deferral to management authority, for example, expediting departure before the crew is sufficiently prepared.

Discipline Problems - Corners are cut and there is inadequate control of operations in the aircraft.

Leadership Problems - The HAC does not delegate adequately.

Communication Problems - Misunderstandings or lack of conversation control.

LEADERSHIP/FOLLOWERSHIP

Thirty Rules for Getting Things Done Through Your People

1. Make the people on your crew want to do things.
2. Get to know your crew.
3. Be a good listener.
4. Criticize constructively.
5. Criticize in private.
6. Praise in public.
7. Be considerate.
8. Delegate responsibility for details in subordinates.
9. Give credit where it is due.
10. Avoid domination or forcefulness.
11. Show interest in and appreciation of the other fellow.
12. Make your wishes known by suggestions or request, not orders.
13. When you make a suggestion, be sure to give the reasons for it.
14. Let your crew in on your plans in an early stage.
15. Never forget the leader sets the style for his people.
16. Play up the positive.
17. Be consistent.
18. Show you have confidence in your people and expect them to do their best.
19. Ask subordinates for their counsel and help.
20. When you make a mistake, admit it.
21. Give courteous hearing to ideas from subordinates.
22. If an idea is adopted, tell the originator why.
23. Remember, people carry out their own ideas best.
24. Be careful what you say & how you say it; it may be misunderstood.

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- 25. Don't be upset by moderate grouching.
 - 26. Build subordinates sense of the importance of their work.
 - 27. Give your people goals.

- 28. Keep your people informed on matters affecting them.
- 29. Let subordinates take part in decisions affecting them.
- 30. Let your people know where they stand.



FIT FOR FLIGHT

Stress in Aviation

Richard O. Reinhart, M.D.

Stress has a tremendous influence on our personal and professional lives, but despite its (usually) negative connotation, it actually can be a positive force. Certainly, stress is inherent in flying. The results of stress, though, have been likened to the price paid to be a race horse instead of a plow horse. Thus, the variety of stress that is particular to flying, in addition to the ability of a pilot to cope with such stress, is precisely what makes him or her a bad, good, or excellent aviator.

But just what is stress? Stress can be defined as any activity that requires us to cope, and putting this energy to our advantage enables us to be that "race horse" mentioned before. If stress becomes unmanageable, though, it changes to distress—anxiety, oppression, affliction, unhappiness—and frequently is disabling because of its debilitating effects on the human body.

Some studies, in fact, have found that 50 to 70 percent of all visits to the family doctor are related to the negative effects of stress. Such distress produces as many symptoms or "body signals" as there are organs in the body and functions of these organs. Symptoms such as headaches and gastrointestinal problems (heartburn, belching, cramps) lead the list, with general fatigue a close second. When stress becomes a problem, sleep is not restful, and your general mental and physical condition is less than it should be.

Nevertheless, no one can be free of stress, and that statement is especially pertinent for career pilots. Additionally, pilots, like doctors, are goal-oriented, which can compound the problems of stressful situations. It has been observed by senior aviators that "any pilot who does not privately consider himself to be the best in the business is in the wrong business." This self-imposed high standard produces stress, but this stress can also hone the pilot's proficiency. If we add to those high expectations the fact that the career pilot is a very visible professional in that he or she is monitored from many perspectives, such as company flight standards, the FAA, peers, medical examiners and the press, the extra pressure of already being "on guard" only heightens any sensitivity to stress.

Furthermore, job security, financial obligation, lifestyles, etc., all have become serious issues facing pilots since deregulation. Another pressure is the periodic medical examination, particularly when the pilot feels he or she has no control of his FAA medical when he walks into the doctor's office. (The pilot does not have control, but many are not aware of the options available.) And consider the tension that is "triggered," by the following: "on reserve," "grounded," "retirement," "commuting," "checkride." Are these subjects distressful to you? Are you feeling as well as you did before deregulation? Could you be under enough stress that you are "distressed?"

Let's assume that, like many of your colleagues, your life could be less distressful. What can you do about it? First, do not use the powerful tool of denial, which many people use to protect themselves from reality. All too often, pilots deny that they are vulnerable. In addition, they frequently have unrealistic expectations of themselves and those close to them. Therefore, the illusions created by a person's ego usually have to be dealt with before the stress can be identified and controlled.

Another priority for any attempt to control stress is to realize and accept that your life is a little hectic and then admit that you, alone, are not omnipotent in dealing with all stressful situations. Once this conflict is resolved, you are ready to take the next step - to take action - in resolving the stressful situation(s). The following suggestions are some specific actions that you can take to keep your life in proper perspective and to cope with those stresses that interfere with a smooth lifestyle.

1. Prioritize your time, activities, and work obligations. One way to control the pace is to make a three-column list of (a) things you have to do, (b) things you want to do, and (c) things you neither have to nor want to do. Then, do not concern yourself with anything in column c.
2. Talk out your worries with someone who can help sort out the priorities. For the best results, this person should be a professional but also someone you can trust.

3. Balance work and recreation. By prioritizing your time, you can find time to get away from the job.
4. Accept what you can't change and give in once in a while.
5. Get the facts about situations that concern you, and don't rely on hearsay from peers.
6. Don't self-medicate. In addition, don't "drown your sorrow" with alcohol. This drug has the power to make things *appear* better but the unresolved stress goes merrily on.

Finally, after you have identified your priorities and have begun to take action, "let go." If you are doing all you can, then worrying about or being obsessed with the outcome is not going to help. It has been said that "worry is imagination misplaced." Worse yet, worrying means that the effects of stress are still being felt.

Remember that few people are able to deal with stress by themselves. Seeking professional help whereby you can talk to competent counselors, therefore, may be necessary. Beware the myth that claims that a pilot's medical certification is in jeopardy when he begins to see such counselors. The FAA does not ground you for seeking help in such matters. In fact, you are not fit for flight if you are having difficulty coping, and furthermore, it is your responsibility to seek whatever help is necessary to resolve your stress. Trying to get by on your own can only lead to your becoming a "human factor."

The truth is that a counselor can be very effective in identifying your particular forms of stress as well as those stresses that are so deep in your mind that even you aren't aware of their existence. Tests, interviews, and surveys all are valuable in assisting you and your counselor in finding hidden problems, which can then be dealt with.

Stress is a real phenomenon and something that everyone experiences in rela-

tively equal amounts. But how we cope with our stress is a major factor in living a healthful, productive, and satisfying life. Horace, the ancient Roman poet, said, "Adversity (stress) has the effect of eliciting talents which in prosperous circumstances would have lain dormant." I encourage you to accept the fact that stress will be with you, coping with it, and making a conscious effort to use stress in a positive way to help you achieve a successful and productive career.

THE COPING RECIPE

Choose the Stress-Reduction Technique That is Right for You

Stress is something most of us try to avoid, but some stress can actually be good for us. Without it, we would lack the energy and enthusiasm that pushes us to grow and learn. The trick is establishing a healthy level of stress and maintaining that level.

While some stress is good, too much can be dangerous to your health - even fatal. It is important to know how to cope with excess stress that can pile up and threaten your healthy stress level.

Stress: A Physical Reaction

Stress is not pressure from the outside, as some people think. It is the physical reaction within your body that prepares you to meet that pressure that triggers the stress response is a stressor.

For example, a husband may be waiting for his wife who is late coming home from work. He may say to himself that she is probably late because she is working overtime or doing errands she couldn't get done earlier. Those reactions are positive and will produce little or no stress.

However, if his reaction is worry or anger, he will undoubtedly be stressed. And, if the wife walks in the door with a perfectly understandable reason for being late, the husband will stand there stirred up and prepared for the worst.

We all continually face many similar stressors. When these stressors threaten us,

our bodies rush to protect us by turning on the chemical juices and preparing to defend us. The fight reaction that results is stress.

Three Stages of Stress

Dr. Hans Selye, known as the "father of stress" for his extensive work and research on the subject, has identified three stages of stress. The first stage is alarm, in which the body gears up for a fight. The heart beats faster, blood pressure rises, digestion slows down, and adrenaline produces a sudden burst of energy.

The second stage is adaptation. This is the negotiation phase when the person works through the crisis. When this is done successfully, the body will slow down, relax, and return to normal. If relaxation does not occur after the alarm stage, the body remains physically geared up and moves into the third stage, exhaustion.

In this stage, if the body is not given the chance to recover and rid itself of harmful by-products, an imbalance occurs. Over time resistance is lowered and illness is likely.

Choosing Coping Techniques

Because stress is an inevitable part of life, it makes sense to develop coping techniques that work. Everyone should have a variety of coping techniques. There are

many from the practical to the creative and avant-garde.

Following are some basic, common sense techniques:

Organize yourself. Take better control of the ways you are spending your time and energy.

Change your environment. Control what and who is surrounding you to get rid of stressors and gain support for yourself.

Build up your strength. If you are in good physical condition, you will be better able to stand up against your stressors.

Listen to your body. It will let you know when you are pushing too hard. When that stomach sours or head aches, slow down and enjoy life.

Find ways to laugh each day. Laughing is one of the purest and most total releases of tensions.

Develop a supportive network of caring people around you. Research indicates that if you do, you will live longer and be healthier.

Learn to relax. Use relaxation techniques for twenty minutes each day. You will be prepared for clearer thinking and decision making.

Coping Skills: Using Mind, Body, and Spirit

Stress is nondiscriminating, an integral part of everyone's life. How do you cope with it?

Coping with stress comes naturally for all of us. We successfully deal with 98 percent of our stressful experiences. It is the small percentage we cannot manage that usually causes 98 percent of our stress.

A problem many of us face in dealing with stress is that we use the same skills over and over. To manage stress, it is important to add to and recombine our coping skills.

Because stress affects the whole person, stress management skills need to make use of our mind, body, and spirit.

The following coping skills can get you started in changing and adding to your list of stress management skills.

Physical Skills

These coping skills help build up your stamina.

- **Relaxation:** Let go of your mental and physical tensions.
- **Nourishment:** Eat for your health.
- **Self-Care:** Treat yourself kindly. Do not push beyond your limits.
- **Exercise:** Strengthen and fine-tune your body regularly.
- **Biofeedback:** Listen to your body and its needs.
- **Stretching:** Take short stretch breaks throughout your day.

Mental Skills

Use your mind to cope with stress more effectively.

- Time management: Set aside time to match your goals, values, and priorities.
- Problem solving: Address issues by yourself or with help from others.
- Life planning: Clarify your long- and short-range goals, then move toward them.
- Organizing: Seek order. Do not let things pile up.
- Relabeling: Change your perspective. See the promise in every problem. Be gracious.
- Imagination: Paint a different picture of your situation. See the humor in life's ironies. Be creative.

Spiritual Skills

Trusting and believing in yourself can relieve your stress.

- Commitment: Say "yes." Invest yourself meaningfully.
- Seek meaning and purpose in life.
- Surrender: Let go of your problems.
- Valuing: Identify what is really important.

Family Skills

Our closest network of people can be used to strengthen our coping skills.

- Balancing: Strike a balance between work and home commitments.
- Togetherness: Spend quality time together.
- Networking: Use family and friends for support.
- Esteem-Building: Help each other grow. Build on good feelings about your family.
- Conflict resolution: Look for solutions where all sides win.
- Flexibility: Stay open to change. Try creative approaches.

Interpersonal Skills

It is important to build relationships in dealing with stress in your life.

- Affirmation: Believe in yourself. Trust others.
- Contract: Invest in others. Form satisfying relationships.
- Expression: Share and show feelings.
- Linking: Share your burdens with your family, friends, and neighbors.
- Assertiveness: Be direct about your wants, needs, and feelings.
- Limits: Set personal boundaries. Accept the boundaries of others.

Diversion Skills

Discovering creative means of escape is a great way to reduce your tension level. Escapes can be found in:

- Learning: Take a class. Appreciate the arts.
- Music: Play an instrument. Join a choir.
- Work: Volunteer for something worthwhile.
- Getaways: Daydream. Spend some time alone.

- Hobbies: Create something.
- Play: Go out with a friend.

The easiest way to build your repertoire of coping techniques is to develop one new habit at a time. Remember, you have the power to choose how you will deal with stressful situations and the ability to cope with stress creatively.

Adapted with permission from "The Stress Kit" developed for Aid Association for Lutherans, Appleton, Wisconsin by Donald and Nancy Tubesing, Whole Person Associates, Duluth, Minnesota.

STRESS COPING AND AIRCRAFT MISHAPS

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To talk about stress, we first need to define it. According to Dr. Hans Selye, the world's leading authority on stress, "Stress is the nonspecific response of the body to any demand made upon it." Stressors are those events that occur in our environment that make these demands. The problem is one of determining cause and effect.

Stressors Defined

A stressor may be a physiological, mental, or psychological demand. Physiological stressors from the environment may include such things as temperature and humidity extremes, noise, vibrations and, for the aviator the lack of oxygen and lowered barometric pressure at high altitudes. Mental stressors may occur through concentrating on a problem, studying for an exam, or attempting to finish a report under the pressure of a deadline. Psychological stressors may occur at home or on the job, during recreation or any other activity in which we find ourselves. These stressors include such things as an illness in the family, financial problems, pressures on the job, or the desire to obtain a promotion or a desired billet (i.e., stressors may be self-generated). In this article, we will concern ourselves only with psychological stressors.

According to Dr. Selye, everyone is always stressed to some degree. He says that the absence of stress is death. He feels that many of the pleasurable things in life are also stressors, since we have to cope with

them in some way. In fact, some stress is good for you in that it keeps you on your toes and prevents boredom and complacency from setting in. This helps prevent accidents. Too much stress, on the other hand, can cause you to become error and accident prone.

Effects of Stress

Our perception of a stressor causes us to ready ourselves to cope with it by marshalling our bodies' resources for action. These bodily reactions involve the release of chemicals into the bloodstream to make blood clotting easier. The metabolism in the muscles of the arms and legs is speeded up to prepare us to *fight* or to *flee* - whatever action is required to survive. The blood is shunted away from the stomach and digestive tract in order to supply the muscles. The glucose level in the blood is increased. Heart rate, respiration, blood pressure and sweating all increase. This is the *alarm* state, according to Dr. Selye's theory of the General Adaption Syndrome.

The effects of stress are cumulative over time. As we adapt to ongoing life stressors, we learn to cope with our stresses. This is Dr. Selye's *adaptation* phase. If we continue to be loaded with stressors over a prolonged period of time, however, we eventually reach a stage of *exhaustion*, according to Dr. Selye. Our bodily resources then collapse from fatigue, and we get sick. This sickness can manifest itself in several ways: physical, mental, or behav-

ioral. Most of us are in situations that occasionally require us to sit and take it from our bosses, our spouses, or whomever. We can't always react by fighting or running away. But by continually preparing ourselves to *fight* or *flee* and by not having the opportunity to act to burn up all the energy being supplied to our muscles, bad things can happen to us physically. The blood supply rushing to the muscles leaves the stomach blanched. That is, the capillaries in the stomach's lining become constricted, leaving the normally healthy pink color a sickly white. The stomach's digestive juices may then start to digest the unprotected stomach lining and cause ulcers.

