

CAP 720

Flight Crew Training: Cockpit Resource Management (CRM) and Line-Oriented Flight Training (LOFT)

(previously ICAO Digest No. 2)

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Important Note

This document was previously published by ICAO in 1989 as Circular number 217-AN/132. Human Factors Digest No. 2 "Flight Crew Training: Cockpit Resource Management (CRM) and Line-Oriented Flight Training (LOFT)". The agreement of ICAO to enable this flight safety information to be made available in this format, is gratefully acknowledged. The document can be found at www.caa.co.uk.

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ISBN 0 86039 881 1

First edition 1 August 2002

Originally published as Digest No. 2, 1989

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The latest version of this document is available in electronic format at www.caa.co.uk, where you may also register for e-mail notification of amendments.

Printed copies and amendment services are available from: Documedia Solutions Ltd., 37 Windsor Street, Cheltenham, Glos., GL52 2DG.

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CAA Foreword

This document was originally produced in 1989 and has been reprinted as per the original, with no updates.

Readers should be aware that CRM (now referred to as Crew Resource Management) has developed since 1989, therefore some of the information in this document may be a little out of date. However the majority of the fundamental principles behind CRM still remain unchanged.

ICAO Foreword

- 1.1 Flight safety is one of the major objectives of the International Civil Aviation Organization. Considerable progress has been made but additional improvements are needed and can be achieved. It has long been known that some three out of four accidents result from less than optimum human performance and this indicates that any advance in this field will have a significant impact on the improvement of flight safety.
- 1.2 This was recognized by the ICAO Assembly which adopted in 1986 Resolution A26-9 on Flight Safety and Human Factors. As a follow-up to the Assembly Resolution, the Air Navigation Commission formulated the following objective for the task:
- "To improve safety in aviation by making States more aware and responsive to the importance of human factors in civil aviation operations through the provision of practical human factors material and measures developed on the basis of experience in States."
- 1.3 One of the methods chosen to implement Assembly Resolution A26-9 is the publication of a series of Digests which will address various aspects of Human Factors technology and their impact on flight safety. Digest No. 1 (published as CAP 719) concerns fundamental Human Factors concepts and provides an overview of the various components which constitute the technology of Human Factors; it is intended primarily for use by States, to increase their awareness of the influence of Human Factors in flight safety and assist them in determining general solutions to Human Factors problems; it can also be used as supporting material for educational programmes on Human Factors conducted by States, aircraft operators, etc.
- 1.4 This Digest is concerned principally with Cockpit Resource Management (CRM); however, since the preferred training vehicle for CRM training is a line-oriented flight training (LOFT) scenario, a description of LOFT is also included.
- 1.5 Other planned Digests have the following working titles:
- Digest No. 3: *Training of Operational Personnel in Human Performance and Limitations*
- Digest No. 4: *The Use of Human Factors in Personnel Selection*
- Digest No. 5: *Ergonomics and Automation*
- 1.6 The ICAO Secretariat will endeavour to assist States with requests for additional information on the documentation available from various sources, on research undertaken by other States, and on the assistance which can be provided by institutions or individuals.
- 1.7 This Digest does not provide all the answers to the question of CRM training. Certainly it would not be possible for a State or an operator to introduce CRM only on the basis of the information presented. However, it is hoped that this Digest will demonstrate the advantages of CRM training as perceived by those who use it.
- 1.8 Many of the insights in this digest have been gleaned from the extensive Human Factors research carried out at the National Aeronautics and Space Administration (NASA) Ames Research Centre in the United States. Information from various airlines as well as from IATA and IFALPA has also been used.
- 1.9 This digest was produced with the assistance of the ICAO Flight Safety and Human Factors (HF) Study Group.

Chapter 1 Human Factors Highlights

1 General

This chapter provides highlights on a limited number of Human Factors considerations, and is intended essentially for those readers who do not have available Digest No. 1: *Fundamental Human Factors Concepts*, which ideally should be read before this digest.

2 Overview

Human Factors is about people: it is about people in their working and living environments, and it is about their relationship with machines, equipment and procedures. Just as important, it is about their relationship with other people. It involves the over-all performance of human beings within the aviation system. Human Factors seeks to optimize the performance of people by the systematic application of the human sciences, often integrated within the framework of system engineering. Its twin objectives can be seen as safety and efficiency.

3 Disciplines and Applications

- 3.1 Human Factors is essentially a multidisciplinary field. The disciplines include, but are not limited to: engineering, psychology, physiology, medicine, sociology and anthropometry (see Figure 1). Indeed, it is the multidisciplinary nature of the field, and the overlapping of its constituent disciplines, that makes a comprehensive definition difficult.
- 3.2 Human Factors has come to be concerned with diverse elements in the aviation system. These include human behaviour and performance; decision-making and other cognitive processes; the design of controls and displays; flight deck and cabin layout; communication and software aspects of computers; maps, charts and documentation; as well as the refinement of staff selection and training. Each of these aspects demands skilled and effective human performance.
- 3.3 Given the contemporary emphasis upon the social sciences within Human Factors, it should be remembered that medicine and physiology are among the many other important sources of Human Factors knowledge. Thus, for example, anthropometry and biomechanics - involving measurements and movements of the human body - are relevant to the design of the workplace and to the equipment therein; similarly, biology and its subdiscipline, chronobiology, are necessary for an understanding of those bodily rhythms which influence human performance.
- 3.4 In spite of the academic sources of information on the various Human Factors disciplines, aviation Human Factors is primarily oriented towards solving practical problems in the real world. As a concept, its relationship with the human sciences might well be likened to that between engineering and the physical sciences. And just as technology links the physical sciences to various engineering applications, there are also a growing number of integrated Human Factors techniques or methods; these varied and developing techniques can be applied to problems as diverse as accident investigation and the optimization of pilot training.

4 Accidents and Incidents

- 4.1 Human error is, by far, the most pervasive cause of accidents and incidents in technologically complex systems such as air transportation. One major data base of world-wide jet transport accidents indicates that 65 per cent of all such accidents have been attributed to flight crew error. It also indicates that for the approach and landing phase of flight, which accounts for 4 per cent of total flight exposure time and 49 per cent of all accidents, flight crew error is cited in 80 per cent as a causal factor.
- 4.2 Other sources of human error, including maintenance, dispatch, and, importantly, air traffic control, account for another significant proportion of such accidents. Such studies indicate that between 80 and 90 per cent of all aviation accidents are attributable to human error in one form or another.
- 4.3 In the tragic terms of loss of human life, these accidents have been responsible for many deaths. It must also be kept in mind that commercial jet transport accidents are only the tip of the iceberg; general aviation alone in one major aviation State suffers nearly 3000 accidents and 1000 fatalities each year. Studies have shown that human performance is involved as a cause in nearly 90 per cent of these accidents. It is abundantly clear from such data that human performance is the critical and enduring issue facing those who have responsibility for the design, operation and supervision of our aviation system. The development of solutions to these long-standing and perplexing Human Factors problems is therefore essential.

5 Human Error

- 5.1 It is most important that all concerned with the operation and administration of the aviation system recognize the inevitability of human error. No person, whether designer, engineer, manager, controller or pilot, can perform perfectly at all times. Also, what could be considered perfect performance in one set of circumstances might well be unacceptable in another. Thus, people need to be seen as they really are; to wish that they be intrinsically "better" or "different" is futile, unless such a wish is backed by a recommendation for remedial action. Such a recommendation can be further supplemented by the provision of means to achieve better design, training, education, experience, motivation, etc., with the objective of positively influencing relevant aspects of human performance.
- 5.2 It is therefore intended that the ICAO Human Factors Digests will become a source of both information and practical measures to be used in the effort to improve education, training and remedial measures in Human Factors.

Table 1 Disciplines frequently involved in Human Factors activities¹

Discipline	Definition	Specific area of interest	Typical area of application
Psychology	The science of mind and behaviour.	Sensory characteristics, perceptual laws, learning principles, information processing, motivation, emotion, research methods, psychomotor skills, human errors.	Display requirements and design, control systems design, allocation of function, training system requirements and methods, selection methods, effects of emotional and environmental stress on performance, simulation requirements.
Engineering	Applying the properties of matter and the sources of energy in nature to the uses of man.	Hydraulics, mechanical, structural, electrical, electronic, and aerodynamics design, systems analysis, simulation, optics.	Design of displays, design of controls, design of control systems, design of complex systems, design of optical systems, simulator design.
Human physiology	Deals with the processes, activities and phenomena characteristic of living matter, particularly appropriate to healthy or normal functioning.	Cell structure and chemistry, organ structure and chemistry, interaction of the various body constituents to promote health and function, functions and requirements of body systems.	Environmental systems, diet and nutrition, effects of environmental factors (heat, cold, hypoxia), establishment of environmental requirements.
Medicine	The science and art of preventing, alleviating or curing disease and injuries.	Effects of various forces, radiation, chemical and disease agents; appropriate preventive methods of protecting health and well-being.	Toxicology of smoke, chemicals, impact protection, maintenance of health.
Sociology	The study of the development, structure and function of human groups	Small and large groups or "teams"; crew composition; behaviour of passengers in emergency situations.	Crew selection, passenger safety.
Anthropometry	Study of human body sizes and muscle strength.	Anatomy, biodynamics, kinesiology.	Ground support equipment, access door size for maintenance, work station layout (reach, range of adjustment of seats, etc.)