In the cardiovascular system, high blood pressure, strokes, and heart attacks can result in the respiratory system, diseases ranging from hay fever and asthma to pneumonia and tuberculosis can occur as a result of unrelieved stress. It is suspected that stress may play a causal role in cancer. Stress, or the inability to adequately cope with it, may also lead to suicide, divorce, career difficulties, and even mishaps.

Stress Coping Styles

Stress handling techniques vary considerably from individual to individual. People experiencing stress from the everyday life changes that are part of the aging process may react in variety of ways depending on each person's particular personality. Our psychological coping strategies may be healthy and adequate to deal with the various problems, or they may be inappropriate and lead to greater stress through a series of self-imposed stressors. For exam-

ple, when we are frustrated in achieving the goals we have set for ourselves, we experience stress and this will often lead to aggressive behavior. Aggression is regarded as an inappropriate stress-coping strategy in a civilized society.

The inappropriate stress-coping strategies typically employed by most people may take one of two forms, depending upon whether they are introverts or extroverts. Introverts turn their feelings inward and withdraw from others. Their behavior may be self-destructive and ultimately lead to their own death. This may take the form of alcoholism, substance abuse, mishaps, or even suicide. On the other hand, extroverts may take out their frustration through aggression directed outwardly. This may lead to interpersonal problems, divorce, child abuse, assault, homicide and, again, mishaps (aggression directed at a machine).

Symptoms of Inadequate Stress Coping

Individuals who turn their aggressive feelings inward often demonstrate the emotional symptoms of depression, preoccupation, sadness, and withdrawal. Physical symptoms may show up as headaches, insomnia, appetite changes, weight gain or loss, indigestion, nausea, vomiting, diarrhea, or constipation. Behavioral symptoms include hypochondria (preoccupation with illness), self-medication, a reluctance to accept responsibility, tardiness, absenteeism, poor personal appearance, and poor hygiene. Introverts' self-destructive behavior may lead them into alcoholism, drug abuse, overeating, suicide, or mishaps. Any one individual will

It exhibit *all* of these symptoms but may exhibit one or more of them.

Extroverts tend to respond to stress and frustration with aggression directed toward other people or inanimate objects. Their emotional symptoms may show up as overcompensation, denial, suspicion, paranoia, agitation, restlessness, defensiveness, excess sensitivity to criticism, argumentiveness, arrogance, or hostility. Behavioral symptoms include desperate "acting-out" (a cry for attention). These individuals tend to abuse alcohol and drugs, get into fights, get traffic tickets, gamble, fall into indebtedness, and may even become child or spouse abusers. Symptoms of their inadequate stress coping may show up as difficulties with interpersonal relationships and as mishaps.

Life Changes as Symptoms

Many of the factors that are named on "Life Change Scales" or "Social Readjustment Inventories" are really *symptoms of stress rather than stressors themselves*. Typical military aviators are extroverted, aggressive individuals. It would be expected that they would respond as the extroverted individuals described above when not adequately coping with their stress. In other words, they would have interpersonal problems, marital difficulties and disciplinary problems. They would also tend to cause mishaps.

Results of a Psychological Questionnaire Study

In order to test this hypothesis, a psychological questionnaire was sent out to the flight surgeon member of all major (Class A) aircraft mishap boards, regardless of the cause of the mishap. The questionnaire was to be completed on the involved aviators. The questionnaire consists of 22 questions covering lifestyle changes and personality variables. During calendar year 1979 and 1980, 585 questionnaires were sent out. Of these, 501 were returned. The returned questionnaires were divided into two groups of aviators, those who had an aircrew error factor assigned and those who did not. Two hundred and forty-eight questionnaires were assigned to the at-fault group and 230 to the not-at-fault group. A statistical test (the Fisher-Irwin Exact Test) revealed that individuals named as contributing cause factors to their mishaps were more likely to have been involved in making a decision concerning their future (i.e., whether to get out of the service or to stay for a career) and more likely to have recently become engaged. But of even greater interest is the finding that these individuals were much more likely to have marital problems, trouble with superiors, peers and others, and difficulty with interpersonal relationships in general (see Table 1). This supports the hypothesis that aircrewmembers assigned as cause factors in aircraft mishaps are more likely to show symptoms of inadequate stress coping strategies. This appears through their "acting out" of their aggressive behavior (directed towards others) rather than internalizing it.

Table 1. Aircrewmembers Who Were at Fault in an Aircraft Accident Were More Likely Than Those Not at Fault to Have:

	<u>Statistical Significance</u>
Had marital problems	.02*
Shown signs of immaturity and instability	.03*
Recently become engaged to be married	.04*
Been making a major career decision (such as getting out of the service)	.0017**
Been having difficulty with interpersonal relationships	.0047**
Recently had trouble with superiors or received disciplinary action	.0029**
Recently had trouble with peers or others	.028*
* Significant at better than the .05 level of confidence	
** Highly significant (at better than the .01 level of confidence)	

Healthy Stress Coping Strategies

How can you go about handling your stresses in more appropriate ways? First, ensure that you are physically fit. A check-up might be useful. Get plenty of rest and maintain a balanced diet. Stay away from alcohol and drugs. Exercise regularly but be careful of competitive sports. These can increase your stress level significantly, especially if you are the competitive, aggressive type. Try jogging, cycling, or swimming instead. Exercise at least three or four times a week. This will help you

get into shape to be better able to resist stressors.

Next, learn to manage your time better so you don't find yourself having to rush to meet deadlines, appointments, etc. Then set priorities for your tasks and goals to cover the most important things first, table some tasks for later consideration, and forget those that are not important or necessary.

Having a realistic self-image helps enormously. Try to discover your strengths and weaknesses. Take advantage of those strengths by attacking goals you know you can achieve. Don't beat your brains out and waste time on things you know deep down you probably won't achieve. They will just frustrate you. This is a process of successful maturation, of course.

Finally, don't hesitate to seek professional help from your flight surgeon, counselor, minister, etc., if you can't solve your own problems. These specialists can introduce you to a variety of techniques—including biofeedback and meditation—that can teach you to relax. Books on these topics are available in your ship's or naval air station's library.

Conclusion

If you (or someone you know and care about) are showing any of the symptoms of inadequate stress coping described here, take steps today to drop those inappropriate strategies and get into a pattern of coping that will enable you to do your job better, feel better about yourself, avoid costly, painful (and sometimes fatal) mishaps, and improve your family and per-

sonal life. You will find it very worthwhile.

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Editor's Note - Dr. Alkov has been studying the effects of life stresses on the Navy/Marine Corps human-error aircraft mishap rate for a number of years. This article is a summary of his latest findings in this area.

OBSERVING TEAM COORDINATION WITHIN ARMY ROTARY-WING
AIRCRAFT CREWS*

Final Technical Report

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EXECUTIVE SUMMARY

The goal of the effort was to identify aircrew coordination deficiencies that could be noted by instructors and used for immediate feedback to improve performance. Research was conducted to demonstrate the feasibility of using team decision models to aid in training crew coordination in the tactical helicopter domain. Ten aircraft crews were studied as they performed a tactical mission in a UH-60 Blackhawk simulator facility at Ft. Campbell, Kentucky. The two-person crews were qualified pilots with one designated as the pilot-in-command.

Overall, five opportunities for aircrew coordination training were identified: 1) mental rehearsal of functional profiles of segments of the mission; 2) analysis of the commander's intent during the premission planning session; 3) sensitivity to time horizons; 4) avoidance of metacognitive problems such as micromanagement; and 5) communicating cues for anticipation and confirmation during the actual mission. The value of these five training opportunities depended on whether the crew was in the premission planning, the mission execution, or the mission debriefing stage.

Observations could be used during premission planning to identify how the crews used mental rehearsal and whether they analyzed and/or clarified the commander's intent. During the mission, observation and videotapes were effective for enabling the researchers to: 1) identify specific areas where the use of mental simulation and analysis of commander's intent helped or hurt their performance; 2) see how the crews worked with various time horizons; 3) observe the metacognitive aspect of the crews' performances; and 4) to note how they used anticipatory and confirmatory cues. Interviews and videotape playbacks were used jointly during the post-mission debriefing. This allowed the researchers to explore some of the understandings and rationales of the crews that could not be inferred through observation alone.

Recommendations were presented for training observers and instructors in the use of the techniques and categories. Methods were also described for representing aircrew coordination for research purposes.

OBSERVING TEAM COORDINATION WITHIN ARMY ROTARY-WING AIRCRAFT CREWS

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OBSERVING TEAM COORDINATION WITHIN ARMY ROTARY-WING AIRCRAFT CREWS

Introduction

The goal of this effort was to identify training requirements for helicopter crew coordination. We wanted to define a set of theory-based categories that instructors could use in evaluating team decision making, in order to provide training feedback.

Crew coordination is vital for mission success in a variety of domains. Rarely is a single decision maker responsible for accomplishing an important task. Usually, groups will be involved. In this project, our emphasis is on teams, a sub-class of groups in which there are several information sources, interdependence and coordination among team members, adaptive management of internal resources, common goals, and defined roles (Orasanu, Duffy, & Salas, in preparation). Specifically, we attempted to learn more about aircrew teams: two-person, rotary-wing aircrews. We attempted to understand how they worked together to perform missions, and to learn what distinguished effective and ineffective teams.

We must learn how to observe crew coordination in order to improve it. If we want to train aircrew coordination, we need to specify the types of behaviors we want to promote, and the behaviors we want to minimize. Whether instructors work in simulators, in classrooms or in actual training flights, they must be prepared with training objectives so they will know what to look for, and what

types of feedback to provide. It is easy for instructors to emphasize procedures. Crew coordination is more subtle, and instructors may just neglect this aspect of performance. Moreover, the observations must be made and interpreted rapidly in order to have training value. Feedback delays can limit the usefulness of the lessons.

We also want to make sure that the instructors understand the reasons for the observations. If instructor pilots are simply given lists of unrelated categories to observe, their burden is increased substantially. Anyone can make up lists of factors that seem to relate to crew coordination. For coherence, ease of applications, and ease of modification, it is important that the categories used for observation and evaluation be linked to theories of team performance and team decision making.

Many researchers have tackled the problems of crew coordination. We cannot review this literature here. The interested reader is directed to recent work by Orasanu, Duffy, and Salas (in preparation) and Swezey and Salas (in press) for more comprehensive reviews. These sources document the need for theory-based methods for observing and evaluating team decision making.

The current effort to develop a theory-based approach to evaluating aircrew coordination was sponsored by the Ft. Rucker Army Research Institute, Aviation Research and Development Activity

(ARIARDA). The rationale for this effort was a set of projects we had recently performed (Thordsen & Calderwood, 1989; Thordsen, Galushka, Klein, Young, & Brezovic, 1990; Thordsen, Klein, & Calderwood, 1990) studying team decision making in commercial aircraft, and in command-and-control settings. In addition, we have developed a cognitive model of team decision making (Klein & Thordsen, 1990; Thordsen & Klein, 1989).

Our goal for this project was to apply our cognitive model of team decision making to the task of describing when rotary-wing aircrews are showing effective versus ineffective coordination. We were not attempting to collect data systematically, but rather to determine which of the team decision-making dimensions seemed useful for the domain of Army helicopter missions. In the next section, we describe the model we used to guide the research.

Cognitive Model of Team Decision Making

A cognitive model of Team Decision Making (TDM) has been proposed by Thordsen and Klein (1989), who assert that a team can be studied and understood using concepts derived from cognitive science.

The cognitive model of TDM treats the team as an emergent entity. The crew of UH-60 helicopter can be considered to consist of three entities: the Pilot Flying (PF), the Pilot Not Flying (PNF), and the team of both of them together. The value of this formulation is in helping the observer focus on the team as an entity rather than becoming engrossed with the individual team members. We want

observers to be able to think about how a team perceives its world, how the team's behavior is directed, how the team makes inferences, and how the team uses its resources efficiently to solve problems and make decisions. In other words, if an instructor can learn to think of the way the team is thinking, using cognitive processes typically applied to individuals, then it may be easier to notice team coordination problems.

The cognitive model of TDM attempts to map a set of cognitive processes from the individual level to the level of team coordination. Accordingly, the following assertions can be made:

i - The mind of a team can be treated as analogous to the mind of a person. The goal of this analogy is to help us understand, study, and represent the performance of a team. The unit of analysis is the team, a group of individuals with common goals and coordinated roles. A team may have extensive experience working together, e.g., an Army division-level headquarters, or, like the crew of a commercial airliner, the members may be meeting each other for the first time just prior to takeoff. In contrast to a team, a group of individuals may not have consensus on goals and roles so that interesting features of teamwork do not emerge.

ii - The team needs to perceive its environment. Just as an individual depends on perception, so does the team. And, limited perceptual and attentional resources come into play at both levels. The team members can each be aware of a great many cues, but only a few of these can be communicated to the entire team, otherwise everyone would be talking

simultaneously and continuously. We are positing a "spotlight" model of consciousness for the team mind, in which team members publicly share only a part of what they are noticing, which results in selective attention for the team as a whole.

Perception is an active process, so a team is not just receiving information, it is also focusing its attention on events in the future, and on critical cues that must be monitored. The way a team perceives a complex environment can be described as its "situation assessment." We feel that a team's ability to form accurate situation assessment, and to share this understanding, affects its success. The sharing of situation assessment is also referred to as a shared mental model (e.g., Salas chapter in Swezey & Salas, in press).

iii - Memory retrieval is important to teams. The wide range of experiences offers teams the strength of a large available memory base. The burden is for the team to know where particular items of information can be retrieved, and to develop strategies for storing information with just enough redundancy; you may want several team members to know about critical facts, but it is distracting to tell everything to everybody.

iv - The team mind depends on metacognition. Metacognition is thinking about thinking, and refers to the way we size up a problem and select a strategy that takes into account our limited working memory capacity, time pressure, likelihood of interruptions, and so on. At the team level, metacognition refers to the team's ability to manage itself as it carries out a task. The team must be careful not to create excessive workload for individual

members, and know how to monitor what is going on. We have seen teams where the leader spent so much time checking on progress that the team members could not get any work done. Another type of metacognition issue is how to assign tasks so that supervision is effective without leading to micromanagement. The management of teams is parallel to the metacognitive management of individual cognitive resources.

v - The team mind is affected by motivation. Here we are interested in the way motivation directs performance. One type of motivation is the intent of the leader. If intent is understood, then teams can readily adjust to unanticipated events thereby improvising effectively rather than being bound to an obsolete plan of action. We have been able to evaluate the team's understanding of its intent by conducting interviews after a decision-making activity and asking each member of a team what the leader wanted to do at a given moment. In a poorly running team, the intent will not be communicated or understood.

vi - Sensori-motor coordination is analogous to the way the team coordinate the actions of individuals. A smoothly functioning team can be identified by its positive efforts to improve coordination. Here the "team mind" would be seen as synchronizing the actions of the individual team member.

vii - Teams show other cognitive phenomena such as reasoning. When various team members know different things, the team must be able to integrate information from all of these sources. The team must be able to *recognize patterns*—

When different components are presented to different team members, the team mind must be able to integrate the pieces in order to find the pattern. The "team mind" is capable of *learning*, and team members must be careful about how they store new information to be sure that it is accessible for efficient retrieval. The "team mind" must be able to perform mental simulations to evaluate proposed courses of action. At Ft. Leavenworth, we observed an example of a request from Corps to move a division line of defense forward. The Division Commander was unsure whether this was feasible but the Operations Officer insisted it could be done, and contacted Corps headquarters to confirm compliance. The instructor for this exercise was watching and simply asked the team what was the risk of trying to move a line of defense forward with little notice and barely enough time. Upon reflection, even the Operations Officer could see it was a poor idea—if the roads were damaged, or if they encountered air attacks or artillery, there was a possibility they would not reach their objective in time and would have to use a hasty defense rather than the prepared defense they had already developed. Until the instructor asked this simple question, the team simply did not attempt to simulate the risks in the course of action they were committing.

In addition to these aspects of a "team mind," there are three levels of observing team processes: behavioral level, pre-conscious level, and conscious level.

i - The team's cognitive processes are linked to *behavior*. The team acts, as does a person. The decision to shut down an engine is a team action, regardless of whether the suggestion was made by the

Captain or the Flight Engineer. Any action or message is considered to come from the single entity, the team.

The embodiment of the team is its observable, recordable behavior. If the Air Traffic Controller issues a directive to any one of the three team members, it is assumed that the directive will be acted on by the whole team. If a distress signal is sent out, it is considered to come from the whole team regardless of which crewmember made the announcement. For a command-and-control team, the embodiment is the set of plans it issues.

ii - Part of the team mind is *pre-conscious*. This refers to knowledge held by one person but not shared with others. It is important to note that we are using "pre-conscious" to refer to any material that is fully conscious for one or more team members but has not been publicly brought to the attention of the team.

The phenomenon of pre-conscious awareness is more easily studied at the team level than at the individual level. Videotapes and interviews will show when one team member had knowledge not available to the others. For example, in our NASA/Ames study (Thordson & Calderwood, 1989), the Flight Engineer noticed that the number 7 slot was not extending as they were getting ready to land. He dug out his checklist before saying anything to the other two team members, who quickly detected the problem themselves. He assumed they would find the problem, and he was preparing for their inevitable request that he go through his checklist of landing problems. But until the other team members noticed the problem, it was pre-conscious in the team mind.

The determination of what information has not been retrieved into the team's working memory, i.e., the team's attention, can be made through observations of videotapes and through interviews that enable us to learn what an individual knew that was not communicated to the other team members. We have also used formal strategies, namely a Critical Decision method (Klein, Calderwood, & MacGregor, 1989) to perform cognitive probes of individual decision-making strategies.

iii - The team's *consciousness* is whatever is publicly articulated, or signaled—so the collective consciousness of a team can usually be studied by listening. In other words, the content of collective consciousness is directly accessible while the team is performing a task. It can be studied without interfering with the task. For example, in the NASA/Ames study (Thordsen & Calderwood, 1989), one malfunction was a leaking fuel tank. When this was detected by the Flight Engineer, it was immediately brought to the attention of the other two teammates, the Captain and the First Officer. At that point, it entered the collective consciousness of the team and we could observe this consciousness on videotape.

An item of information has entered the team's situation assessment when all or most of the team members are aware of the information and/or intentions. This joint awareness is achieved by discussion, or by watching for non-verbal cues, including sounds of switches being thrown or the sounds of flap wheels turning. Cues are shared and crewmembers know the cues have been shared and observers can generally detect the sharing as well.

The model of team mind is intended to help observers become sensitive to the functioning of the team, rather than the performance of individuals within the team. We can present a partial list of cognitive functions that seem applicable to team decision making. Doubtless, there will be additional cognitive phenomena that will be identified. As we evaluate these phenomena, we hope to clarify a number of team performance issues.

Link Cognitive Model of Team Decision Making to the Domain of Rotary-Wing Crew Coordination

We wanted to use the cognitive model of team decision making as the basis for the project. While there has been a substantial amount of research on individual and team decision making that has not been anchored to specific cognitive models, one requirement of this project was to make sure it was built on a cognitive foundation.

Based on our observations of various team decision activities, particularly our research at NASA/Ames studying Boeing 727 crews, we identified four cognitive processes as particularly relevant for the rotary-wing exercises we were going to observe at Ft. Campbell. These processes or dimensions appeared to be the most salient for distinguishing effective and ineffective teams: perception, meta-cognition, motivation, and reasoning.

Perception. We hypothesized that there would be two ways that perception affected crew coordination for the mission we were studying: communication of new inputs and situation assessment.

We expected to see differences in the way crews described new data. For example, aircrew members rely upon instrumentation to provide them with information about things that they are not able to perceive directly, such as the Radar Warning Receiver (RWR) which provides a crew with information concerning enemy threats to their aircraft. Because the ship often is flying very close to the ground, it is critical that the individual who is actually flying the aircraft keep his/her attention "outside" the cockpit. Therefore, when the RWR goes off, transmission of the information on the RWR screen by the person not flying to the person flying becomes an important crew coordination issue. Otherwise, the person flying will have to come "inside" the cockpit and look at the RWR indicator to know which direction the threat is coming from which in turn helps determine the necessary direction and type of evasive maneuver.

We also expected to see differences between crews in the way they formulated and communicated their shared mental model, or shared situation assessment. Situation assessment (SA) is the attempt to take perception of the current state, along with knowledges of previous experiences, and evaluate this information to reach some understanding of: critical cues that should be attended to, what to expect if the appraisal is correct, and possible actions that can be taken.

We anticipated that it would be important for aircrews to learn how to coordinate their understanding of expectancies and cues. Because of the elevation and speed at which the aircraft is flying, there will be a need for the navigator (PNF) to inform the person flying about what types of

terrain features she/he should expect to see if they are still on course. Simultaneously, the person flying needs to inform the person navigating about the terrain features (cues) that can be observed. That is, the navigator needs to provide expectancy information while the person flying needs to provide actual visual sighting information so that they can determine whether the expectancies are confirmed or not.

Metacognition. Almost all teams require some metacognitive processes to keep the team itself operating smoothly. That is, some effort must go towards keeping the team functioning as a team, for example, making sure that workload is reasonably distributed, seeing that communication is flowing adequately, assuring that elements of the team have (at least minimally) an understanding of what the other components of the team are doing, and so forth. In this domain, we anticipated a possible problem regarding role confusion. Since helicopter crewmembers are comparably trained and they interchange roles during the mission (person flying versus person not flying), there may be difficulties if crewmembers inadvertently or unexpectedly shift roles, leaving some tasks unattended. This should require special diligence on their parts to make sure they are aware of the *current* roles and tasks each other is fulfilling. Therefore, we need to be open to the possibility that metacognitive issues might be important in this setting. Conversely, the fact that these teams were very small (two members of the crew), were not geographically distributed (which helps to avoid many complex communication problems and simultaneously allows non-verbal communication to contribute to the metacognition of the team), were in well-

defined roles (pilot flying, pilot not flying), and were flying a well-defined mission (improving the probabilities that the team conducted the exercise with a fairly good overall understanding to begin with) made us feel that while metacognitive issues would be present, they would not be as critical as in some other domains.

Motivation. On an overall mission level, there should be a fairly good understanding of the goals since these should be clearly stated in the mission plan. However, there could be confusion about sub-goals when the crews are confronted with unexpected situations such as becoming lost. In these cases, it may be important to attend closely to whether and how crews communicate the emergence of sub-goals.

The Army's term for the direction function of motivation is Commander's Intent (CI). CI is important since plans seldom work as well as anticipated. In fact, in many settings, the plan is obsolete within hours of implementation. The statement of intent should provide the participants with a broader perspective that includes not only the plan itself, but some of the logic and reasoning behind it. The importance of this is to provide a framework from which to resolve points of confusion and to assist in determining how to continue (i.e., improvise) in the event that the planned actions no longer appear appropriate. In an ideal situation, if confusion arises or if the plan falls apart, the crewmembers could contact their headquarters, ask for clarification or additional orders, and continue accordingly. However, this presupposes two things: their communication channels are working properly and time is available to make the

call. In any tactical, military domain, it is not prudent to assume the former, and as mentioned earlier, the latter is not necessarily true during many stages of these helicopter missions. Therefore, comprehension and, if necessary, clarification, of the CI is considered important in mission coordination (i.e., not just for their own ship) since the crews' understanding of intent will impact their interpretation of the mission goals which in turn guides any improvisation determined necessary.

Reasoning. The form of inference most relevant here is mental simulation. After the situation assessment has taken place, there are usually some potential options identified. Mentally rehearsing the execution of these options is often a key component in the decision-making process. Sometimes it may be possible to begin implementing the options immediately, anticipating that if difficulties arise, mental simulation and problem-solving techniques can be brought to bear to help modify the planned actions. Planning to make adjustments during implementation may be reasonable in a domain where there is time available for troubleshooting. However, in the tactical helicopter domain, this is seldom the case. In fact, there is often barely time to make critical adjustments to the flight path to avoid collisions with obstacles. The implication is that there are many stages of flights when crews cannot count on being able to do mental simulation and problem solving. These apparent restrictions on using mental simulation during many stages of the mission could contribute to coordination errors. That is, when difficulties arise that are not anticipated

e.g., through mental simulation), the workload demands are such that many other tasks (including coordination) will be neglected.

There is another cognitive process that should be discussed here because of its potential relevance: *sensori-motor coordination*. This refers to the synchronization of actions for different team members. Since members of these crews are not geographically distributed and are directly connected through communication sets, many of the synchronization problems are minimized. Both pilots are briefed on the mission's overall goal and are instrumental in planning how they will accomplish it. Thus, some of the implementation problems that could occur because of misunderstandings are reduced. In addition, the pilots also have direct visual contact with the environment which reduces some potential problems since crews do not have to rely as heavily on "third party" descriptions of their environment. While coordination most definitely is important in the successful implementation of a plan, because of the mentioned factors, we did not anticipate that it would be a major area of difficulty for these crews.

Observations of the UH-60 Simulation Exercise

The UH-60 Blackhawk helicopter simulator facility at Ft. Campbell, Kentucky, was the site of the simulation exercise. Three observers from Klein Associates were present during 10 flights having the same mission.

Mission. The mission was comprised of two distinct legs. The first leg involved picking up fuel blivets (refueling tanks) from the assembly area (AA) and moving them to a forward arming and refueling point (FARP). After the blivets were placed, the helicopter was to return to the assembly area to begin the second leg of the mission.

Leg Two of the mission was more complicated and dangerous than Leg One. In this leg, the helicopter was to lead a five-helicopter mission. The helicopter was to carry eleven soldiers to a landing zone (LZ) inside enemy territory. From there, it was to recross the forward line of own troops (FLOT) back into friendly territory, and refuel at the temporary (or jump) FARP created by the first leg of the mission. Finally, it was to link up with another helicopter to fly a possible follow-on mission. Several tasks and conditions that made this leg more difficult to complete follow.

1. The helicopter was to be flown across the FLOT. This would require the transponder (IFF) to be turned off going into enemy territory and back on when recrossing into friendly territory.
2. At several points enroute to the LZ, the helicopter would be within range of enemy Air Defense Artillery (ADA).
3. Radio calls to be made on several different frequencies were required at various points in the mission (no radio calls were required on first leg).

4. The primary LZ was actually unavailable. If a radio call was not made on the correct frequency, the crew could not receive instructions to go to the alternate landing zone.
5. There was a "hard time" established for reaching the LZ. Shelling in the area would cease for only one minute (the precise time for this was set prior to the mission) while troops were inserted by the helicopter crew.
6. During the follow-on mission, the lead helicopter gets shot down. The crewmembers must avoid enemy fire and follow correct procedures for the situation.
7. The helicopter encounters an inadvertent instrument meteorological condition (IIMC) in the way back to its airbase. This required a conversion to instrument flight by the crew.

Mission characteristics. The characteristics of this helicopter mission differed from other team decision-making exercises we have observed. Table 1 presents a set of task features that we have found useful for distinguishing different domains, along with our evaluation of this task. Compared to other domains such as commercial aviation and military planning, we felt there was a low margin for error, along with high risk and extreme time pressure.

Table 1. Key Domain Attributes for Tactical Helicopter Domain

<u>Attribute</u>	<u>Rating</u>	
Margin for error	Low	(Errors could result in immediate crashes)
Geographical distribution	Low	(Crewmembers were seated next to each other)
Uncertainty	Medium	(Task was dynamic, but mission was carefully planned)
Risk	High	(Errors could lead to crashes)
Adversary	Yes	(Enemy air defense artillery was employed)
Time Pressure	High	("Hard" times employed)
Team Cohesion	High	(Team members understood roles and goals)
Individual Expertise	High	(Crewmembers had 190-2500 hours flying)

Data collection. We have stated that the primary objective of this subcontract was to aid in the development of a training method for team coordination. It appeared that the most effective way to conduct this research was to make observations of the crewmembers while they were actually performing their tasks. To approximate a real-world environment, observations were made using the UH-60 Blackhawk simulators at Ft. Campbell.

At Ft. Campbell data collection took place between May 14-18, 1990. Three researchers from Klein Associates were present to conduct the observations. Ten crews comprised of two pilots each were observed as they carried out their mission in the simulator, and were then interviewed about particular portions of the mission as well as coordination issues not directly tied to that mission. The pilots interviewed included mainly WO1s and CWO2s, although there were several Lieutenants and one Captain. The Klein Associates researchers worked either individually or in teams of two for each aircrew observed.

The crew observations were conducted via a monitor that tracked four cameras, three of which were inside the simulator cockpit. Cameras 1 and 2 filmed each of the two pilots from the lower torso up to his/her head. Camera 3 was positioned behind the pilots to catch their hands moving to different areas of the instrument panel. Camera 4 recorded, from a remote location, the forward display seen by the pilots in the cockpit. The monitor used to make observations was capable of displaying four quadrants containing pictures from each of the four cameras or could allow the image from any one of the cameras to cover the entire monitor screen.

The crews were given a two-hour time period for the mission briefing and planning. Next, they flew the mission in the simulator, typically taking between 1.5 and 2.0 hours to complete. They were then debriefed by an Instructor Pilot (IP) who made observations from the back of the simulator during the mission. After debriefing, the pilots were given questionnaires to complete. At this point,

interviews were conducted by Klein Associates lasting from 45 minutes to 2 hours. All told, the pilots made themselves available for about 6 hours.

After several days of observing mission flights, we requested permission to observe the mission briefing and planning sessions held before flight. We received permission for this and observed three crews during this portion of the exercise. As stated, premission briefing took about two hours and proved to contain many of the planning and coordination issues that would manifest themselves during the actual mission.

The goal of the observations and interviews was to generate hypotheses about critical observation categories and potential aircrew training opportunities. We did not attempt to collect objective data (with a few exceptions noted below) on team behaviors, and we did not obtain data on team performance.