1. Other disciplines with representatives actively engaged in Human Factors activities include education, physics, biochemistry, mathematics, biology, industrial design and operations research.

Chapter 2 Cockpit Resource Management (CRM) Training

1 Background

1.1 Over the last decade, an increasing amount of evidence has accumulated suggesting that some 70 per cent of air carrier incidents and accidents have been caused, at least in part, by a failure of the flight crew to make use of readily available resources. Research programmes have demonstrated that these types of occurrences have many common characteristics. One of the most compelling observations of these programmes is that often the problems encountered by flight crews are associated with poor group decision-making, ineffective communication, inadequate leadership, and poor management. In addition, many traditional training programmes emphasize the technical aspects of flying almost exclusively, and do not deal effectively with various types of crew management strategies and techniques that are also essential to flight safety.

1.2 These observations have led to a consensus in both industry and government that more emphasis needs to be placed upon the factors which influence crew co-ordination and the management of crew resources. Briefly defined, cockpit resource management (CRM) is the effective use of all available resources, i.e. equipment, procedures and people, to achieve safe and efficient flight operations. CRM training programmes have been or are being developed by several major operators. Although the concept is receiving widespread acceptance, limited progress has been made in the industry as a whole. Moreover, there is some confusion with respect to the key elements of CRM training, and how to go about developing a CRM training programme.

1.3 General

1.3.1 CRM training is but one practical application of Human Factors. Although CRM can be approached in many different ways, there are some essential features. The training should focus on the functioning of the flight crew as an intact team, not simply as a collection of technically competent individuals; and should provide opportunities for crew members to practise their skills together in the roles they normally perform in flight. The programme should teach crew members how to use their own personal and leadership styles in ways that foster crew effectiveness. The programme should also teach crew members that their behaviour during normal, routine circumstances can have a powerful impact on how well the crew as a whole functions during high-workload, stressful situations. During critical emergency situations, rather basic skills and knowledge come into play, and it is unlikely that any crew member will be able to take the time to reflect upon his or her CRM training to determine how to act. Similar situations experienced in training increase the probability that a crew will handle actual stressful situations more competently.

1.3.2 Research studies from the behavioural sciences strongly suggest that behaviour change in any environment cannot be accomplished in a short period of time, even if the training is very well designed. Trainees need time, awareness, practice and feedback, and continual reinforcement to learn lessons that will long endure. To be effective, CRM training must be accomplished in several phases.

What CRM Training Is
CRM is a comprehensive system for improving crew performance.
CRM addresses the entire crew population.
CRM is a system that can be extended to all forms of flight crew training.
CRM concentrates on crewmember attitudes and behaviours and their impact on safety.
CRM is an opportunity for individuals to examine their behaviours and their impact on safety.
CRM is an opportunity for individuals to examine their behaviour and make individual decisions on how to improve cockpit teamwork.
CRM uses the crew as the unit of training.
What CRM Training Is Not
It is not a "quick fix" that can be implemented overnight.
It is not a training programme administered to only a few specialized or "fix-it" cases.
It is not a system that occurs independently of other on-going training activities.
It is not a system where crews are given a specific prescription on how to work with others on the flight deck.
It is not another form of individually centered crew training.
It is not a passive lecture-style classroom course.
It is not an attempt by management to dictate cockpit behaviour.

Figure 1

- 1.3.3 Accordingly, CRM training should include at least three distinct phases:
- an awareness phase where CRM issues are defined and discussed;
 - a practice and feedback phase where trainees gain experience with CRM techniques; and
 - a continual reinforcement phase where CRM principles are addressed on a long-term basis.
- Each of these phases is discussed in more detail below.

2 CRM Training Phases

2.1 Awareness

- 2.1.1 Awareness is the essential first phase and usually comprises instructional presentations focusing on the roles of interpersonal and group factors in the maintenance of crew co-ordination. It is important because it provides a common terminology and a conceptual framework for crew members to begin thinking about crew co-ordination problems and how such factors have contributed to accidents and incidents in the past. A useful way of beginning the awareness phase might be to introduce CRM skills as they pertain to communication, situation awareness, problem solving, etc.
- 2.1.2 Other useful techniques might include computerized instruction, preparatory work for classroom instruction, detailed case studies of accidents and incidents looking for crew performance issues, and videotaped examples of good and poor team behaviour in the cockpit. The exposure of line and training staff to the awareness phase is a critical part of CRM training and such exposure is also beneficial in heightening awareness in an organization.
- 2.1.3 Awareness promotes credibility and helps in changing attitudes; however, it is important to recognize that it is only a first step. Some programmes rely almost exclusively on this aspect of training, but classroom instruction alone will probably not significantly alter crew member attitudes and behaviour in the long term.

2.2 Practice and feedback

- 2.2.1 The second phase of CRM training is practice and feedback. Some programmes use role-playing techniques to provide group skills practice, as well as personality and attitude-measuring questionnaires as a means of providing feedback to individuals on their own interpersonal styles, some aspects of which they probably have not previously evaluated. Personality and attitude insights allow individuals to recognize some of their strengths and weaknesses. Role-playing or group exercises can provide useful practice in areas of crew decision-making and other skills discussed in the awareness phase of the CRM curriculum. The review of videotaped examples of good and poor team performance in both low- and high- workload flight regimes is another good practice technique.
- 2.2.2 Line-oriented flight training (LOFT) is a well-proven method of providing practice and feedback in crew co-ordination and CRM. LOFT is a group performance training exercise. Well-designed LOFT scenarios require the co-ordinated efforts of all crew members for successful crew performance. LOFT appears to be particularly effective when it is coupled with videotape feedback and self-critique. For further discussion of LOFT see Chapter 5.
- 2.2.3 If available, simulators should be utilized for LOFT exercises coupled with video feedback in a CRM training programme. If flight simulators are not available, role-playing exercises which require group problem-solving can be used with video feedback.
- 2.2.4 Videotape feedback is particularly effective because the third-person perspective creates a level of awareness not possible with other techniques. This perspective provides insight and provokes "self-critique" which appears to be a strong stimulant for attitude and behaviour change. It is virtually impossible to deny the presence of an ineffective managerial or interpersonal style if one sees it for oneself. Moreover, these video feedback exercises provide opportunities for peer critique. There is ample evidence for the effectiveness of the video feedback technique, which should be used whenever possible.

2.2.5 In the past, many CRM programmes have finished with the practice and feedback stage, and while crew members usually leave such programmes feeling that they have learned valuable lessons, these insights more often than not tend to fade very rapidly. Today we know that for a CRM programme to produce more than short-term insight, it must be reinforced and integrated into a recurrent training programme.

2.3 Reinforcement

2.3.1 The third phase is reinforcement. No matter how effective the CRM classroom curriculum, interpersonal drills, LOFT exercises, and feedback techniques are, a single exposure will be insufficient. Undesirable attitudes and norms which contribute to ineffective crew co-ordination are ubiquitous and have developed over a crew member's lifetime. It is unrealistic to expect a short training programme to counteract a lifetime of development. For maximum effect, CRM must be embedded in the total training programme, it must be continually reinforced, and it must become an inseparable part of the organization's culture. The last factor is often overlooked; however, it is clear that effective CRM training requires the support of the highest levels of management.

2.3.2 CRM training should therefore be instituted as a regular part of the recurrent training requirement, and should include refresher curriculum and practice and feedback exercises such as LOFT, or a suitable substitute, employing video feedback. It is particularly important that some of these recurrent CRM exercises take place with a full crew, with crew members operating in their usual positions. For example, recurrent training LOFT exercises designed for CRM should only be conducted with complete crews. This is stressed because there is a natural tendency to think of CRM as training only for the "managers" or captains. This belief misses the essence of the primary CRM training objective, which is the prevention of crew-related incidents and accidents. The training will be most effective in the entire crew context and this requires training exercises that include all crew members working and learning together. In the past, much of flight crew training has been separated by crew position, and while this may be effective for certain types of training such as technical skills and systems knowledge, it is not appropriate for CRM training.

3 Curriculum Development

3.1 Assumptions and preconditions

3.1.1 Before attempting to develop a programme of CRM training, three major areas must be dealt with on the part of both operator management and course developers:

- a) global goals;
- b) awareness of "good" versus "poor" cockpit performance; and
- c) critical planning elements.