Results and Discussion

This section examines four topics. First, we discuss primary and secondary training recommendations—training the aircrews and also training the trainers. Second, we link these recommendations to categories for observing team decision making—the dimensions we expected to use, the dimensions we actually used, and the reasons for the differences. Third, we present some of the direct observations we were able to make. Fourth, we describe some indirect techniques we used to provide a different perspective of the team performance.

Training Recommendations

This section will cover two issues: primary training refers to how to train the aircrews, and secondary training refers to how to train observers and instructors.

Primary training. Primary training has to be accomplished using material collection during direct observations. We have identified five key opportunities for training aircrew coordination: 1) improving the time horizon so the crew is not behind the power curve, 2) reducing micromanagement in the cockpit, 3) encouraging feedback such as confirmations, 4) improving the understanding of commander's intent, and 5) using rehearsal strategies to anticipate changes in the functional mission profile. The first three (time horizon, micromanagement, and confirmations) would be trained during the mission, whereas the last two (rehearsal strategies and commander's intent) would be trained during premission planning. Again, these recommendations are based on subjective impressions in which we compared performance in this domain to other team performance domains we have observed.

Time horizon. The ability of a crew to focus on an appropriate time horizon falls under the category of perceptual functioning. The concept of time horizon refers to how far ahead the aircrew is directing its attention. If it is not looking far enough ahead, it will continually be surprised by cues it failed to anticipate. If it looks too far ahead, it may confuse itself and may fail to pay sufficient attention to important details of the immediate visual scene.

Our informal observations suggest that the ineffective aircrews are flying behind the aircraft, whereas the more effective crews are actively moving the perceptual horizon forward, ahead of the aircraft. It appears that the optimal horizon is just ahead of the visual horizon, about one navigational instruction in advance. This provides a lead time of about 30-60 seconds, but it depends on the terrain, speed, and complexity of the route the pilot was flying.

Below are two examples of time horizon. The first demonstrates a helicopter crew flying with a time horizon near zero. Note the pilot flying is leading the pilot not flying.

Example 1

PNF: O.K. come back around left and follow the river up.

RADIO: Whiskey 41 this is Whiskey 17
I have us at grid 87-90 . .
correction 87-80.

PNF: Yes, that's about where . . .
well that's the LZ, lo' and
behold. I thought we were
down about 3 grids but we're
in the right AO.

PF: O.K. which way?

PNF: O.K. turn around.

PF: Right, left?

PNF: Left.

PF: Coming left.

The second example shows a crew that is operating comfortably within the time horizon of the helicopter. The pilot not flying provides a directive to the pilot flying and receives a rhetorical question in return indicating that the pilot flying has understood the directive.

Example 2

PNF: O.K. Swing around to the left just a tad bit. Looking for a road intersection up here.

PNF: And there it is right there. (points)

PNF: O.K. come around to the left just a tad.

PNF: I hope that's not too far off. O.K. roll out.

PNF: Sort of parallel this road coming through here (looks out window).

PNF: We'll be crossing over it numerous times. It's gonna zigzag back and forth in front of us.

PF: O.K. so we're going to the right of these hills?

PNF: Yes.

The concept of time horizon can be more broadly applied in this domain, since the pilots need to become sensitive to several different time horizons, each conditioned by delay cycles. There is the time horizon for maneuvering and navigating the helicopter, the time horizon for coordinating the actions of the other

helicopters in the mission, and the time horizon for coordinating with the Tactical Operations Center. In each case, there is likely to be a tendency to focus farther in, and to assume that the system is more responsive than it really is. The training requirement is to learn how to counter this tendency and push the focus farther out.

It is difficult to learn how to coordinate the different time horizons, but we do not feel it is practical to teach crewmembers to adopt an overall mental model. This is something that will have to come through experience. All that can be done is to provide the training opportunities for encountering each different type of time horizons, so that the crewmembers can capitalize on their experience.

We hypothesize that more experienced pilots would be able to use longer time horizons. Therefore, it would be counterproductive to try to teach any "optimal" horizons that would just have to be unlearned as the crewmembers became able to anticipate events farther into the future. Another complicating factor is that pilots can be overloaded if they are asked to anticipate events too far into the future. For these reasons, the training should simply attempt to help the crewmembers fly ahead of their aircraft, and to counter tendencies to fly behind the aircraft.

Micromanagement. This is one aspect of metacognition that we observed—the autonomy given by the PNF (usually the pilot in command) to the PF. In some crews, the navigator gave the pilot sufficient information to perform his mission, whereas in other crews, the navigator (pilot in command) tried to do both jobs, with poor results. Crew 15 was a prime example of micromanagement.

The PNF (also the pilot in command) gave the PF minimal guidance about what was happening. Instead, the directions to the PF were all at a micro level: turn left here, stop, turn, etc. Because the PF had no idea where they were in the mission, the PNF had to continually provide detailed instructions. This effort left little opportunity to navigate the helicopter. Not surprisingly, this crew was lost for much of the mission, and had little success in re-orienting its position. The PNF created his own problem by micromanaging the PF, a clear metacognitive error. Furthermore, the IP never mentioned this problem during the After-Action Review. The term "micromanagement" seems appropriate here.

Confirmation. An obvious training need is to sensitize the crewmembers to the potential for confusion in the other pilot. This type of concern is also linked to metacognition—thinking about how crewmembers need to signal each other. The crews that appeared to do better were more careful to anticipate information needs, and especially to confirm that instructions and comments were heard. We also observed some crewmembers cross-checking to remind the other crewmembers about a task that might have been forgotten. Many aspects of communication can be trained as rote responses, e.g., how to transfer controls, how to request turns. We are interested in the less procedural aspects of communication, where the pilots must learn to appreciate what the other team members need to know. The capability of shifting perspectives will enable a pilot to sense when to confirm an instruction, and when to initiate a cross-check.

Instructors can easily make note of instances where cross-checking is provided, or where confirmation is offered or omitted. For purposes of training, the term "metacognitive" is a poor one to use in an operational setting. The terms (anticipation," "preparation," and "confirmation" are much more descriptive.

During the After-Action Review, the instructor could present the mission observations. The instructor could explain what was noted in terms of time horizon, anticipation, and confirmation, and can use specific instances where these have been noted.

We also found the use of videotapes to be very helpful. The trainees themselves commended on the "awesome" potential of the videotapes. Clearly, it is not efficient to spend 90 minutes reviewing a 90-minute training session. However, the videotaping took little effort, and the videotapes were readily available as soon as the mission was completed. If instructors were shown how to correlate their notes with the videotape counter, they could perform a very effective debriefing by fast forwarding to the training segments they want to review. The tapes can help focus the training on specific examples of crew actions rather than just ratings or frequency counts. Good vs. bad instances can be replayed and discussed. Another use of the videotapes is to present examples of aircrews that were considered good exemplars for flying a particular simulator mission. Other crews can be shown these and can be asked to contrast aspects of their own performance with the exemplar performance.

mental simulation and functional mission segments. During premission planning, crews have the opportunity to build a shared mental model in advance of the mission. Such preparation would support crew coordination at critical points in the mission where there is no time to think through what is happening.

Some crews did a good job of this, but our observation was that a number of crews were failing to visualize the mission adequately. This represents a failure to derive important inferences about features of the mission. This lack of mental rehearsal extracted a toll on the crew's mission performance because in effect it left them ill-prepared to handle difficulties that they may have been able to anticipate with simulation. Thus when they ran into a problem in the actual mission, they had to either ignore the problem or divert attention from other critical tasks to make corrections or adjustments. When we questioned crews about this, they complained that they had much less time to plan than they would in an actual mission. This may be true of peacetime training missions, but it is unclear how much planning time would be available during combat. Moreover, the personnel responsible for preparing the task used planning durations that appeared consistent with operational constraints.

We also received the impression that there was little instruction in how to perform useful mental simulations of a mission, and that instructors were not prepared to critique the planning approach a crew took.

The ideal would be a crew that looked over the mission and the map and tried to imagine how they would fly through each

functional segment of the mission. For example, in handling segments marked by difficult navigation, they would visualize what the terrain would look like, and what terrain features to search for. Segments marked by exposure to enemy air defense could be studied in order to imagine how to use terrain features for masking. The aircrews would perform this type of visualization and would discuss it so that each crewmember knew what to expect during the different functional stages of the mission.

In actuality, the mission was planned around checkpoints that were major geographical features. These features were useful for tracking progress but they did not divide the mission into functional units. Thus, the helicopters crossed the FLOT between two checkpoints. It is essential to turn off the transponder when flying into enemy territory, but many of the crews we observed failed to do this. Their attention was focused on the checkpoints, and the change in mission status (flying over hostile territory) was not a part of their mental model. Similarly, there were no markers for returning to friendly territory, and many crews failed to turn their transponders back on.

Even worse, we saw premission planning sessions where the pilot in command did the route planning, and spent less than three minutes showing the map to the pilot flying.

Therefore, we recommend the use of functional mission segments in rehearsing a mission, to supplement the geographical checkpoints. The mission segments can help draw attention to segments where the time pressure will be great, communication demands will be high,

navigation demands will be severe, concealment will be necessary, and so on. In this way, the unique problems of each segment can be anticipated by the two crewmembers. They could share their identification of problems and strategies.

It should be noted that mental rehearsal can be conducted during the mission itself, and not just during the premission planning phase. There are periods of low workload during missions (e.g., waiting for planned takeoff times), when the crewmembers could be actively preparing for different functions. Because it is not feasible to provide active instruction during the simulated mission, we see the premission planning phase as offering the best opportunity for training in mental rehearsal. During such instruction, crews could be told that they could take advantage of low workload periods during the mission. Once the mission is over, the aircrews could be given feedback about whether they made effective use of slack times.

It is necessary but not sufficient to have crews that look at the mission from a checkpoint to checkpoint perspective. The checkpoint strategy, by itself, tends to collapse too much information into too small a package. It does nothing to help the crewmembers recognize the differing demands that different subsegments of the mission will place on their skills, attention, and needs. To simplify communication, we recommend that the term "mental simulation" be avoided, and replaced by terms that are less technical and more understandable, e.g., "active rehearsal" or "visualization," or "analysis of mission segments."

Commander's intent and improvisation. We did not see much confusion between the two pilots about what was intended, but there was a clear gap in understanding of intent between the aircrew and the Tactical Operations Center (where the mission plan was issued). The aircrews appeared to take an alarmingly uncurious attitude about commander's intent. The mission was described (i.e., drop off the fuel blivets during Leg One, and transfer the infantry to the LZ on Leg Two), and the only additional advice was to "Conduct (the) operation with speed, surprise, and precision." We contend that this advice was fairly useless, and in some ways contradictory since speed, surprise, and precision may represent conflicting goals. For example, the aircrews seemed to have little sense of how to proceed (and how to improvise) during Leg Two when complications arose—should they abort the mission if unable to make the drop during the scheduled one-minute period? If detected, thereby losing surprise, should they press on anyway? If they are not exactly sure of the drop zone, is it more important to make a drop on time or at the precise location, and how much margin of error is acceptable?

An example comes from one particular crew that found itself well off course and being tracked by the enemy. The crew abruptly changed the mission and shifted to the alternate landing zone without requesting permission or even checking with anyone:

The Radar Warning Receiver (RWR) begins to beep slowly, increasing in speed as time goes on indicating that the enemy is tracking the aircraft.

Pilot Flying (PF): [The RWR shows] us heading right towards an ADA site.

Pilot Not Flying (PNF): Just use the hill as a backdrop out the right here.

(beeps continue)

PF: What the heck!?

PNF: Do you see it? There it is over there (points towards missile site).

PNF: Come left, come left.

PF: Uh, we don't want to be here.

PNF: No.

PNF: We're gonna have to go to the alternate LZ.

One reason the plan was improvised to go the alternate landing zone was because the crew recognized how far off course they were (near an ADA site) and that by the time they got to the primary landing zone, they would have missed the one minute window. However, it was not clear from the intent statement that missing the hard-time window provided just cause to abandon the primary landing zone. Clarification of the intent statement may have prepared the crew for a situation such as this and helped them to avoid confusion about which LZ would be the proper one.

It is likely that the aircrews did not request mission-related information

because they didn't conduct a meaningful mental simulation. Had they tried to imagine how the mission could run into difficulties, they might have noticed some of the ambiguities and asked for clarifications in advance.

We contend that aircrews can be trained to notice ambiguity and incompleteness during the premission planning session, and that they will be able to take active steps to understand what constitutes mission success in order to improvise effectively.

These first two training recommendations are linked to preplanning. During the mission stage, the training can focus on time horizon and metacognition.

Secondary training. The goal of secondary training is to teach observers and instructors how to apply these five opportunities. Instructors are often prepared to attend to the content of performance, rather than the team decision processes. Our impression was that instructors typically do not notice or mention team coordination issues. Yet the instructors participating in the ARI study at Ft. Campbell did become sensitive to crew coordination. They were able to learn how to notice aspects of effective and ineffective coordination. Therefore, we feel that instructors can be readily trained to observe critical team coordination behaviors.

There may also be value in training researchers who are attempting to answer questions concerning the adequacy of different cockpit configurations for improving crew coordination. We have presented some compiled and indirect measures in order to illustrate what can be

done to analyze crew coordination data. Careful research seems to depend on getting transcripts of the comments made by the aircrews, and these are expensive and time consuming. We have no shortcuts to offer for improving the process of transcription.

Since it is desired that the training be handled by operational personnel (e.g., instructor pilots) during routine checkrides and simulator sessions, it is necessary to identify ways to pass on these methods to these personnel, that is, training the trainers. This will include helping them learn the data collection techniques (observation methods, note taking, what to be alert for), methods of collapsing the data into meaningful categories and summarizing it (identifying and using the underlying dimensions, etc.), and ways to present what they observed and summarize back to the trainees to optimize their learning potential (videotapes, reference to notes, questioning, and interviewing techniques, etc.).

Once the most important primary training objectives are defined, these secondary training materials can be developed. In initial attempts to present the observational dimensions to ARIARDA personnel, we found that specially prepared videotapes could be useful instructional material. For each dimension of interest, we were able to find positive and negative examples from the crews we have observed. It was relatively straightforward to put together a "highlight film" of these positive and negative instances as contrasting sets to help people learn what each dimension consisted of. This training video was developed for demonstration

purposes only, and if there was a requirement, a more carefully prepared video would be developed.

Review of Cognitive Categories

A number of the dimensions we expected to use turned out to be inappropriate for this domain. From our earlier experiences observing teams in operational settings and from the models we have developed from these experiences (Thordsen, Galushka, Klein, Young, & Brezovic, 1990; Thordsen & Calderwood, 1989; Taynor, Klein & Thordsen, 1987), we expected that crew coordination would be affected by perception, metacognition, motivation, and inference (mental simulation). We were correct about the importance of some of these categories but we failed to observe some categories we expected to find, and we did not anticipate others that turned out to be salient. The specific characteristics of the tactical helicopter mission were different from other domains we had studied, especially with regard to the need for rapid and coordinated action under extreme time pressure. The closest we have seen to this set of conditions is in the domain of commercial aviation—and for malfunctions occurring during takeoff and landing. In the subsections below, we review some of our expectations, and link the five categories of observation described above to the cognitive model of team decision making.