3.1.2 There are two global goals which override all other aspects of any flying operation. First, all flying is conducted to satisfy the demands of management and these demands are mainly based on economic considerations. Second, safety must be maximized through joint management and crew responsibility as well as crew co-ordination. These two goals are sometimes mutually supportive and sometimes in conflict. A correct balance is not always easy to maintain, nor is it always clear when one goal or the other is paramount. It is essential that global goals be defined and consciously identified, for they, and the conflicts they can present, are frequently at the root of operational problems.

- 3.1.3 Awareness of "good" versus "poor" performance is also vital. "Poor" performances can be more easily identified than good, but "good" performance can be stressed through development of individual role-models. The concept of "good" performance is also vital to preservation of self-image. While one cannot desire improvement until the need for improvement is felt, positive aspects must be stressed in the course development. The need for supportive and co-operative interrelationships among crew members must be accepted by students before a desire to alter individual behaviour can be evoked. Finally, flight crews must be trained to cope with difficult individuals.
- 3.1.4 The following list presents critical planning elements in any course of CRM training:
- a) careful selection of instructors (or co-ordinators, as they are often called in CRM programmes). They must be credible and selected on the basis of motivation, instructional skills, and sensitivity to student needs;
 - b) motivation of students;
 - c) justification of CRM, CRM concepts, and the training programme itself;
 - d) management support. No course will be effective without the clear support of both upper and middle management; and
 - e) professional organizations. The support of the people to be trained is essential.
- 3.1.5 Finally, it should be stressed that although negative behaviour patterns must be identified, the atmosphere of the training itself must be positive. For example, one may point out the potential danger that a passive crew member poses and identify the kinds of behaviour that are "passive", so that individuals can assess themselves and others. However, the CRM co-ordinators should not project a negative or evaluative tone toward the participants themselves; instead they should take a positive stance by focusing on the skills and concepts conducive to individual improvement.

4 Essential Curriculum Elements

4.1 Introduction

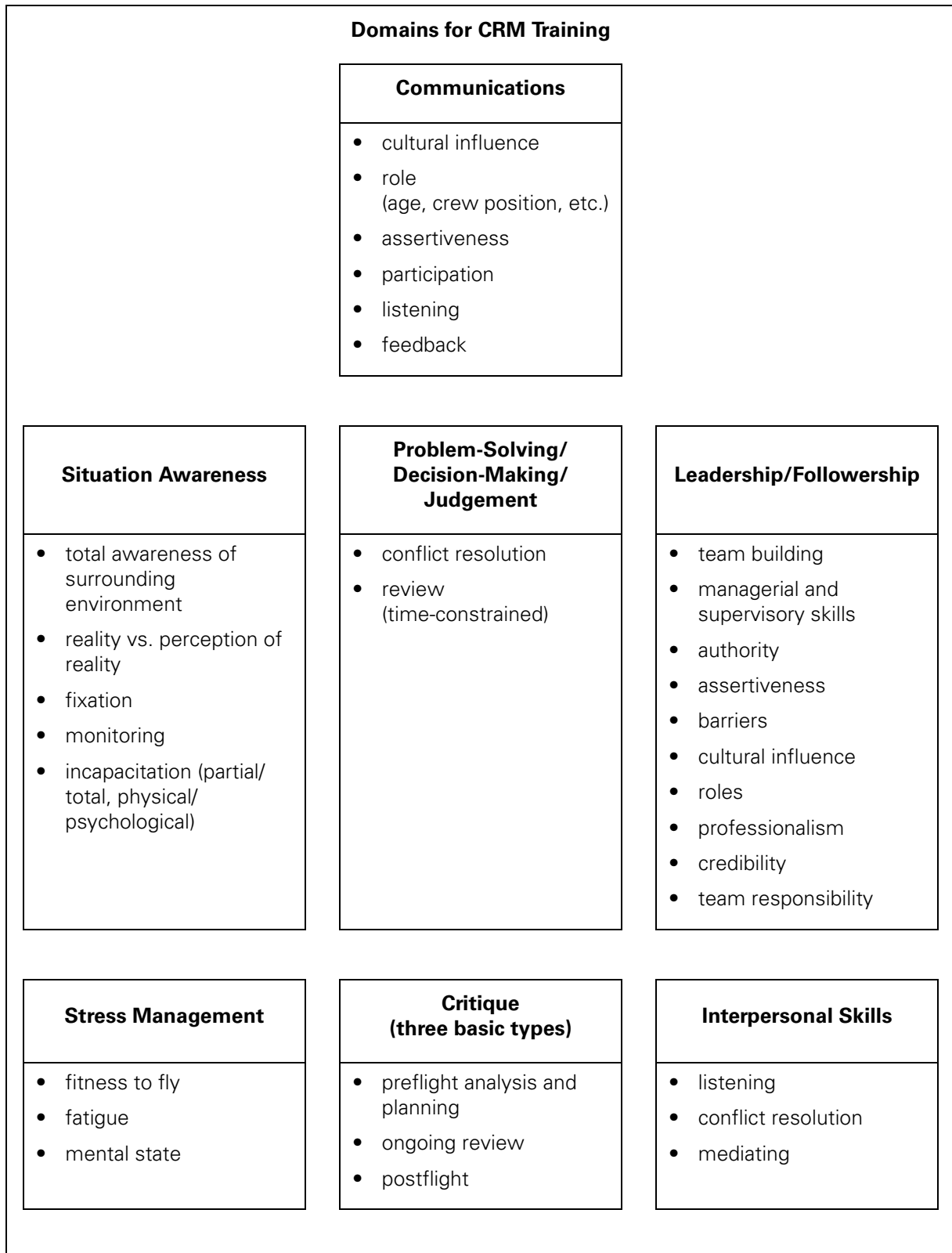
Curriculum elements are divided into two major areas: concepts to be understood and skills to be acquired. There is a great value in enhancing "understanding" of certain topics which pertain to the interrelationships between crew members. It is of equal importance, however, to develop "skills."

4.2 Concepts to be understood

The following list of topics is not complete, nor is it intended to substitute for the conceptual learning which is an integral part of learning skills. However, the topics constitute the "language" and awareness that enable skills to be understood and ultimately used in an operational environment. These are the topics to understand:

- a) a common language or glossary of terms;
- b) the concept of synergy (a combined effect that exceeds the sum of individual effects);
- c) the need for individual commitment to CRM principles;
- d) guidelines for continued self-improvement (continuation training);
- e) individual attitudes and behaviour and how they affect the team effort;
- f) complacency and its effect on team efforts;

- g) fitness to fly: the concept that each individual is responsible to arrive at work "fit to fly" and the ramifications and refinements of this concept;
- h) the impact of environment, such as company policy and culture, air traffic control, aircraft type, etc.;
- i) resources available: identification and use;
- j) identification and assignment of priorities;
- k) human components and behavioural characteristics: awareness of the human being as a composite of many complex characteristics, often not controllable. Each crew member must be aware of these characteristics in order to adjust his or her own actions and behaviour;
- l) interpersonal relationships and their effect on team work: the way in which crew members approach, or respond to each other has a critical effect on team-building and team results;
- m) "team required" versus "individual" tasks: For example, if someone spills coffee on his foot, normally team effort is not required. If however, someone spills coffee on the master copy of the computer flight plan, partially destroying its legibility, team effort may be required to reconstruct vital data. Thus, some problems require a team solution while others may be solved through individual effort;
- n) identification of norms (i.e., tacitly accepted actions, procedures and expectations): Whether consistent or deviant with written policy, norms exert strong pressures upon individuals to conform;
- o) pilot judgement: once all information is available to the pilot-in-command, the situation may be clear-cut or may require judgement. These judgement calls are the ones which are most likely to spark dissent, produce initial resistance and have a negative effect on the team;
- p) the statutory and regulatory position of the pilot-in-command as team leader and commander: All decision-making must be done by or funnelled through the pilot-in-command; and
- q) ground rules: policies and procedures to be followed during the course of instruction, as well as subsequent operations. For example, management support for the programme and concepts taught; management support for those who attempt to act in accordance with learned principles; and absence of punitive action during the course and afterwards in actual flight operations

**Figure 2**

NOTE: In paragraph 4.3 below "Communications" and "Interpersonal skills" have been grouped together.

4.3 Skills taught

There are six major areas to be taught:

- a) Communication/interpersonal skills
 - i) cultural influence
 - ii) barriers, e.g. rank, age, crew position
 - iii) polite assertiveness
 - iv) participation
 - v) listening
 - vi) feedback
 - vii) legitimate avenues of dissent;
- b) Situation awareness
 - i) total awareness of surrounding environment
 - ii) reality versus perception of reality
 - iii) fixation/distraction
 - iv) monitoring (constant, regular)
 - v) incapacitation: partial/total, physical/mental, overt and subtle;
- c) Problem-solving/decision-making/judgement
 - i) conflict management
 - ii) review (immediate, ongoing);
- d) Leadership/"followership"
 - i) team-building
 - ii) managerial and supervisory skills: plan, organize, direct, control
 - iii) authority
 - iv) assertiveness
 - v) barriers
 - vi) cultural influence
 - vii) roles
 - viii) professionalism
 - ix) credibility
 - x) responsibility of all crew members
 - xi) time/workload management;
- e) Stress management
 - i) fitness to fly: mental and physical
 - ii) fatigue
 - iii) incapacitation in varying degrees; and
- f) Critique (three basic types)
 - i) pre-mission analysis and planning

- ii) on-going review
 - iii) post-mission.
- 4.4 **Communication/interpersonal skills.** Specific skills associated with good communication practices include such items as polite assertiveness and participation, active listening and feedback. In order to improve the communication channel, cultural influences must be taken into account as well as factors such as rank, age, and crew position, all of which can create barriers to communication in the cockpit situation. Polite assertiveness is a skill frequently ignored in communications training but vital to a healthy cockpit. A pilot-in-command may be open to communication but temporarily unable to receive and comprehend. Other crew members must be aware of the importance of the information they hold and have a strong feeling of self-value; a single hesitant attempt to communicate important data constitutes a failure to discharge individual responsibility. Pilots-in-command must constantly strive to emphasize this responsibility in their team-building efforts. The concept of "legitimate avenue of dissent" is an important vehicle for "clearing the air", maintaining lines of communication, and maintaining self-image.
- 4.5 **Situation awareness.** Situation awareness refers to one's ability to accurately perceive what is going on in the cockpit and outside the aircraft. It further extends to the planning of several solutions for any emergency situation which could occur in the immediate future. Maintaining a state of awareness of one's situation is a complex process, greatly motivated by the understanding that one's perception of reality sometimes differs from reality itself. This awareness promotes on-going questioning, cross-checking, and refinement of one's perception. Constant, conscious monitoring of the situation is required. Note that the situation referred to here includes the human environment. The evaluation of oneself and others for partial or total incapacitation is vital but often overlooked.
- 4.6 **Problem-solving/decision-making/judgement.** These three topics are very broad and interrelate to a great extent with each other as well as with the other areas. One may consider problem-solving as an over-all cycle of events beginning with information input and ending with pilot judgement in making a final decision. During the phase in which information is requested and offered, some conflicting points of view may be represented. Skills in resolving conflict are therefore especially appropriate at this time. All decisions must come from the pilot-in-command because the team will fail if command authority is not maintained. This requires the support of all crew members. The inflight, immediate post-decision review is likewise a vital concept for promoting good decision-making.
- 4.7 **Leadership/"followership".** In this area, there is clear recognition that the command role carries a special responsibility. For instance, although individual crew members should be actively planning and managing their own workloads with respect to time, the pilot-in-command is responsible for supervising the over-all management of the flight. This command authority must be acknowledged at all times. The effectiveness of command authority cannot be assumed by position alone. The credibility of a leader is built over time and must be accomplished through conscious effort. Similarly, every non-command crew member is responsible for actively contributing to the team effort, for monitoring changes in the situation, and for being assertive when necessary.
- 4.8 **Stress management.** Stress creates a special kind of problem for a crew since its effects are often subtle and difficult to assess. Although any kind of emergency situation generates stress, there is also the stress, both physical and mental, that a crew member may bring to the situation and which others may not be able to detect. A crew member's over-all fitness to fly may nevertheless decline because of fatigue,

mental and emotional problems, etc., to the extent that other crew members should consider that individual as incapacitated. Skills related to stress management refer not only to one's ability to perceive and accommodate to stress in others but primarily to anticipate, recognize and cope with one's own stress as well. This would include psychological stresses such as those related to scheduling and rostering, anxiety over training courses and checks, career and achievement stresses, interpersonal problems with both cabin crew and other flight crew, as well as the home and work interface, including related domestic problems (family health, children's education, etc.). It would also include so-called life event stresses, such as those related to the death of a spouse, divorce, or marriage, all of which represent major life changes.

Several operators are attempting to alleviate stress problems by encouraging open and frank communications between operational management and flight crew members, and by viewing stress as part of the "fitness to fly" concept. The prerequisite for this is management understanding of the stress problem. In at least one case the understanding required by management personnel was fostered by having managers and other non-crew personnel attend the CRM training.

4.9 **Critique.** Skills of critique generally refer to the ability to analyse a plan of action whether future, current, or past. Since techniques for accomplishing critique vary according to the availability of time, resources, and information, three basic types of critique are distinguished:

- a) pre-mission analysis and planning;
- b) on-going review as part of the in-flight problem-solving process; and
- c) post-mission debriefing.

All three are of vital importance but are often overlooked both in operations and during instruction. Each type has two fundamental elements, i.e. remembering to perform the critique, and structuring of the critique itself.

5 Training Techniques

5.1 Introduction

The effectiveness of specific techniques varies with the training phase:

- a) **Awareness.** This phase is weighted toward individual instruction. The principal objective is to motivate the trainees and get them off to a good start, and to provide a conceptual framework for CRM.
- b) **Practice and feedback.** Here the objective is to achieve an understanding of the principles as defined in the syllabus. It is best accomplished in a group.
- c) **Reinforcement.** This is primarily a small group function. The final goal is to achieve lasting acquisition and enhancement of the required skills in all cockpit crew members.

5.2 Basic principles

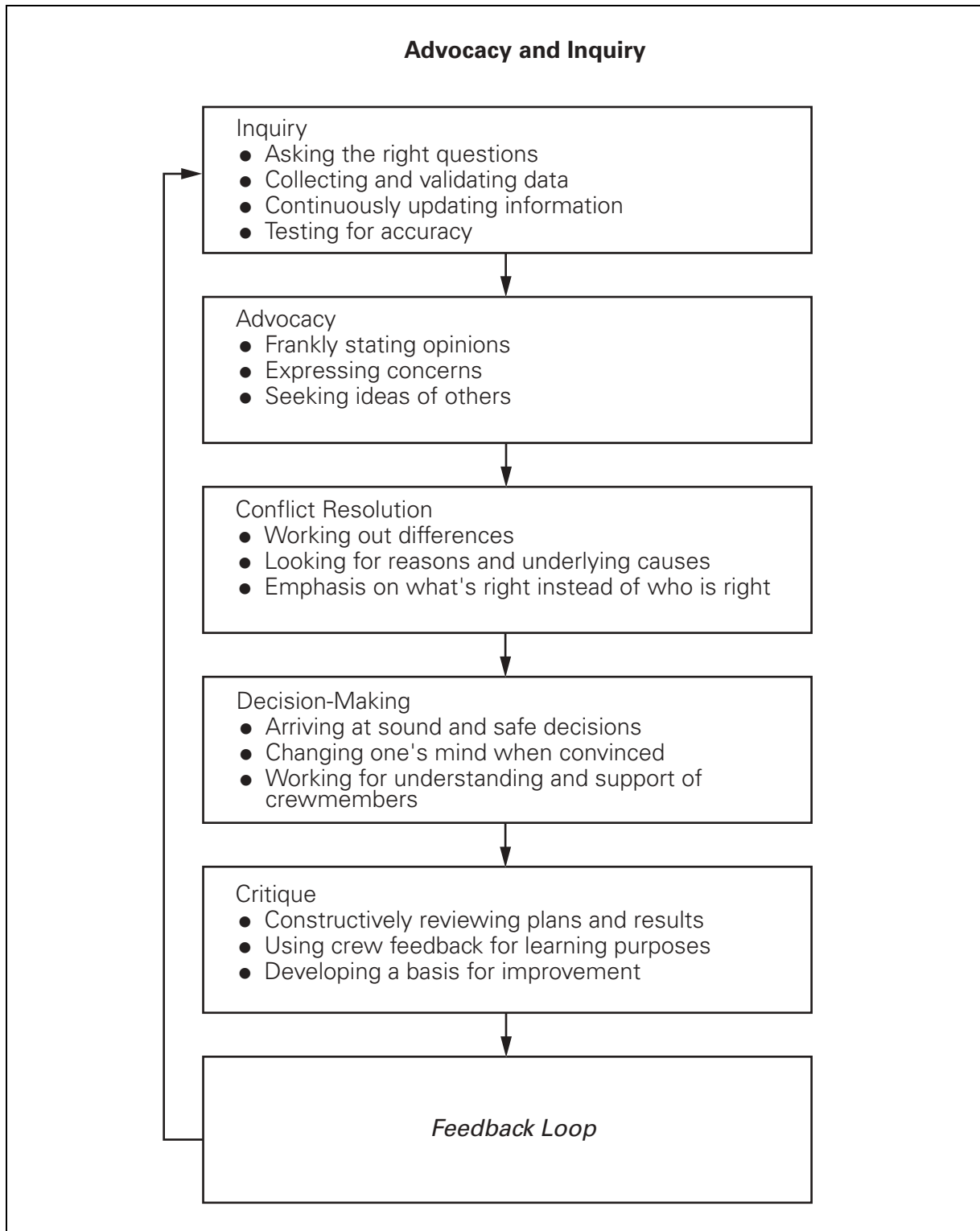
The following basic principles are applicable to all training, regardless of the characteristics and resources of the training organization:

- a) Pilot-group participation is essential.
- b) Instructors/co-ordinators must be credible.
- c) It is important to establish and use terms and principles that are familiar to the pilots and common in the organization.