Perception. We did not anticipate that the team's initial perception of its situation would be that critical since both team members would have access to much the same information (directly outside and inside the cockpit). This was not entirely true. The PF often had little knowledge of

navigation data other than what the PNF described. So there were some additional burdens upon the "inside" crewmember regarding how she/he conveyed this information to the person flying. Another problem was that the simulator masked information—the person in the left-hand seat could not see much out of the right-hand window and vice versa.

We failed to anticipate a crucial dimension of a team's perception—time horizon. This refers to how far in advance the crew is functioning with respect to the real-time of the aircraft. For example, if the navigator gives navigational instructions that barely give the PF time to make the proper adjustments, it could be argued that they are operating with a near zero time horizon. While we have always been aware of time horizon as an important function of team performance, we have never seen it as critical as in this domain, because of the extremely low margin of error and the need to keep the PF alert to the next landmark about to come into view, which is a demanding task for the navigator.

The problem of time horizon may be seen as a breakdown in shared situation assessment. We have seen this in our prior research, where one team member may hold information that is needed by others. In this case, navigators had trouble communicating cues that were about to appear, and describing expectancies, and as a result some teams were behind their aircraft.

Metacognition. The primary shortcoming in metacognition that we observed was micromanagement, and we had not anticipated this. The difficulty we had expected was that there would be some

role confusion. In this setting, both crewmembers are pilots and they interchange flying/not-flying roles during the mission. Each time they switch roles or tasks, they must be careful to clearly communicate the transition to each other. The PNF is always responsible for tracking information inside the cockpit, while the PF is not to bring his/her attention inside the cockpit at any time.

An example of the crewmembers not recognizing the transition in roles follows: During one simulated mission, the PNF gave a series of instructions such as, 'go to the north side of the mountain,' 'slow your airspeed back a little,' and 'stop turn here.' After giving these instructions, the PNF finished with 'What's your time?' This statement pulled the PF into the cockpit for a moment to check the clock. In this brief instant, the helicopter flew into the ground. Had the PNF recognized that this request would pull the PF into the cockpit, the resulting crash would have been avoided.

Another area that seemed to be important concerning self-management focused on specific communication techniques that the crews used. This centered largely on whether they provided information to each other in anticipation of needs, whether they confirmed for the other individual real-time information in response to anticipatory remarks or on their own, and whether they double-checked tasks and actions the other crewmember was responsible for. There seemed to be differences in the way crews provided such feedback. In particular, some crews were very good about confirming instructions, whereas others rarely made any confirming comments at

all. This topic is presented in more detail below.

Motivation. The ability of the team members to understand the commander's intent generally impacts a team's coordination. A good and common understanding of the overall mission goals allows a team to press on regardless of whether the original operational plan becomes obsolete. Intent provides the framework for any improvisation in the event things do not go as anticipated. Shared and accurate understanding of intent is especially important in situations where the implementors of the planned actions are geographically distributed. Since the two crewmembers were side-by-side, intent was not a problem inside the cockpit but it was a problem for the aircrew in understanding the mission.

Reasoning. Mental simulation is a form of inference in which a team can learn about the complexities of a task before it is performed. This is normally considered as one sign that a team is functioning effectively. We had anticipated that we would see some types of mental simulation within this domain. However, because of the extreme high time pressure and low margin for error, we observed little of this taking place during the mission itself. It was during the premission planning session that mental simulation and rehearsal seemed most important.

Opportunities for Collecting Observations

In this section, we describe in more detail what we actually looked for and observed during the data collection. This section

describes the different observations and data that can be collected during the four phases of the exercise: the premission planning, the mission, the after-action review, and the post-exercise analysis of videotapes and transcripts.

The premission phase. The first two hours of the session were set aside for premission planning and equipment checks. It is during this stage that the crews have the greatest opportunity to do the actual planning for the mission, to anticipate what might take place including problems they may encounter, and to clarify any confusion or misunderstandings that they may have. From an observational point of view, it is the best time to see what the crews plan to do, whether they mentally rehearse components of the plan's execution to identify weaknesses, whether they use imagery (a form of mental simulation) to envision situations where their instructions would be inadequate to help them make proper decisions (thus the need for additional clarification), and so forth. In other words, it is a good stage to watch how they do their planning, mental simulation and rehearsal, and clarify misunderstandings.

The mission phase. The second two hours of the session involved the crew actually implementing the flight plan that was finalized during the premission planning. During this stage, the crews are totally immersed in their mission execution, specifically flying and navigating. There is no time for intervention and questioning on the part of the observers thus data collection techniques must rely on observation alone. Things that can be observed include mission performance

measures such as whether stages of the mission were completed, whether they were executed within the framework of the commander's intent, how the crews communicated between themselves and the nature of these communications, how much advance information they provided each other, and how well they maintained an understanding of the task the other was doing. The data collection techniques must focus on performance and communication issues. This stage of data collection can be augmented by flagging things during the premission period that deserve special attention during the mission execution.

After-action review phase. The final two hours of the session involved debriefing, questionnaire completion, and 45 minutes of interviewing time. It was during this latter period that the crews and observers could freely speak about specifics of the premission planning and the mission execution. This afforded us the opportunity to show them playbacks of the mission tapes, to question how various things helped or hurt their performance, and to explore with them how well or poorly they shared mental models during certain periods of the mission. This stage provided the greatest opportunity to interact directly with the crewmembers although the information collected was subject to the crews' recall accuracy. Using videotapes of portions of the mission crew can help minimize some of these inaccuracies.

Tables 2, 3, and 4 present many of the specifics we looked for during the mission simulation and are separated according to the stage of the mission during which they were observed. Table 2 addresses mental simulation issues including a commander's

intent, mission segments, and specific tasks; Table 3 presents shared mental model factors such as the communication techniques including anticipatory, confirmatory, and cross-checking remarks; and Table 4 covers metacognition, with a focus on time horizon issues.

Conclusions

In this project, we identified five key training opportunities, or categories, that appear to distinguish effective from ineffective helicopter crews: rehearsal, commander's intent, time horizon, anticipation/confirmation, and micromanagement.

These categories are an integral part of a cognitive model of team decision making. Rather than just listing target behaviors, we have tried to show how we can use a cognitive model of the individual as a metaphor for understanding a team, so that an observer can try to understand the way the team receives and processes information. In an environment as dynamic as military helicopter missions, there is little opportunity for problem solving, and so planning, rehearsal, and reasoning must take place in advance of the mission. An analogy can be drawn to a basketball team, which depends on advance preparation but whose success depends on effective improvisation to meet actual conditions. For the helicopter crews, important aspects of preparation involved rehearsal and understanding the motivation for the mission. Once the mission was begun, the important categories were perceptual (having the team members exchange information to stay ahead of the aircraft) and metacognitive (managing the flow of

Table 2. Mental Simulation

	Premission Planning (PMP)	Mission	Briefing
Commander's Intent	- Do they concentrate at all on interpreting the commander's intent? - Do they concentrate at all on looking for weaknesses or points of confusion in the intent? - Do they clarify the commander's intent at all? - Do they identify critical areas where the plan may fail and see if the intent gives them good enough guidance to improvise?	- Did the mission succeed within the framework of the commander's intent?	- Would clarification of the intent, with respect to critical portions of the mission, have helped?
Mission Segment Profiles	- Do they break the mission into functional segments? - Do they identify the more difficult segments for mental simulation/ rehearsal? - Do they look for areas where the time horizon will be at or near zero? Do they rehearse these types of situations? - Do they look at the plan from the enemy perspective, or at least elements of it? - Do they consider at all how to get found?	- Do they remind each other when transitioning into mission segment with different profile? - Do they miss tasks such as radio calls, switching on/off IFF, etc. that may have been covered if they simulated the mission in advance? - Did critical segments of the mission go well/poorly?	- Use tape to provide good and bad examples. - Contrast critical segment planning with actual execution. - If good/good: examine what about PMP that helped the mission go well. - If bad/bad: Examine what about the PMP that may have helped the mission go well. (mental simulation, etc.). - If good/bad: Probe for why and how it could have been done better. - If bad/good: Probe for how they pulled it off. - General discussion regarding mission segment profiles and use of mental simulation.
Tasks	- Did they mentally simulate/rehearse any key tasks of the mission (e.g., landing, radio calls, etc.)?	- Did they successfully complete rehearsed portions of the mission? - Make notes of other tasks that they did successfully or unsuccessfully complete.	- Discuss how much simulation/rehearsal helped with successful areas. - Discuss whether simulation/rehearsal would have helped with problem areas. - Tape: examples of good/bad.

Table 3. Communications

	Pre-mission Planning (PMP)	Mission	Briefing
Anticipation	- Do they discuss any communications protocols?	- Did the crewmembers provide each other with information in advance of their needs/requests?	- Show tape and discuss how this helped or hurt. - Did they desire more or less? - How could it have been better?
Confirmation	- Do they discuss any communications protocols?	- Did the crewmembers confirm for the other member real-time information, actions, etc. either in response to anticipatory remarks or on their own?	- Show tape and discuss how this helped or hurt. - Did they desire more or less? - How could it have been better?
Cross-Check	- Do they discuss any communications protocols? - Do crewmembers double check tasks/actions the other crewmember is responsible for?	- Do the crewmembers double check tasks/actions the other crewmember is responsible for? - When they cross check, is it done in a way that does not pull the pilot flying into the cockpit?	- Show tape and discuss how this helped or hurt. - Look at how they handled this. - Use examples such as: - Without pulling PF inside. - When pulling PF inside. - Note: verbal versus visual cross checking.

Table 4. Time Horizon

Time Horizon	Premission Planning (PMP)	Mission	Briefing
	- Nothing -	- Is the navigator providing advance information? - Does the PF ask for more (too short a time horizon)? - Does the PF: ask to have it repeated, ask to repeat what is first, forget or confuse the instructions (too long a time horizon)? - Do they adjust the time horizon when dealing with outside ships/agencies?	- Show tapes and discuss how this helped or hurt (good and bad examples). - Show requests for more. - Show requests for less. - If available, show examples of zero or negative time horizons and ask them to calculate how far back the time horizon should have been.

information to reduce ambiguity without creating distraction).

We believe that observers will be able to use these categories during premission and mission activities in order to provide direct feedback for instruction. The five categories are readily observed during preplanning and during missions. The use of videotapes during After-Action Reviews seems especially helpful for training crew coordination.

Furthermore, we have presented strategies for training instructors to evaluate crew coordination processes. The use of specially prepared videotapes to illustrate positive and negative examples of dimensions appears to be very helpful in this regard.

Therefore, it should be possible to develop a program of instruction for crew coordination training. Such instruction can be provided at relatively low expense through the use of existing simulations and training exercises. Instructors can be taught to make note of crew coordination dimensions, and the After-Action Reviews can be expanded to include coverage of these factors. Therefore, current training in simulators and in actual training missions can be modified to provide additional benefits.

The next step is to develop and evaluate an instructional program for crew coordination. For training dimensions that appear to have major benefits, instructors can be shown how to identify and note the target behaviors, and evaluations can be performed to see whether such training results in improved performance. Because there is so little instructions on crew coordination, the opportunity to receive

direct feedback on rehearsal, sharing an understanding of commander's intent, increasing time horizon, providing confirmations, and avoiding micromanagement, would appear to have great impact on shaping up crew coordination skills.

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STRATEGIES OF DECISION MAKING

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This article posits that military decision makers have come to rely too heavily on analytical decision-making processes, contributing to a reduction in the effectiveness of training and decision support systems. The author examines the strengths and weaknesses of competing decision-making processes and offers a "recognitional model" for use in most combat or field situations. His recommendations have impact on training and decision-aid development.

It is time to admit that the theories and ideals of decision making we have held over the past 25 years are inadequate and misleading, having produced unused decision aids, ineffective decision training programs and inappropriate doctrine. The Department of Defense (DoD) often follows the lead of behavioral scientists, so it is important to alert DoD policy makers to new developments in models of decision making.¹

The culprit is an ideal of analytical decision making which asserts that we must always generate options systematically, identify criteria for evaluating these options, assign weights to the evaluation criteria, rate each option on each criterion and tabulate the scores to find the best option. We call this a model of concurrent option comparison, the idea being that the decision maker deliberates about several options concurrently. The technical term is multiattribute utility analysis.

Another analytical ideal is decision analysis, a technique for evaluating an option as in a chess game. The decision maker looks at a branching tree of responses and counter-responses and estimates the probability and utility of each possible future state in order to calculate maximum and minimum outcomes. Both of these methods, multiattribute utility analysis and decision analysis, have been used to build decision training programs and automated decision aids.²

These strategies sound good, but in practice they are often disappointing. They do not work under time pressure because they take too long. Even when there is enough time, they require much work and lack flexibility for handling rapidly changing field conditions.

Imagine this situation (which we actually observed): An Army brigade staff engages in a 5-hour command and control exercise. One requirement is to delay the enemy advance in a specific sector. The operations and training officer (S3) pinpoints a location that seems ideal for planting mines. It is a choke point in a wooded area where the road can be destroyed. A plan develops to crater the road, mine the sides off the road and direct the artillery on the enemy as he either halts or slows his advance to work around the obstacles. During the planning session, there are objections that it is impossible to have forward observers call in the artillery, and that without artillery support to take

advantage of the enemy slowdown, the mines would do no good. Someone suggests using FASCAM (family of scatterable mines), but another person notes that FASCAM will not work in trees, only in open areas. Only after this thorough consideration and subsequent rejection of his initial choice, does the S3 consider an open area also favorable for an artillery attack and select it as the point of the action.

Suppose the planners had tried to list each and every available option, every possible site all over the map, and then evaluate the strengths and weaknesses of each? There was simply not enough time in the session to do this for each possible decision. We counted 27 decisions made during the 5 hours, an average of one every 12 minutes. Even this is misleading, since it does not take into account time taken by interruptions and communications. We estimate that about 20 of the decisions took less than 1 minute, five took less than 5 minutes and perhaps only two were examined for more than 5 minutes. Obviously, there is not enough time for each decision, using analytical concurrent option comparisons. And if we try to approach only a few choices in this way, which ones? It is even more complicated to screen decisions for deliberation. Analytical strategies just will not work in this type of setting.

I am not saying that people should never deliberate about several options. Clearly, there are times to use such analytical strategies. We have watched DoD design engineers wrestle with problems such as how to apply a new technology to an existing task. Here it *did* make sense to carefully list all the options for input devices and displays and to systematically

analyze strengths and weaknesses to get down to a small number of configurations for testing.

The point for this article is that there are different ways to make decisions, analytical ways and recognitional ways, and that we must understand the strengths and limits of both in order to improve military decision making. Too many people say that the ideal is for soldiers to think more systematically, to lay out all their options and to become, in effect, miniature operations researchers. This attitude is even built into military doctrine. For example, US Army Field Manual 101-5, *Staff Organization and Operations*, advises decision makers to go through the steps of multi-attribute utility analysis.³ Such advice may often be unworkable and sometimes may be dangerous. To understand why, we must get a clear idea of what skilled decision makers do.