- d) Techniques that work well in one culture may not work at all in another. The availability of the personal skills and other resources required by some of the techniques is an obvious consideration.

NOTE: The term culture is used here in its broadest sense and includes the norms of organizations and their management, ethnic origin, religion, etc.

- e) Instructor training is critical. Instructors require special training to develop understanding and skills above and beyond the basic syllabus.
- f) In virtually all instances more than one technique can be used effectively.
- g) There is considerable confusion regarding the requirement for the optimum use of simulators. As a general guideline, high-fidelity simulators are not required in awareness training. They are, however, required for handling/skill training.
- h) More than one type of medium (such as lectures, film strips, audio or video recordings, etc.) can be effectively used in several of the techniques, and equally important, several techniques can effectively utilize the same media.

**Figure 3**

NOTE: This model concerns several of the six areas taught.

5.3 Categories of training techniques

The CRM techniques fall into two categories: basic techniques that are important in all aspects of CRM training and techniques that are particularly effective in specific phases of training.

5.3.1 Basic techniques for all training phases:

5.3.1.1 **Pacing (or timing) of the presentation of training material.** This involves both the amount of material that is presented and the time frame in which it is given. Variables are the phase of training, the knowledge and experience of the trainees, and the specific techniques being used.

5.3.1.2 **Credible co-ordination.** This does not mean that the co-ordinator (instructor, lecturer, etc.) must be a line-qualified pilot, although considerable success has been achieved by maximizing the use of line pilots in this role. It is essential that trainee pilots recognize the co-ordinator as a subject expert, and perceive the subject as relevant and important to flight operations.

5.3.2 Techniques for specific training phases:

5.3.2.1 **Seminars or workshops.** Seminars or workshops are more effective if they can be held at a location that is isolated from the normal home or work environment, particularly for the awareness phase. However, this is not always possible and there are several examples of successful seminars held in the regular training setting.

One airline uses up to eighteen trainees for its seminars or workshops which are held in a private setting off the company premises. The group is then split into smaller teams of five or six for the interactive training phases. Prior to the seminar, trainees are also given a small amount of introductory material. The aims are to establish a conceptual framework for resource management and to motivate the trainees. Another airline runs workshops with twenty-five to thirty participants. The objectives are to provide individuals with insight into their own behaviour and reactions, and to provide ideas on how to deal with individual shortcomings and problems in normal, abnormal and emergency situations. The three-day workshop (eighteen hours) is then followed by a one and a half hour LOFT simulator exercise.

5.3.2.2 **Panels.** Panels are effective. This includes "expert" panels, participants panels, or a combination of the two. They can be presented live or through such media as audio or video cassettes.

5.3.2.3 **Group exercises.** A wide variety of group exercises have been used and found to be particularly useful.

CRM knowledge can be taught in a group or on a one-to-one basis. CRM skill acquisition and retention needs an interactive medium and a group.

Videotaping of group exercises is important for maximum effectiveness. While at least one airline gives the video cassette to the trainee because of its continued training potential, in another airline this is forbidden under an agreement with its pilots for fear of potential misuse. In such cases erasure after use is mandatory.

5.3.2.4 **Role playing.** Role playing leads to considerable discussion and some controversy. Knowledge of CRM principles and a skilful, credible co-ordinator (instructor) are important.

a) This technique can be very effective where roles are exchanged because it gives participants a different perspective.

b) It is very good training for new pilots.

c) It can be used for personal evaluation on the first day, and then on the last day to observe behavioural changes.

5.3.2.5 **Attitude tests.** These tests must be used with caution. Although they facilitate effective role-playing it must be made clear to the participants:

- that the tests are not trying to change what sort of persons they are, only how they act;
- that the goals are better understanding of self and better interpersonal relations.

Another advantage of attitude tests is that they can help sensitize people to the way they react to others. The Myers-Briggs Personality Test has been found to be very effective by at least one organization.

Psychological tests which must be administered by a clinical psychologist should be avoided. A credible co-ordinator must be able to administer the tests used. In any case, guidelines established by psychological professional organizations related to the use of attitude tests should be followed.

5.3.2.6 **Feedback of interpersonal traits.** This technique is related to attitude tests, but involves evaluation by the co-ordinator and feedback in numerical form to the trainee during normal debriefing. The feedback can be used to improve monitoring effectiveness, to identify individual interpersonal styles and in critique of the performance of both self and others.

The rationale for using this technique is that different resource management skills, such as communication, can be measured and quantified. The profile generated in this way can be accompanied by discussion of alternative approaches to improve performance and achieve objectives. It enables communicators to develop a means for choosing the "right tool for the job." The analytic technique is called behavioural analysis. It requires a skilled leader or instructor, and has been found to be very effective in a wide range of airlines and aeronautical organizations.

5.3.2.7 **Situational leadership.** This technique uses a special inventory to stimulate thought on alternative styles of leadership. It stresses the importance of recognizing the characteristics and "readiness" (both job readiness and psychological readiness) of the followers (other team members) in order to develop the full potential of the team. A leadership style that is effective in one group may not be effective in another. Situational leadership recognizes the need for leaders to adapt to the needs, attributes, and readiness of the other individuals with whom the leader has to work effectively.

5.3.2.8 **Evaluation/critique.** This technique should be performed by the crew involved after a group session. Voice and video playbacks of crew members' performance can be very effective.

5.3.2.9 **Case studies.** Video scenarios of accidents and incidents are very effective. Replays of actual cockpit voice recordings are particularly dramatic and effective, if available.

5.3.2.10 **LOFT.** LOFT should be used if at all possible. In LOFT exercises, videotaping is important for maximum effectiveness. Note that there may be a requirement to erase the tape after use in the debriefing.

5.3.2.11 **Structural observations.** This technique involves the use of examples, through videotapes, lectures, etc., that encourage the trainee to look for similar things in the real world. For example, in the teaching of listening skills, trainees can be asked to look for misunderstandings caused by the failure of participants to listen actively.

5.3.2.12 **Classroom instruction.** This technique is mainly used in the early stages of training and usually decreases as more group activities are introduced. Lectures are a good vehicle for establishing common semantics, organizational culture, etc.

5.3.2.13 **Computer-assisted training.** Two advantages of computer-assisted instruction are that it can be performed at the individual's own pace, and that it is interactive with the trainee.

6 CRM Effectiveness

6.1 Introduction

There is sufficient evidence supporting the effectiveness of CRM to warrant its use in the training environment. This conclusion is based upon several types of evidence. First, the programmes have a high degree of validity. That is, they reflect sound operating principles and are focused on areas of known weaknesses as supported by accident/incident data. Second, the skills which are targeted for improvement in these programmes and the means to achieve that improvement have been incorporated into effective programmes already in use in other areas, such as business management. Third, feedback from pilots, training management, check pilots and others in the training community supports the need for and the effectiveness of CRM programmes. Fourth, objective data, although very limited in scope, is encouraging. United Airlines, which has one of the more established and fully integrated programmes, has reported improvements in a number of areas, including training and checking.

6.2 Scientific evaluation of individuals

As yet, no large-scale scientific evaluation has been carried out on individuals. The reason is that the performances of individual crew members have to be not only assessed but also recorded; a practice contrary to the requisite confidentiality in effective CRM training. In other words, a checking-type environment would be created or perceived.

6.3 Operator formal assessments

6.3.1 A formal evaluation of CRM effectiveness should be incorporated as part of the programme. It must be stressed that such evaluations must maintain strict confidentiality of crew member data and that the objective is to evaluate the programme and not the individual.

6.3.2 Formal evaluations should be used to modify the programme to the specific needs of the organization.

6.4 Formal assessment of the CRM concept

Many experts consider that the CRM training concept in the future should be assessed by a neutral organization, such as a national research institution. This would include measurements at both the macro level (accident and incident records, etc.) and the micro level (observation of crew members, procedures, etc.). It is expected that a comprehensive database, to which operators would report, could be created to serve both the research programme and the operators.

Chapter 3 CRM Training for Small Operators (Regional, Corporate, etc.)