For the past four years, my colleagues and I have been studying experienced decision makers, faced with real tasks that often have life and death consequences. We have studied tank platoon leaders, battle commanders engaged in operational planning at Fort Leavenworth, Fort Riley, Fort Hood, Fort Stewart and the National Training Center at Fort Irwin. (Prior to that, we observed Air Force and Army battle commanders at *BLUE FLAG*.) We studied urban fireground commanders and wildland fireground commanders (with over 20 years of experience) as they conducted actual operations. We also studied computer programmers, paramedics, maintenance officers and design engineers. Many of the decisions we examined were made under extreme time pressure. In some domains more than 85 per-

cent of the decisions were made in less than 1 minute.

We found that concurrent option comparison hardly ever occurred. That is, experienced decision makers rarely thought about two or more options and tried to figure out which was better. In this article, I will describe the recognitional decision strategies we did find, differentiate between the situations that call for analytical or recognitional strategies and examine some of the implications for military decision making.

Recognitional Decision Making

When we told one commander that we were studying decision making, he replied that he never made any decisions! What he meant was that he never constructed two or more options and then struggled to choose the best one. After interviewing him, we learned that he did handle decisions all the time. After studying over 150 experienced decision makers and 450 decisions, we concluded that his approach to decision making is typical of people with years of experience and we have derived a model of this typical strategy.

Basically, proficient decision makers are able to use their experience to recognize a situation as familiar, which gives them sense of what goals are feasible, what cues are important, what to expect next and what actions are typical in that situation. The ability to recognize the typical action means that experienced decision makers do not have to do any concurrent deliberation about options. They do not, however, just blindly carry out the actions. They first consider whether there are any potential

problems and only if everything seems reasonable, do they go ahead.

A recognitional approach can save time and effort for more important concerns. An experienced brigade commander looked at a map and selected a site for an engagement area (a place to set up artillery and air attacks on an enemy advance). Other sites were then proposed that he had not even bothered to consider, although they seemed plausible to his less-experienced subordinate. He was able to explain why each alternative was defective and seemed surprised that anyone would even think about them. In other words, his skill enabled him to generate only plausible options so that he did not have to bother with computing advantages and disadvantages. He could use all of his experience to judge what was needed for the situation. He could generate a workable first option, so there was no reason for him to generate many more options and then have to perform a painstaking evaluation of them.

We call this a "recognition-primed decision (RPD)." The officer used experience to recognize the key aspects of the situation, enabling a rapid reaction. Once a decision maker identifies the typical action, there is usually a step of imagining what will happen if the action is carried out in *this* situation. If any pitfalls are imagined, then the decision maker will try to modify the action. If that does not work, the officer jettisons it and thinks about the next most typical action.

Notice that the experienced decision makers are not searching for the best option. They only want to find one that works, a strategy called "satisficing." We have found many cases where decision makers

examined several options, one after the other, without ever comparing one to another. Because there is no deliberated option comparison, experienced decision makers may feel that they are relying on something mysterious called "intuition" and they may be mildly defensive about it if they are questioned carefully. One implication of our work is that this is not a mysterious process. It is a recognitional, pattern-matching process that flows from experience. It should not be discounted just because all aspects of it are not open to conscious scrutiny.

Figure 1 shows a schematic drawing of the RPD model. It shows that if the events contradict expectancies, the experienced decision maker may reexamine the way the situation is being understood.

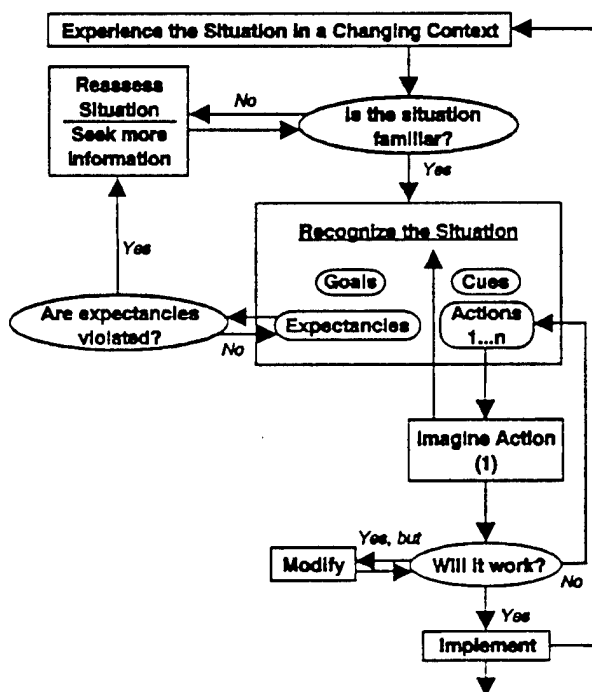


Figure 1. Recognition-Primed Decision (RPD) Model

The basic thrust of the model is that decision makers handle decision points, where there are several options, by recognizing what the situation calls for rather than by calculating the strengths and weaknesses of the different options. The concept of recognitional decision making has been developing only in the last few years.

We have found that even with nonroutine incidents, experienced decision makers handle approximately 50 to 80 percent of decisions using recognitional strategies without any effort to contrast two or more options. If we include all decision points, routine plus nonroutine, the proportion of RPDs goes much higher, more than 90 percent. For novices, however, the rate of RPDs can dip to 40 percent. We have also found that when there is deliberation, experienced decision makers deliberate more than novices about the nature of the situation, whereas novices deliberate more than experts about which response to select. In other words, it is more typical of people with lower levels of experience to focus on careful thinking about the best option.

What about team decision making? Since many decisions are made within a network of coordinating organizations and by several people at each node in the network, we have also examined distributed decision making.

Teams and networks demand more justification and conflict resolution, so we expect to find more examples of concurrent option comparison; that is, contrasting two or more options. However, in our studies, this has not occurred. Earlier I described a 5-hour command and control planning session in which we tabulated 27 decisions.⁴ Only one of these showed any evi-

ence of concurrent option comparison. My earlier example of the operations planning officer choosing a site to disrupt the enemy advance illustrates recognitional decision making by a team. Similarly, our other studies of team decision making found the team behaving much like individuals—generating a plausible option, evaluating it by imagining what could go wrong, trying to "satisfice," trying to improve the option to overcome its limitations and sometimes rejecting or tabling an option to move on in a more promising direction.

How Is the RPD Model Different from Analytical Decision Making?

The RPD model describes how choices can be made without comparing options: by perceiving a situation as typical; perceiving the typical action in that type of situation; and evaluating potential barriers to carrying out the action. This recognitional approach contrasts to analytical decision making in several ways:

- The RPD model concentrates on "satisficing," whereas models of decision analysis and concurrent option comparison have emphasized optimizing (trying to find the *best* option).
- The RPD model asserts that experienced decision makers generate a good option as the first one they consider. However, concurrent option comparison assumes that generating options is a semi-random process, with some coarse screening to ensure that only relevant options are considered.

- The RPD model focuses on situation assessment. In contrast, concurrent option evaluation models have placed more of the emphasis on selecting among options than on recognizing situations.
- Another difference is the evaluation of options. The RPD model assumes that decision makers evaluate typical actions by imagining how they will be carried out in that situation. Such an evaluation lets the decision maker improve the option and also reject it, if necessary. Analytical models present strong methods for evaluating sets of options. These models make it inconvenient for the user to improve options since that would force the evaluation to begin again.
- The RPD model assumes that decision makers will usually have an option available regardless of how tight the time constraints are. Experienced decision makers usually start with a typical option. If time permits, this option will be evaluated; if defective, it will be replaced by the next most typical option. In contrast, analytical models provide no guidance until after options are generated, evaluation criteria and weights established, ratings accomplished and tabulations completed. If a reaction is needed before this process is finished, the decision maker is out of luck.

By contrasting recognitional and analytical decision making, we can see the strengths of each. Recognitional decision making is more important when experienced personnel are working under time pressure on

concrete, contextually dependent tasks in changing environments and have a "satisficing" criterion of selecting the first option that looks like it will work. It comes into play when the unit is an individual or a cohesive team that does not reach deadlocks over conflicts. Recognitional decisions can ensure that the decision maker is poised to act. Its disadvantages are that it is hard to articulate the basis of a decision and it is difficult to reconcile conflicts. Furthermore, it cannot ensure "optimal" courses of action and this is especially important for anticipating the opponent's strategies in preparation for the worst case. Also, it is risky to let inexperienced personnel "shoot from the hip."

Concurrent option comparison has the opposite strengths and weaknesses. It is more helpful for novices who lack an experience base and for seasoned decision makers confronting novel conditions. It is apt to be used when there is ample time for the decision. It comes into play when the data are abstract, preventing decision makers from using concrete experiences. It makes it easy to break down new tasks and complex tasks that recognition cannot handle. It is especially important when there is a need to justify the decision to others, since justification usually requires us to list reasons and indicate their importance. Analytical decision making is more helpful when there is a conflict to be resolved, especially when the conflict involves people with different concerns. It is usually a better strategy to use when one needs an optimal solution. And finally, analytical decision making is needed when the problem involves so much computational complexity that recognitional processes are inadequate. However, its cost is more time and effort, and more of

a disconnect with the experience of the decision maker. Figure 2 presents the conditions that increase a decision maker's tendency to use analytical strategies rather than rely on recognitional decision making.

Factor	Effect on Using Analytical Decisions
Experience Level	Decrease
Time Press	Decrease
Abstract Data	Increase
Justification	Increase
Conflict Resolution	Increase
Optimization	Increase
Computational Complexity	Increase

Figure 2. Factors Affecting the Use of Recognitional and Analytical Decisions

I am not claiming that there is a right way or a wrong way to make decisions. Different conditions call for different strategies. My goal is not to reject analytical decision making, but to make clear what its strengths and weaknesses are so that it can be applied more fruitfully.

For too long we have emphasized one strategy—the analytical one. That is the one required by doctrine. That is the one we have been teaching. That is the one we have been building decision aids to promote.

Problems with Analytical Decision Making

We create problems of *credibility* when we present doctrine about one right way to make decisions—the analytical strategy—

and thereby force officers and soldiers to ignore doctrine in making the vast majority of time-pressured operational decisions during training exercises. It does not take them long to realize that doctrine is irrelevant in this area and to wonder whether it can be trusted in other areas.

We can create problems in *efficiency* when we teach analytical decision techniques to military personnel who will have little or no opportunity to use them. Worse yet, we create problems in *effectiveness* for personnel who try to apply these techniques and fail.

We create problems of *competence* when we build decision aids and decision support systems that assume analytical decision strategies. These systems are likely to reduce inputs to the form of abstract alphanumeric data and to restrict the operator's job to that of assessing probabilities, entering subjective utilities, providing context-free ratings and so forth. This misses the skilled operator's ability to size up situations, to notice incongruities and to think up ways to improve options. In other words, these decision aids can interfere with and frustrate the performance of skilled operators. It is no wonder that field officers reject decision aids requiring them to use lengthy analytical processes when the time available is not adequate.

Human error is often explained in terms of decision bias.⁵ The concept of decision bias is that people are predisposed to make poor decisions because of several inherent tendencies, such as inaccurate use of base rates, overreliance on those data that are more readily available or appear more representative, low ability to take sample size into account and difficulty in

deducing logical conclusions. This argument is often made by scientists who want to convince us that human decision makers (other than themselves) cannot be trusted, and we therefore need these scientists to develop decision aids to keep the rest of us from making grievous errors.

However, the decision bias argument has been recently attacked as unjustified and self-serving.⁶ The evidence that humans are inherently biased decision makers comes from experiments run under artificial laboratory conditions. Furthermore, judgment biases appear to have a very small impact outside laboratory conditions. It is easy to use the benefit of hindsight to label each accident an example of decision bias that can best be controlled by more rigorous analytical procedures. For example, expert testimony was given by some psychologists about the *Vincennes* episode. With the benefit of hindsight, it was clear that something had gone wrong and there was an assumption that human error was to blame. One piece of testimony suggested that the crew was guilty of expectancy bias. They were expecting an F-14 attack and focused on cues that fit that expectation. However, if the error had been in the other direction, an F-14 attack that was missed, then the blame would have been placed on base-rate bias, failure to take base rates and prior expectancies into account. My impression is that with hindsight, every error can be explained as a bias, but this may not be telling us much. I am more in agreement with the testimony showing how the *Vincennes'* control room failed to provide the crew with the cues and information that would have enabled them to take advantage of their expertise. They were prevented from using recognitional decision strategies.

My own impression is that experienced decision makers do an excellent job of coping with time pressure and dynamic conditions. Rather than trying to change the way they think, we should be finding ways to help them. We should be developing techniques for broadening their experience base through training, so they can gain situation assessment more quickly and accurately.

If we can give up our old single-theory analytical perspectives and appreciate the fact that there are a variety of decision strategies, we can improve operational decision making in a number of ways.

One opportunity is to improve strategies for effective team decision making. Staff exercises are too often a charade, where subordinates present options to a commander who then picks the best one. Usually, however, the subordinates know which option they prefer. They present, as other options, ones that had been rejected to round out the field. This procedure can be inefficient because it divorces the situation assessment activities from the response selection step and it gives the subordinates the more demanding job of assessing the situation. It asks the commander to make a choice rather than working with the team to modify and improve options. There may be times when it is more effective to have the commander work with the staff to examine the situation and then turn over to them the job of preparing implementation plans. If alternative viewpoints and criticisms are wanted, they should come during the assessment and initial planning to strengthen the option to be implemented.

A second opportunity is to understand how commanders can present their strategic intent so that subordinates are able to improvise effectively. It is dangerous to have subordinates ignoring direction and carrying out their own plans, but it is also dangerous to have subordinates carrying out plans that no longer make sense. Improvisation arises when there is recognition that the situation has functionally changed. We need to understand how commanders can communicate their situation assessment so that their subordinates can recognize and exploit changed conditions.

A third opportunity is to revise training procedures. Certain specialties need training and analytical decision strategies. But generally, training can be more productive by focusing on situation assessment. Along with teaching principles and rules, we should present actual cases to develop sharper discrimination and improve ability to anticipate the pitfalls of various options. The goal of analytical decision training is to teach procedures that are so abstract and powerful that they will apply to a wide variety of cases. If this had been successful, it would have been quite efficient. However, we have learned that such rules do not exist. Instead, we need to enhance expertise by presenting trainees with a wide variety of situations and outcomes, and letting them improve their recognitional abilities. At the team level, we can be using after-action reviews to present feedback about the *process* of the decision making and not just on the *content* of the options that should have been selected.

A fourth opportunity is to improve decision support systems. We must insist that

ne designers of these systems have appropriate respect for the expertise of proficient operators and ensure that their systems and interfaces do not compromise this expertise.⁷ We must find ways to present operators with displays that will make situation assessment easier and more accurate. We also want displays that will make it easier for operators to assess options in order to discover potential problems. In other words, we want to build decision support systems that enhance recognition as well as analytical decision strategies.

Notes

1. For a fuller view, see G.A. Klein (in press), "Recognition-Primed Decisions," *Advances in Man-Machine Systems Research* ed. W. Rouse, (Greenwich, CT: JAI Press), 5.
2. For the purposes of this article, the term "analytical decision making" will be used to refer to these two methods, and particularly to concurrent option comparison.
3. US Department of the Army Field Manual 101-5, *Staff Organization and Operations* (Washington, DC: US Government Printing Office, May 1984), 5-9 to 5-10.

4. M. Thordsen, J. Galushka, S. Young, G.A. Klein and C.P. Brezovic, *Distributed Decision Making in a Command and Control Planning Environment* (KATR-863(C)-87-08F) (Yellow Springs, OH: Klein Associates Inc., 1987). Prepared under contract MDA903-86-C-0170 for the US Army Research Institute, Alexandria, VA.
5. D. Kahneman and A. Tversky, "Intuitive Predictions: Biases and Corrective Procedures," *TIMS Studies in Management Science*, 12, 1979, 313-27.
6. L.L. Lopes, *The Rhetoric of Irrationality*, paper presented at Colloquium in Mass Communication, Madison, WI, November 1986 (currently under revision). J.J.J. Christensen-Szalanski, "Improving the Practical Utility of Judgment Research," *New Directions in Research of Decision Making*, ed. B. Brehmer, H. Jungerman, P. Lourens and G. Sevón (North Holland: Elsevier, 1986).
7. I have made some suggestions in an earlier paper, see G.A. Klein, "Automated Aids for the Proficient Decision Maker," *IEEE Proceedings*, (1980), 301-4.

Gary A. Klein is the president of Klein Associates Inc., a research and development company that performs work in applied cognitive psychology. Previously, he was a research psychologist with the Air Force Human Resources Laboratory.

SEX, SIGHS AND CONVERSATION

Why Men and Women Can't Communicate

by Deborah Tannen

A man and a woman were seated in a car that had been circling the same area for a half hour. The woman was saying, "Why don't we just ask someone?" The man was saying, not for the first time, "I'm sure it's around here somewhere. I'll just try this street."

Why are so many men reluctant to ask directions? Why aren't women? And why can't women understand why men don't want to ask? The explanation, for this and for countless minor and major frustrations that women and men encounter when they talk to each other, lies in the different ways that they use language—differences that begin with how girls and boys use language as children, growing up in different worlds.

Anthropologists, sociologists and psychologists have found that little girls play in small groups or in pairs; they have a best friend, with whom they spend a lot of time talking. It's the telling of secrets that makes them best friends. They learn to use language to negotiate intimacy; to make connections and feel close to each other.

Boys, on the other hand, tend to play competitive games in larger groups, which are hierarchical. High-status boys give orders,

and low-status boys are pushed around. So boys learn to use language to preserve independence and negotiate their status, trying to hold center stage, challenge and resist challenges, display knowledge and verbal skill.

These divergent assumptions about the purpose of language persist into adulthood, where they lie in wait behind cross-gender conversations, ready to leap out and cause puzzlement or grief. In the case of asking for directions, the same interchange is experienced differently by women and men. From a woman's perspective, you ask for help, you get it, and you get to where you're going. A fleeting connection is made with a stranger, which is fundamentally pleasant. But a man is aware that by admitting ignorance and asking for information, he positions himself one-down to someone else. Far from pleasant, this is humiliating. So, it makes sense for him to preserve his independence and self-esteem at the cost of a little extra travel time.

Deborah Tannen, professor of linguistics at Georgetown University is the author of the recently published book, "You Just Don't Understand: Women and Men in Conversation."

CRM TRAINING IN THE 349TH MILITARY AIRLIFT WING

*MAJ John T. Halliday
LT COL Conrad S. Biegalski
MAJ Anthony Inzana
349th MAW
Travis AFB, CA*

Introduction

MAJ HALLIDAY: Our group is made up of Reservists. We are part-time employees of the Air Force. We are the classic cases of the "citizen soldier." I am a pilot for Air California, my partner, MAJ Tony Inzana, is a pilot for Western Airlines, and LT COL Biegalski is a civilian with the federal government. Our Commander, LT COL Bill Jenkins, is a United Airlines pilot and is here with us. Our group has been working in this area for about two years and running seminars for over a year. My own background includes work for United Airlines Services Corporation on their successful bid for the C-5 Aircrew Training System contract.

We have created our program on our own time, on airline trips, or during evenings at home. We built our program on little or no funding. MAJ Inzana personally financed the printing of our CRM questionnaire. CRM training can be done on a limited budget.

I want to take a moment to describe a C-5 crew. We are faced with a unique physical plant. We have crewmembers scattered all over an airplane that is the size of a B-747. The minimum crew size is seven, but can grow to a maximum of 22. We have a mix of officers and enlisted crewmembers. They talk by headset and interphone,

rather than by simple face-to-face communication.

It seems that everyone has a special name for their CRM program. We have created a new program and selected the title, "Aircrew Resource Management" (ARM) to emphasize the use of the full resources on our aircraft. That is meant to specifically include our loadmasters. The name also emphasizes the concept that *all* crewmembers are responsible for safe completion of the trip. Our loadmasters have been our brightest students to date. We feel they are a classic under-utilized resource. Together, their crew position has been credited with more ARM "saves" than the engineers and pilots.

We have a seminar-based program run by two seminar facilitators that is reinforced by LOFT sessions run by our active-duty counterparts. A complete program would be impossible without their help. We are selecting our seminar facilitators very carefully. Not everyone has the skills needed to serve in this capacity.

We have planned for three phases in the program and are 75% complete through Phase I. The Phase I seminar is made up of a typical ten-member C-5 crew—three pilots, three flight engineers, and four loadmasters. It is a nine-hour training day with no breaks. Fatigue is part of the course design. It is designed around group

interaction and team drills as opposed to a workbook approach. It is also time-intensive. Most of the exercises have a time limit.

We emphasize three main learning objectives: 1) synergy, the concept; 2) the synergy graph—a common language (much of this based upon the work of Dr. Bob Helmreich); 3) the synergy formula—the heart of our program. These three concepts are quickly backed up by case studies and practical exercises to use these new tools to analyze crew behavior and to practice the new ARM skills. The goal of the seminar is to give crews something *practical* to take to the airplane, and this practical information is what the synergy formula is about. We have achieved this, and feel strongly that the seminar *presentation* of the *learning objectives* and *ARM tools and packaging* are critical. They must be something the student is comfortable with. These points are as critical as the ARM concepts themselves. For example, we have judiciously inserted conflict into several seminar segments. Carefully managed, conflict is the energy that electrifies the seminar, the role-plays, and the *learning* experience.

We feel that we have several strengths in ARM training and we have some new concepts under development. Our first strength is the synergy formula. It is the centerpiece of our program and is simple. Another strength is our use of videotape and replay of role-plays. This offers a change to practice and evaluate the groups' use of new ARM skills. We are forcing LOFT learning objectives identified by our own observations and NASA research down into videotaped role-play. Our objective is to download the LOFT

sessions and to provide better personal feedback. This approach has been very successful and opens up the question of the level of required fidelity (of training devices) to train CRM. We are the guys with bathroom plunger that Dr. Helmreich talked about. I'm glad you laughed, our students do too. It is simple, and it's funny, and it *works*. The plunger trains captains to let the copilot fly while he/she manages. The videotape role-play also offers subordinate crewmembers their first opportunity to observe and analyze the decision-making process.

Another strength is a new team model that we have under development. We also include something we call "Intruder Training"—the insertion of a new crewmember into an already formed group. Finally, among other things, we are working on a new role-play design and post-mission critique model.

We have several long-term goals. Among others, they are: 1) to seek to induce our crews who fail in CRM to analyze and critique their own work; 2) to incorporate three ARM phases with subsequent phases adding new concepts and reinforcing Phase I skills; 3) to continue basic ARM research with Dr. Bob Helmreich, including research on an active-duty Air Force unit that has not been exposed to any CRM training.

ARM is pervasive in our organization. As examples: 1) ARM is the number one long-term goal of our Commander; 2) we have reorganized our entire unit to promote ARM goals; 3) we will soon be using an ARM attitude inventory to *select-in* the right "new hires;" 4) we have created an ARM staff that reports directly to the

Commander; 5) we are using ARM for remediation; 6) our examiners are using Phase I ARM in their corrective action recommendations when they observe poor teamwork; 7) we are creating an ARM critique guide for our check airmen to use on line missions; 8) we will soon be putting loadmasters into LOFT sessions to promote full teamwork; 9) we have created and are using pilot-coordinated, yet flight engineer-initiated, simulated inflight emergencies for our local training flights, and this really draws the crews together.

Everyone wants to know if CRM works. We feel we are up to about 12 "saves" as the result of our program. As a graphic example, one of our ARM-trained crews recently prevented a repeat of the tragic loss of a 100 million dollar C-5 at Clinton-Sherman Municipal in 1974. Only the copilot, LT COL Jenkins, and the engineer were ARM trained on this recent "save." The brakes had been "capped off" improperly prior to departure by maintenance. Subsequently, the wheel locked during taxi-out. This created a white-hot brake that would have been retracted after take-off. A serious fire would have ensued. The ARM-trained copilot and engineer voiced their concerns during taxi to the Captain, who was concerned with an on-time take-off. Their concerns about a locked wheel were initially rebuffed by the Captain. They *persisted*, however, and the Captain stopped to investigate. The "scanner" reported that the brake was "white hot," and the crew and passengers completed a safe emergency evacuation.

Ladies and Gentlemen, we need your help at this workshop. We could use help in developing: 1) a post-mission self-critique model; 2) CRM instructor training; and 3) video support—aircraft crashes, "saves,"...

One final point—any CRM program is going nowhere without the *open, vocal, visible, support of your organization's leadership*. Our own program has flourished under the leadership of LT COL Jenkins.

I have the pleasure of introducing LT COL "Ski" Biegalski to you. Ski is a civilian Air Reserve Technician in the Civil Service and is a C-5 check airman. He is the Chief of Flight Standards for our Reserve Wing. Ski has worked our program from the start and is the Wing ARM Program Manager. Ladies and Gentlemen, my partner and good friend, "Ski" Biegalski.

The Synergy Formula

LT COL BIEGALSKI: I would like to digress, momentarily, from the topic of Cockpit Resource Management or Aircrew Resource Management, and take you back to a time when you owned your first automobile. You were younger then, and your income was substantially lower than it is now. Let's say that your automobile engine had gone kaput. The entire engine is shot, and you don't have the funds to rebuild it. So, what to do? Since you can't afford to pay for someone else to do the job, you'll have to do it yourself, but you don't know how. You have to learn.

A logical move would be to go to your local junior college or vocational school and enroll in a course of instruction on automotive engine theory. Now, though it's true that you need to know about engine theory before you attempt to do the work, after you finish the course and understand how engines work, you still can't rebuild one. So, what's the next step?

You enroll in the next logical course—one specifically dedicated to engine-rebuilding. You finish and finally understand exactly how to rebuild your dead engine, but you are still unable to tear it apart and rebuild it. Why? Because you have no tools and no training in how to use them. So, you finally buy the correct tools and receive appropriate training in their use. And now, you finally have a new *ability* or *skill*, and are finally ready to get out in the driveway, to tear an engine entirely apart, and to rebuild it.

Now, let me return to the subject of this workshop, CRM. The Synergy Formula is our inflight tool, if you will, for problem-solving and decision making in the cockpit. It enables graduates of our seminar to act/ behave better inflight so that the solution they reach will be the result of coordinated group effort instead of the decision of only one person, working from potentially incomplete information.

In our Phase I seminar, we have anywhere from three to four hours of lead-in discussion before we get to the Synergy Formula itself. The formula is the heart of Phase I training. The formal goals of Phase I are twofold: 1) to understand and internalize the formula, and 2) to use it inflight for problem-solving and decision making.

When does it apply? Whenever group or team-coordinated action is required by the situation. It is my belief that although many problems can be successfully solved by one person, the penalty for incorrect decision making in an aviation environment is so severe that group problem-solving is almost always the safest solution. A corollary to this theory is that some situations specifically require group

problem solving, in that each person has only a piece of the puzzle and a synergistic solution is required. Without it, unilateral decision making will almost surely lead to an incomplete and potentially disastrous solution.

Lead-in topics to the formula include motivational information, a discussion of barriers to communication, training in communication skills, and a discussion of behavioral characteristics of individuals in a group problem-solving environment (among other things). This is, in effect, training in a new language which will ultimately enable students to understand, internalize, and apply the Synergy Formula. A side benefit of learning the lead-in material is that students increase their understanding of interactive relationships and increase their communicative skills. It is important to re-emphasize, at this juncture, that our training is quite tool- or skill-oriented. The reason for this is that we are striving to maximize effect in the short time available for training. It is our desire that each crewmember literally visualize the formula inflight, as if it were placarded on the instrument panel. Why? Because it is easier to visualize a simple graphic display than it is to remember, consider, and use a list of items.

In our seminar, after teaching and discussing the formula, and prior to initiating role-playing (our method of forcing the internalization process), we hand out three-by-five cards with the formula written on them. We watch as the students actively refer to these cards during role-plays. Final indication that the information is considered valuable is that the students refuse to return the cards. We have little difficulty in recovering any of the other

se materials, but the three-by-five cards of the Synergy Formula do not come back—the students take them home.

Figure 1 portrays the Synergy Formula. As you can see, the information it contains is not new, although it may be arranged in a somewhat different fashion than you've seen before. There is no real magic about the process of problem-solving and decision making. Psychology books have contained information on the topic for years. What is new, of course, is the display.

"Q" stands for questioning, seeking, and searching for information, data, and ideas. While this task is not solely the task of the captain or aircraft commander, it is a task which tends to fall primarily on his shoulders. The captain is the person who will ultimately make the decision, and it is quite obviously to his advantage to acquire as much information as possible before making a decision. It must be remembered, however, that not all captains are strong leaders, nor will all captains question effectively. All crewmembers have the responsibility for seeing to it that every part of the formula is used.

The Synergy Formula (expanded)

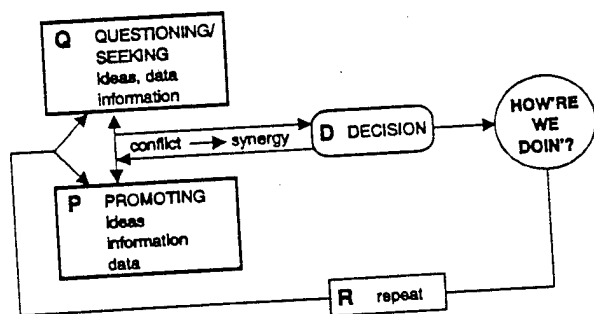


Figure 1

"P" stands for *promoting*, or advocating the information, data, ideas, needs, requirements, etc., which each member of the crew possesses. Think of this as "placing information on the table" so that the captain can inspect it all at once. An uninformed, or partly-informed, captain can hardly be expected to make an appropriate decision. Crucial to the act of promoting, is the delicate art of polite, but aggressive communications. To initiate communication with a confrontational statement tends to destroy the chances of accurate reception. Excessively timid communication, likewise has little chance of success.