1 Introduction

- 1.1 A full-scale CRM training programme is the ideal objective for small operators. However, several obstacles currently prevent any industry-wide realization of such an objective. These include rapid turnover of flight crew/training personnel since in some States the small transport operations tend to serve as a flow-through channel for pilots making career transitions from small aircraft to the heavy wide-body jets. A yearly pilot turnover ranging from 10 to 50 per cent of the work force is not unusual. The relatively limited experience of replacement pilot applicants exacerbates the training problem, and makes it difficult to pursue new areas. In addition, severe financial constraints are often present.
- 1.2 Some small operators now include resource management principles within their training syllabi. Standard operational procedures are frequently merged with CRM policies and CRM philosophy in order to attain optimum behavioural patterns in the cockpit.
- 1.3 Small operators differ from large ones in various operational areas. The major differences appear to be:
 - a) more short-haul, multi-sector flights with frequent take-off/landing cycles;
 - b) minimum financial support for add-on training costs;
 - c) reduced availability of crew members for scheduling into CRM programmes; and
 - d) lack of simulators for some small operators.
- 1.4 Corporate flying also differs from major airline operations. The industry encompasses first-class, "red carpet" operations and small, spartan, one- or two-pilot work force complements. Rank, seniority, and status at times are unclear; junior crew members may be in command, or two captains may crew the aircraft with the role of the pilot-in-command being determined by the flip of a coin.
- 1.5 Often, corporate flight departments are isolated from higher-level management, particularly in organizations where the primary business activities are unrelated to aviation. Similarly, company management in these organizations may have little knowledge of pilot concerns or flight crew training needs. There may be direct high-level management pressures on the cockpit (i.e. in corporate flight, the "boss" may be the passenger riding in the cabin). The cost of proper flight crew training may be difficult for the financial managers of the corporation to accept.
- 1.6 With such variable sets of economic and operational circumstances, it is considered that industry adoption of full-scale CRM training is currently unfeasible and beyond the financial capabilities of many small corporations.

2 CRM Training Steps for Small Operators

2.1 These steps can be progressively adopted by any transport operator according to financial constraints:

- a) development of pilot awareness of CRM policies through distribution of booklets, pamphlets, republished articles and studies, and videotapes stressing "this could happen to you" types of incidents or accidents;
- b) conduct of in-house seminars for crew members using role-playing for demonstrations of CRM techniques;
- c) phase-in of CRM principles into initial first officer training programmes. Open cockpit atmosphere and assertiveness training would be key elements in such training;
- d) integration of CRM policies into recurrent ground school curricula, into captain upgrade training, and into flight operations manuals;
- e) recruitment of a core-nucleus of training-staff personnel for development of in-house CRM training programmes;
- f) employment of an outside consultant for preparation of in-house CRM programmes; and
- g) outright purchase of a complete CRM programme from a third-party vendor.

2.2 In summary, CRM training is an important element in small airline operations. At a recent workshop a recurring theme sounded throughout all panel discussions regarding small operators:

"Go home, go back to your airlines and start doing something about it. No matter how small the training budget, take that first step toward a comprehensive, integrated CRM training programme."

Chapter 4 CRM - The Operator Experience

1 Introduction

- 1.1 In September 1987 the Secretariat of ICAO wrote to eleven operators regarding their experience with LOFT/CRM. The letter stated in part:

"In particular, (I am) interested in the management considerations which would have prompted the introduction of LOFT and CRM, any benefits which may have accrued from such training, the methods used and anything else that you consider useful for the purpose."

- 1.2 Some of the replies are presented below. They were selected because they were particularly pertinent to the purpose of this digest and because their length fitted the format selected. Although excellent, some replies had to be omitted because they were too long or included information already presented elsewhere in this digest.
- 1.3 It will be seen that while the fundamentals of CRM remain the same for these operators, the training has in each case been tailored to meet the operator's requirements and culture. The terminology used by individual operators is sometimes different from the terminology used elsewhere in this document. It should also be noted that these operators are at various stages of CRM development.

2 Alaska Airlines

The following is a summary of Alaska Airlines' "Integrated Crew Experience" training programme.

Alaska Airlines has designed its own version of "Cockpit Resource Management Training"; we call it "Integrated Crew Experience (ICE)." This programme has been developed by conducting a "needs analysis" designed by R. Helmreich Ph.D of the University of Texas at Austin, who is operating under a NASA grant to evaluate Cockpit Resource Management programmes. A review of the Needs Analysis for Alaska Airlines flight crew members has shown emphasis is needed in four primary training requirements.

- a) Group co-ordination: These are items that relate to smooth group operational problems, verbalizing and acknowledging procedures, reporting of overloads and the process of critique.
- b) Personal invulnerability: These items relate to invulnerability to fatigue, working with inexperienced crew members, personal problems and macho pilot myths.
- c) Pilot-in-command dominance: These items relate to undesirable crew dominance and authority issues, such as captains dictating procedures and flying the aircraft, with everybody else being silent and inactive.
- d) Social consideration: These items relate to social niceties and consideration of others in the crew.

The Alaska Airlines ICE programme addresses these training needs through a three-part, long-term programme. First we conduct a three-day, intensive workshop, designed to give each crew member training in each of the following subjects:

Part One: Awareness

- a) Introduce crew members to the concept of human factors as a cause of aircraft accidents
- b) The process of voluntary and involuntary change
 - i) barriers to change
 - ii) synergy concept
- c) Best/worst crew member characteristics
- d) Leadership/followership
 - i) administer leadership styles instrument
 - ii) leadership/management theories
 - iii) situational leadership
- e) Conflict resolution
 - i) response to conflict
 - ii) coping with conflict
- f) Assertiveness
 - i) aggression
 - ii) non-assertion
 - iii) assertion
- g) Crew dynamics
 - i) styles of crew evolution
 - ii) functional crews
 - iii) disfunctional crews
- h) Stress management
 - i) positive stressors
 - ii) negative stressors
 - iii) mental and physical reactions to stress
- i) Communication training
 - i) information
 - ii) questioning
 - iii) listening
 - iv) feedback
- j) Pilot judgement/decision making
 - i) demonstrate how judgement leads to decisions
 - ii) blockages to effective decisions
 - iii) introduce a model for effective decision making
- k) Summary experience (role playing)

Uses actual air carrier accidents and incidents to create problem-solving dilemmas that participants must act out and critique through the use of videotape playback.

All of the topic areas are taught using an experiential training method that requires each crew member to actively participate in each phase of the training.

Part Two: Practice and feedback

The second part of ICE training is conducted as line-oriented flight training. In this phase each crew member flies a one and a half hour, real time, full mission simulator session that is designed to introduce a human factors problem that the crew will have to cope with, just as they would on a typical line trip. The LOFT is videotaped and used to provide feedback to the crew members during the debriefing.

Videotape feedback is particularly effective because the experience of viewing oneself from a third-person perspective creates a level of awareness not possible with other techniques. This perspective appears to be a strong motivator for attitude and behaviour change. It is virtually impossible to deny the presence of an ineffective managerial or interpersonal style if you see it for yourself.

Part Three: Reinforcement

Each calendar year, Alaska Airlines will develop a three-hour block of classroom training that will reinforce one or more of the ICE concepts. In addition, each calendar year we will develop new LOFT scenarios that will further develop the crew members' ICE skills.

Each part of the ICE programme will be evaluated by Dr. Helmreich using proven measurement instruments that he has developed while conducting the NASA CRM evaluation study. The results of this study will be used to continually upgrade and improve ICE training. This method of evaluation will also "validate" ICE training, ensure that information transfer has occurred, and measure any change in crew member attitude and behaviour.

Alaska Airlines believes that ICE training will result in a significantly safer flight operation, cause crews to operate with an even higher standard of excellence and reduce operating costs through greater standardization and improved performance.

3 All Nippon Airways

All Nippon Airways (ANA) stated in part:

We enclose a copy of our LOFT and CRM training status.

Some parts of CRM training have just begun this year (1987). The flight operations division of our company continues studying LOFT and CRM training to take further action

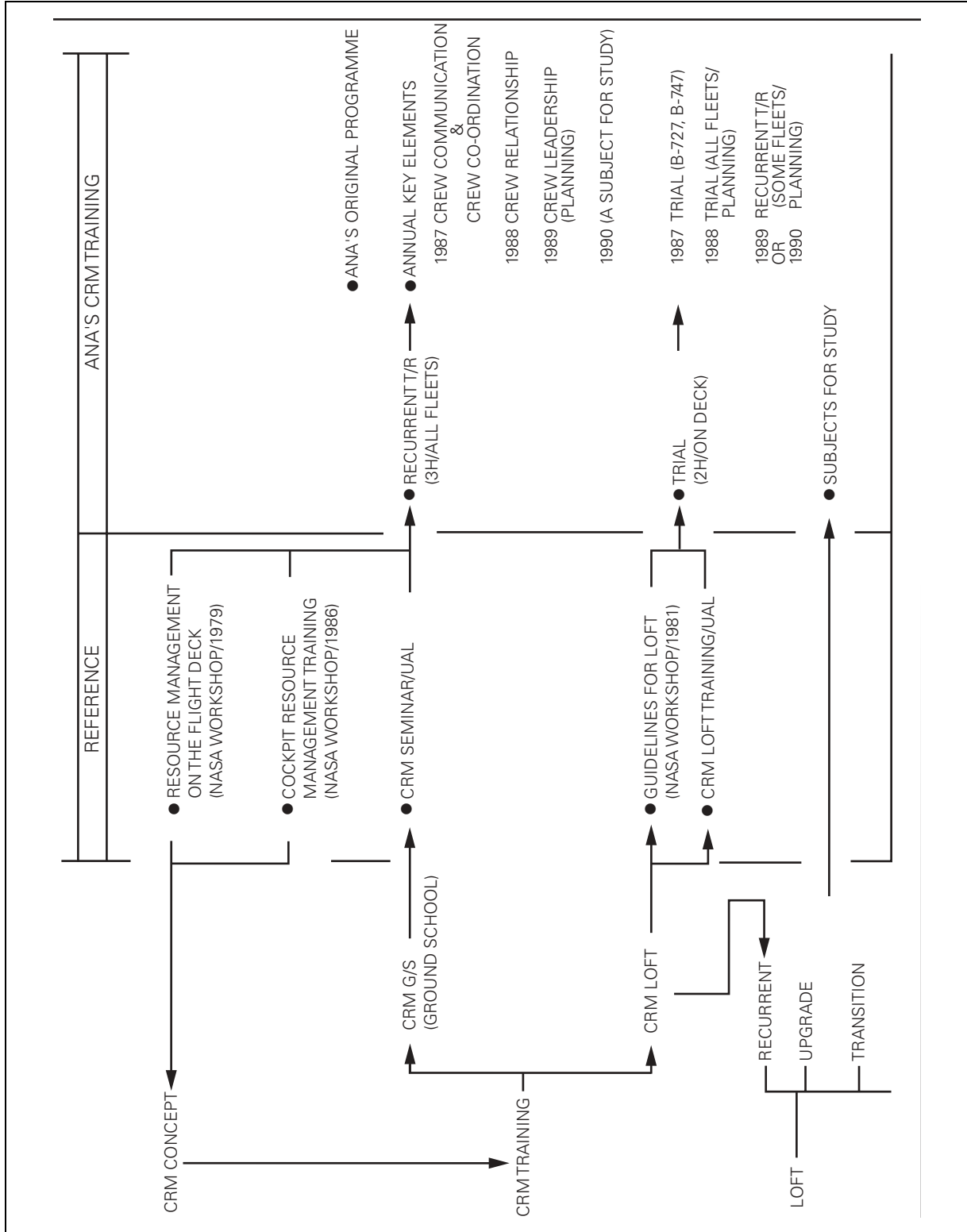


Figure 4 All Nippon Airways

4 American Airlines

The following briefly presents an evaluation undertaken by American Airlines of its CRM programmes and the reasons for the evaluation.

For almost a year, the American Airlines Flight Academy has been actively evaluating and improving its Cockpit Resource Management programmes. First I will mention something about the history of this effort, then something about the progress we are making in the development of a new, career-long CRM training system.

There were four distinct reasons for turning our attention towards upgrading our CRM training. First, our own analysis of recent industry accidents and incidents convinced us that we could ensure safer flights by training crew members to make better use of all their potential resources. This includes the use of the pilot himself as a resource, the use of his fellow crew members, and, finally, the use of all the external resources and systems at his disposal.

The second reason for focusing attention on CRM was the results of our "Operation Microscope". It is the policy of the American Airlines Flight Department to do intensive evaluations of our own flight operations at regular intervals using specially trained check airmen. Last fall, within a two-month period, we completed approximately 2100 line checks observing the cockpit performance of nearly 5000 crew members. Using the data collected in this effort, a series of recommendations and action steps were developed to maximize pilot and flight operations performance. Among these were several suggestions having to do with crew briefings, communication terminology, leadership, and the interface between the flight crews and other American Airlines personnel.

The third reason had to do with the feedback we were receiving from our own training surveys as well as those from the Allied Pilots Association. As the LOFT concept took root, a lack of co-ordination developed between what was being taught in the simulator and the CRM material presented in the classroom. It became clear that these two experiences had to be integrated in order to obtain optimum cockpit performance.

Lastly, some of our emphasis on CRM course improvement came about as the result of the FAA Administrator's "Impact 88" programme. As part of that effort, an FAA consultant, Dr J. Berlin, commenced the development of a new type CRM programme using the AA Flight Academy as the first "test bed". The initial results of this effort were so encouraging that we asked Dr. Berlin to continue his work, this time in the role of Consultant to American Airlines. Since June 1, 1988 he has headed up the development of a CRM programme unique to the needs of our operation. Before the development of specific training modules began, Dr. Berlin completed a needs analysis by interviewing training and flight managers, by interviewing flight crews of all types of equipment and seat positions, and by observing cockpit performance during more than 100 flights. As a result of the needs analysis three themes emerged which, in addition to the usual CRM subject matter, became the focus for the development of new training modules.

The first theme concerns American Airlines' extraordinary use of procedures. It became clear, both from comparing operations manuals

and from actual cockpit observations, that we have one of the most, if not the most, procedure-oriented flight departments in the industry. In addition, reliable evidence indicates that extremely high adherence to these procedures exists.

While this emphasis upon procedures is entirely laudable, there is growing concern among both the flight crews and management that the ability to creatively solve problems for which there are no standard procedures requires additional development. Although evidence does not support this, the concern is great enough for us to have decided to develop some special training modules which reinforce creative problem-solving without decreasing adherence to our procedures.

The second theme concerns the number and qualifications of new crew members. Because of the rapid expansion of our company, almost 1000 pilots have been hired and trained during each of the past three years. Although American Airlines tends to get the "cream of the crop", it is extremely important that our captains contribute to the development of these new pilots, especially because they often move into the right seat very soon after coming on the line. Many of the pilots who voiced these concerns are themselves new captains, and it is to their credit that they express the need for help in becoming effective "coaches" and teachers to the lesser experienced group. Perhaps the most exciting module thus far developed for the CRM programme is the "helping relationship" module given in the captains' upgrade course. The response to the module has been unanimously favourable.

The third theme deals with our pilots' changing perceptions of themselves as managers on one hand, and highly skilled professionals on the other. While we continue to emphasize the importance of the pilot in making operational decisions, the so-called marketing decisions have largely been removed from the pilot's domain. Even though this is the correct thing to do from a corporate viewpoint, it does leave many pilots feeling less trusted and admired as a member of the operations team.

There is another experience affecting our crew members. It is the perception among pilots that automation has lowered the requirement for their highly developed motor skills, thereby making them feel less needed and important. Because of this and other factors, they perceive that their general status both within the company, as well as in society in general, is decreasing. Here too, we are attempting to face this issue openly and helpfully in our developing CRM programme. Already we have completed one training module dealing with this subject, and another is in the testing phase.

These themes, which may or may not be specific to American Airlines, are being integrated into the other training experiences which include sessions devoted to leadership, management, communication, assertiveness, and the proper use of authority in the cockpit environment.

Perhaps the most innovative aspect of our new CRM programme is the concept of "career-long" training. All of us in aviation recognize the problem of degradation of skills over time. This is why we bring pilots back for proficiency checks and training as often as we do. Strangely enough, this has been less recognized when even more complex behaviours such as attitudinal change and personality development of flight crews were the goals of training. Early in the planning for the new

CRM programme, we decided to confront this issue head on, and the emerging CRM instructional system will include simulator, frontal teaching and group laboratory experiences at least once a year for the entire career of the American Airlines pilot. In addition, because we are integrating the CRM programme into the regular and ongoing flight training as much as possible, we are able to accomplish this on a surprisingly cost-effective basis.

The CRM programme starts in the very first week of training for the new AA pilot. During what we call the Basic Indoctrination course, a half-day is devoted to teaching the principles of CRM. Within the next few months, a new training module dealing with the successful integration of the flight engineer as a participating crew member will be added to the programme. Thereafter, each time a crew member upgrades, he will attend a carefully designed and tested CRM training course which in addition to reviewing general CRM concepts, will focus upon the specific responsibilities, problems, and contributions common to that new position. Our Flight Academy is currently using advanced simulator LOFT training in initial, transition, and upgrade training programmes. As part of the over-all CRM effort, our flight managers are evaluating a recurrent LOFT training programme as recommended by the FAA. If this proves feasible, the recurrent CRM classroom day will be taught in conjunction with the LOFT training, with videotapes of the LOFT training used as a central focus of the classroom activities. To this end, the purchase of sophisticated video equipment has been approved. Every year the CRM teaching team will be collecting case histories of CRM incidents on the line. They will then translate these into LOFT scenarios and related training modules for use in the next year's training.

Much of the success of this entire programme rests upon the attitudes of the Flight Training Academy personnel. Therefore, we have already begun CRM orientation training for the staff. When this is completed, all managers, check airmen, and simulator and ground instructors will have been trained in what will be for some, an entirely new learning area. The first of these sessions have been met with enthusiasm by almost all participants.