Once all the information is "out on the table" (remembering of course, that this metaphorical table is in the mind of the captain/aircraft commander), some of it will tend to be in conflict. Needs and requirements of different sections of the airplane may be dichotomous (we've lost cabin pressure, we have to fly at a higher altitude to make destination, but the passenger with the bad heart will die if we can't keep cabin altitude below 10,000 ft.). Ideas or concepts may be in conflict (so what if the fuel flow gauges are inoperative at both pilot and flight engineer stations. . . we can't safely monitor the engines during takeoff without at least one set of fuel gauges). It is right here that the synergy is developed. In the act of working out the conflict through a "purification and refinement" of data, the pilot-in-command is able to make a "synergistic decision," one based on more data than was previously available to any single individual on the airplane.

"D" is the decision. Decisions are made by the pilot-in-command. Command authority is statutorily and by regulation assigned to the captain. Command authority may

only be removed by removing the pilot-in-command. This is possible in both its physical and figurative sense. Removal from command inflight, however, is a maneuver fraught with danger. Under almost all circumstances, it is the duty of all crewmembers to preserve the authority of command. A flightcrew is not a democratic organization, nor should it be. It is, further, a survivable entity only so long as all decision-making is funneled through the pilot-in-command.

The next step, shown on this slide as "how're we doin?" was one of our biggest stumbling blocks. Getting our guys to *remember* to do an immediate and ongoing inflight review, an assessment of how actions solved (or failed to solve) problems was one of our biggest problems as course-ware developers. How did we solve this problem? I need to digress again.

You may have heard of the old airline joke about the company that decided to standardize the names of the cockpit crew positions. To make a long story short, they were trying to avoid the use of first names (Larry, Frank, and John sounded a bit unprofessional, while John, John, and John was downright dangerous). They considered captain, first officer, and second officer, but found this too cumbersome. The management finally settled on the names, "Captain Sir" (for the captain), "Bubba" (for the copilot), and "Hey-Boy" (for the flight engineer). Well, to get back to the Synergy Formula, in our unit we decided not to have any "Hey-Boys." Our airplane flies with the captain in command, and everyone else on the crew gets to be a "Bubba"—captain's little helper. We started calling our immediate inflight

review, shown on the slide as "how's it going?" as "Bubba's review," so named because any "Bubba" can call for the review if the captain forgets. All he has to do is wait for that lull in the activity that indicates that the immediate pressure is off and ask for a "Bubba review."

The contents of a "Bubba review" are simple. If the captain has forgotten to inform the crew of his decision, "Bubba" asks, "sir, please announce your decision." The captain must always make his decision clearly known to the flight crew if he expects to get the right actions in response. Once the decision has been announced, or clarified, the captain asks for a report from all involved crewmembers. He needs to find out how things are going and if he still has problems which need attention. If the optimum solution to all problems has not been achieved, he closes the loop by reinitiating the Synergy Formula. Repeat this process as many times as necessary.

Why did we insist on using such a dumb name as "Bubba's review?" The answer is simple, the name is so excruciatingly corny that I mentally cringe when I say it, but by the same token, I'll never forget it either. That, of course, is the whole point. *Nobody* can forget it once they've heard it and used it during role-plays. The most important point to be made is that trained crewmembers also remember the "Bubba review" in the cockpit.

Finally, I'll return to the placard theory. This is what we want visualized in the cockpit. If I had control over the airplanes our crews fly, I'd literally placard each panel at each crew station. For the present, we must rely on visualization. That's why it is so important to display and train vital

skills in as simplistic and graphic a manner as possible. Most people, particularly crewmembers, resist the use of a memorized list, but can remember a diagram.

The Synergy Formula (placard format)

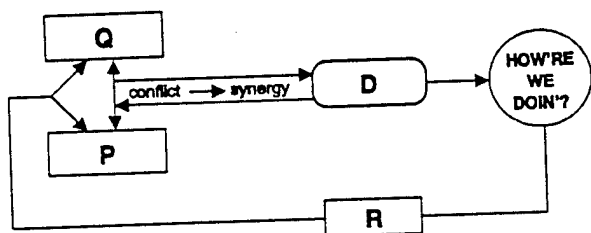


Figure 2

Finally, after you've seen an overview of Phase I training, and discussion of the Synergy Formula, the question still remains, does this type of training actually work? Our belief is that it does. Some of our research tells us a very encouraging story about the effectiveness of the training. To present that information to you, I'll introduce MAJ Tony Inzana, the third member of the ACM Development Team. He is a pilot in the 312th MAS and a pilot for Western Airlines. He is also one of our primary seminar leaders.

MAJ INZANA: One of the tasks of this workshop is to help answer the question, "Is cockpit or aircrew resource management training effective?" Do we know? If not, how do we find out? I wish it were as simple as asking for, "the envelop, please?" However, with help and sincere thanks to Drs. Fouschee, Kanki, Helmreich, and Wilhelm, who have flown with us, attended seminars with us, and provided an invaluable sounding-board for us, we can

shed some light on this question. We can show that a seminar-based aircrew resource management program when carefully crafted and supported by videotaped role-play, can change attitudes positively on the flight deck.

The findings help to verify our approach to the training, and the information obtained allows the administrator to tailor his presentation to meet the needs and unique requirements of our student population. It gives him the ability to design the program for the people, as opposed to trying to fit the people into the program.

We surveyed over 250 crewmembers in an effort to: 1) establish the first database applicable to military air crews on the effectiveness of aircrew resource management training; and 2) to improve our implementation of that program. We enjoyed a 90% response rate to our survey. The results indicate that the students developed a highly receptive and improving attitude toward the seminar format in the areas that we selected for emphasis. However, student receptivity does not necessarily validate a concept of training or courseware content. Just because a student is in favor of a course, or its format or mode of presentation, does not necessarily mean that it is effective as an educational or learning process. But, the survey, which gathered personality and attitudinal data from our pilots prior to undergoing formal resource management training, suggests that some positive change is occurring.

To those who had such training, we asked questions with respect to their own opinions of the value of the training they had experienced. For those who had not had such training, we asked questions in two

key areas. First, we wanted to know if they had heard of CRM training either in the military or civilian world. Approximately 90% of those who had not had such training were aware of it. Eighty percent of crewmembers who had not had CRM training felt that it would be of benefit to them personally. Seventy-five percent of our respondents had flown with someone who had undergone CRM training and felt that those individuals demonstrated recognizable behavioral changes.

Finally, we asked if crew coordination had been improved as a result of aircrew resource management training, and 80% of those untrained individuals felt they had observed better coordination and flight-deck atmosphere from those crewmembers who had undergone training. We feel these results are fascinating and suggest that improvement is underway as a result of this type of training. For example, in a videotaped role play in a recent seminar, a crusty 20+ year pilot was faced with three bad choices. He was unable to solve his in-flight dilemma himself, and you should have seen the impact on the pilot's face (on video replay) when the solution was provided by the junior loadmaster (physically removed from the flight deck by 100 feet). The visual relief that slowly surface on the screen for all who were present was unquestionably real and was seen by all who were present.

Ladies and gentlemen, resource management training works. Thank you.

Discussion

CAPT. CARROLL: If I understood correctly, you made a reference to a failed crewmember in this particular program being brought back or given additional exposure. Was my understanding correct? And, if so, I'd be very interested in knowing how you recognized the deficiency, how you brought it to their attention, and what action was taken.

MAJ HALLIDAY: This individual's problem was seen on an annual flight evaluation. He does have a problem, a known problem in the area of aircrew resource management. We think that we now have the tools to pick that up. He failed his flight evaluation not for lack of technical skills, but for inadequate resource management skills. He had already been a Phase I resource management graduate, but I guess it did not take. He was one of our worst students. We since re-entered him into our program in an effort to help him, but I think that it was an experiment that so far has had only limited results. I think he is a case of the problem crewmember that was raised yesterday, and that we perhaps need a far more powerful vehicle than a seminar to solve such a person's personal problems. Does that answer your question?

CAPT. CARROLL: Yes, but may I take it a little bit further? Because, I am going to be chairing a group that is going to be asking about how you can assess the effectiveness of training and so on. So I think this input is going to help us. Was there an assessment or a recognition at the time

of this individual's problem that the rest of the crew had made an effort to help or support or obviate his concerns or problems? In the past, the question has been raised in the civilian environment: Can a whole crew fail a proficiency check when perhaps it's the primary problem of one individual's technical competence? I would like to extend this now into the area of resource management. Was the crew effective in trying to work with that individual?

LT COL BIEGALSKI: Ed, I share your concerns on this topic. To address that question the best I can say is there are no real guidelines to follow in this area that we have been able to find. We had a presentation on retraining the recalcitrant crewmember yesterday, and I spoke to that presenter, but was unable to get much more of a resolution to the problem than we already had. What we are attempting to do is not only deal with individual crewmembers who fail a checkride for resource management reasons, but we are also looking at flight crews who will come back periodically and report anecdotally

that such and such happened, and they could have done a better job. Or maybe they thought they did a good job, but we feel that they could have done a better job. What we attempt to do is to reform the crew, discuss the whole thing, rehash the situation in resource management terms and analyze it—hoping for a degree of success. We hope this success will be realized in terms of individuals' recognition of failures and their dedicated intent to try to go out and do better. We have had limited success. I will use myself as an example. I am particularly hard-sell on that. I have a tendency to think with a single-seat mentality. It is a constant battle on my part to overcome that. I am not alone in this battle. Pilots have a tendency to be individuals. In an attempt to get other crewmembers to be more promoting and sharing of information and to be more receptive, we find that they sometimes say, "Golly, you're right, I screwed up—I'm going to do better next time." That doesn't mean that they will, but we have at least successfully provided recognition and motivation to improve.

CRM TRAINING FOR FAR PARTS 91 AND 135 OPERATORS

*Douglas Schwartz
Flight Safety International, Inc.*

Introduction

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

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

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

each simulator represents the state-of-the-art at the time of manufacture.

Levels of equipment include Phase II, Phase I, visual, non-visual, and training devices.

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

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

co-pilots, second officers, or any other crewmembers.

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

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

An analysis of the Safety Window yields the following observations:

- The window represents only 7 percent of total flight time (based on an average stage length of 75 minutes).
- More than 80 percent of accidents and incidents involving professional pilots occur in the window.

- Most of these events are generic. That is they are accidents that have as a root cause some sort of crew management error rather than a mechanical failure.
- Crew workload intensity peaks within the window.

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

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

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

It is important to note that situational awareness has a very direct relationship to safety. It is a simple one. The more a pilot knows about what is going on around him, the safer he will be, and the less he knows about what goes on around him, the less safe he will be.

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

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

Essential Elements of Situational Awareness

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

Experience and Training

We describe experience as a mental file or experience file that every pilot uses to assess conditions and make decisions throughout the progress of a flight. Study of human performance indicates that when an individual is put under a great deal of pressure, the tendency is for that individual to revert to a previously established pattern of behavior. Therefore, if

you can instill within an individual's experience file the desired response to stimuli, there is more likelihood of a safe and desirable outcome.

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

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

Physical Flying Skills

Physical flying skills contribute to situational awareness. The role of the pilot is changing from that of a control manipulator to that of an information processor. However, it must be remembered that

pilots still have to fly airplanes. Control skills are essential and contribute to situational awareness.

Spatial Orientation

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

Cockpit Management Skills

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

Health and Attitude

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

Dynamics of Situational Awareness

With this overview of what situational awareness is in place, it is worthwhile to examine its dynamics. The heart of this is a model of individual versus group situa-

tional awareness. A captain and a copilot can each have their own view of what is happening, each with his or her level of situational awareness. However, the key to safety lies within the cumulative effect of what these pilots know—that is, the group's level of situational awareness. Contrary to what one might expect, group situational awareness does not appear to be the sum total of the levels of situational awareness of the crewmembers. Instead, group situational awareness is limited to the level of situational awareness of the pilot-in-command.

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

The captain and copilot each have a sense of the situation—that is, a level of situational awareness. For the sake of this illustration, let us assume that the captain does not know the mountain is dead-ahead. By the equation relating safety and situational awareness, the captain has low situational awareness. He is not safe.

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

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

high situational awareness, the crew is unsafe.

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

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

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

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

So far, this paper has examined situational awareness from several perspectives. The concept has been defined. The definition

was expanded upon by identifying the five elements that contribute to situational awareness. Finally, the dynamics of situational awareness are described in the model of individual versus group situational awareness. The next step in this process is to put the idea of situational awareness into a practical format that a pilot can use.

The Error Chain

The dynamics of situational awareness are embraced by the concept of the "error chain." It is rarely the case that accidents result from one clearly defined catastrophic error. Instead, accidents tend to result from a series of errors or events. This so-called chain-of-events is called an error-chain. The cliché that "no chain is any stronger than its weakest link" might hold here. That is, if a pilot or a crew could be taught to break one or more of the links in an error-chain, then in theory, the accident might not happen. This may appear to be too simplistic, however, after applying the concept to selected accidents, there is reason to believe that it works. In fact, by breaking only one of the links in an error-chain, it is possible to stop the progress of a flight towards an accident.

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

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

2. **Fixation or Preoccupation:** when attention of the crew is focused on one item, event or condition to the exclusion of all other activity in the cockpit.
3. **Empty Feeling or Confusion:** when a pilot or crew is unsure of the state of the aircraft or its condition.
4. **Violating Minimums:** when minimums are intentionally violated or consideration is given to doing so.
5. **Undocumented Procedures:** when consideration is given to using an undocumented procedure or when an undocumented procedure is, in fact, used.
6. **Nobody Flying the Aircraft.**
7. **Nobody Looking Out the Window.**
8. **Failure to Meet Targets:** when parameters or expectations of events are not met.
9. **Unresolved Discrepancies:** when confusion, questions, or statements of concern are not resolved.
10. **Departure from Standard Operating Procedure:** when standard operating procedure fails to be used at the appropriate time.

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

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

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

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

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

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

Cockpit Management Training Elements

The cockpit management courseware used by Flight Safety addresses ten specific skill areas. Before reviewing them, it is first necessary to provide a reference point by establishing a definition of cockpit man-

agement. We define it as "the use and coordination of all resources available to the crew to achieve the established goal of safety, efficiency, and comfort of flight." The skills used to help achieve this goal are:

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

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

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

The third is crew self-critique. This involves the use of video cameras to record simulator sessions for use in debriefing.

Our application is to permit crews to view portions of their own performance and to critique themselves. The learning potential is extraordinary.

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

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

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

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

We have chosen to include CRM training in four sections. One section of material will be taught at each subsequent training

interval. The purpose of this sectional approach is to introduce this new material in a fashion that will allow it to be absorbed into a pilot's experience file, ready to be used effectively, when needed.

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