Unfortunately, we have encountered some obstacles in developing a programme such as this. For each new captain who is upgraded, two first officers must be trained. This makes it difficult to schedule real-life crew experiences in both the simulator and the classroom. In addition, captains are required to undergo recurrent training at six-month intervals, while first officers receive their recurrent training once a year. That, too, presents some terribly difficult hurdles when constructing a programme such as ours. A Special Federal Air Regulation is being developed which, hopefully, will alleviate some of these problems. Indeed, it would be welcomed. Nonetheless, we continue to search for new methods to maximize our crew concept training within the scope of the current regulations, and remain committed to developing the finest CRM programme in the industry.

5 Delta Airlines

- 5.1 This operator's efforts are leading to the introduction of a full programme in 1989. In the following you should note that the term "facilitator" is used for what in this digest has been referred to as "co-ordinator".

In 1987 we undertook a review of our flight operations. From this we embarked on a large-scale, in-house inspection to determine if any specific operational factors were apparent. While no significant revelations occurred, one subtle fact became readily apparent across the spectrum of the investigation: There was a need to train pilots in the area of cockpit resource management (CRM).

Historically, our airline has been known for its congenial, close-knit pilot group, and due to this congeniality the assumption had been made at the onset of CRM that we were not in need of such training. In addition, the cost effectiveness of such training was questioned. However, as a result of the before-mentioned inspection process, the solicitation by many pilots for such training and the overwhelming agreement of the inspection team that CRM training would be beneficial at our airline, our management consented to the research and development of a CRM programme. To do this, a CRM Steering Committee was formed.

The Committee was to be chaired by a line pilot who had been a part of the inspection team in the area of human factors. He picked as Vice-Chairman another pilot who had been a part of the same team and who had done extensive research into other CRM efforts. Through this process, they became very familiar with CRM and formed the Steering Committee. It was decided to use line pilots predominantly, but to also include representatives from all aspects of the flight operation. As a result, people were selected from the following areas: ALPA, Chief Pilots, Flight Training, Ground Training, In-Flight Service (Flight Attendants), retired pilots and a cross-section of line pilots from all positions and a variety of bases. This Committee was formed in November of 1987.

The Steering Committee held its first meeting in November 1987. The first thing they established was a list of objectives which would guide the Committee in their endeavours. Here is a list of those objectives:

- a) enhance safety through optimized team performance;
- b) develop and enhance crew decision-making skills;
- c) increase job satisfaction through increased decision-making efficiency, customer satisfaction and personal growth;
- d) develop improved communication skills;
- e) enhance group interaction skills;
- f) provide for individual development;
- g) provide for crew/team development;
- h) modify the cockpit "shell" to optimize crew performance;
- i) encourage modification of organizational support where necessary; and
- j) create a mechanism to remedy problem behaviours.

Given these objectives, the first task of the Committee was to research CRM: what it is, its purpose and how it is implemented. To aid them, they used the NASA Publication 2455, regarded as the "bible" of CRM. In addition, much information was gathered on existing CRM programmes at other airlines and commercial vendors. Learning from this research that there is a small group of academic experts in the field of CRM, efforts were made to personally contact each of them to seek aid and advice concerning the subject. These men included: Dr. C. Foushee' with NASA; Dr. R. Hackman at Harvard University; Dr. R. Helmreich at the University of Texas; Dr. E. Weiner at the University of Miami and Dr. J. Lauber with the NTSB. Having researched in depth these resources, the next question became apparent: Do we buy an existing CRM programme or develop one in-house?

Weighing these alternatives and considering advice from the experts, the Committee decided that our airline would be best served by a tailor-made, next-generation programme. To this end, it was determined that we should enlist the services of some of the experts on a consultation basis to ensure our programme was up to date and of high quality. Consequently, Drs. Hackman and Helmreich were employed for this purpose. In addition, by virtue of his NASA affiliation, Dr. Foushee' would also be available to provide us with NASA-backed research. Working with these experts, the Committee was ready to get specific about the structure and contents of our programme.

In January, after laborious discussions over structure, it was determined that our optimum programme would include a two-day workshop seminar followed by a LOFT period with video feedback (low impact - 1½ hours). Six months later the pilot would return for a one-day workshop followed by another LOFT with video (2½ hours - medium impact). In the following year, the pilot would receive a full mission LOFT (2½ hours - high impact). This was "blue-sky" to us, i.e. the very best; however, we needed to be able to mesh this training with our existing recurrent training requirements. There still exists some concern over simulator resources and the logistics of scheduling. Beyond this though, the structure had been determined, it was time for the Committee to get specific about the content of the seminars and LOFTs.

In February, the Committee selected a set of modules to be taught during the three days of workshops. By this time, we had established the importance of orienting the training toward a "team" concept. Therefore, we broke the three days into three general categories of targets for training: awareness, personal skills and team skills. Within these broad areas, we will teach the modules that we have ascertained will be appropriate for CRM training.

The modules to be taught are: Traditions/Bonding/Culture; Accident Analysis I and II; Communications; Leadership/Followership; Stress Management; Problem Solving/Decision Making; Work-load Management/Automation and Conflict Management. The development of these modules will be accomplished by the Committee with supervisory advice from Drs. Hackman, Helmreich and Foushee'. Committee members were assigned in pairs to each module. At this point (March 1988), we have established learning objectives for each module. In April, we will have an outline of the module, followed in May by a rough

draft. In June we will finalize the workshop content (all modules). With seminars complete, we will turn our attention to LOFT.

Our airline has been using LOFT since the early 1980s, so it is not a new concept to us. However, the profiles utilized in the past will be of little value to use for the CRM training. Therefore, profiles for each LOFT session for each individual aircraft will have to be developed. At this time, we have not begun this task. It is scheduled for July. Also in July, we will begin studying the massive logistics problem which faces us.

For a large airline, the scheduling logistics of CRM are formidable. In the past, we have not trained adhering to a strict crew complement; occasionally a captain would train or check with another captain rather than with a first officer. However, one aspect of the previously mentioned inspection pointed out the need for crew complement training. Consequently, our flight training department is in the process of a change to this type of training for 1989. Therefore, it appears that our training structure should overlay nicely with normal recurrent criteria. As mentioned before, we will evaluate the logistical needs in July. The next big step is to train the people who will teach the workshops and LOFT sessions, i.e. the facilitators.

"Facilitator" is the term widely used across the CRM front to refer to the person (or persons) who guide the learning process in both the workshops and the LOFTs. The term is used because the process is truly self-learning. The leaders simply facilitate this process by keeping the group on task and functional. Our facilitator training will begin in September 1988 when they receive essentially the same training which the pilots will receive. Facilitators will be line pilots who volunteer and are judged to be emotionally and mentally capable of such a task. We anticipate the need for two facilitators in every workshop. Of course, leading up to this point, there has been a number of administrative tasks, small but important, to get us this far.

Over the course of the last four months we have developed several administrative adjuncts to this programme development. First, in November 1987, we created a video to be shown in 1988 recurrent training which briefly described CRM and the fact that we would have CRM training in place in 1989. In addition to this, we established a plan to disseminate information over the year 1988 in an effort to promote the training. To aid us in understanding where we should concentrate our efforts in training, we are setting up an information-gathering device by way of our line check and simulator check airmen. Another part of gathering information was accomplished by way of a pilot survey distributed in March of 1988. The purpose of this survey was to provide data on pilots' attitudes to help in tailoring the programme content, and to allow us to compare our pre-training position to our post-training feelings when the same survey will be distributed in 1990. Hopefully, at that point we will see the justification of our labours.

Though statistical justification may be hard to obtain, the experts widely agree that training in the area of cockpit resource management is targeting the primary causal factor in aviation accidents and incidents: "pilot error". Obviously, we on this Steering Committee agree with this theory. The main point we want to emphasize is that although we are attempting to change the attitudes of the individual, it is the "team" as a

whole which needs to be strengthened. Therefore, our concentrated effort over 1988 as we prepare our CRM training programme will be to deeply embed this philosophy through the entire spectrum of our programme.

6 KLM - Royal Dutch Airlines

This airline has long been in the forefront of LOFT and CRM training in Europe. Its Human Factors Awareness Course for aircrew constituted one of the earliest airline human factors courses. KLM provided a brief and a long version of its programme. The brief version follows.

Management considerations

From the start of the use of flight simulators instead of link trainers KLM has been convinced that this not only meant simulation of the aircraft as such, but also simulation of the circumstances of a flight. In other words, almost right from the beginning, in fact, well before the name was invented, KLM has adopted LOFT for its type recurrent training. About seven years ago LOFT was also introduced during type qualification training.

Benefits

It goes without saying that in respect of benefits from LOFT and CRM no hard figures are available. However, we think KLM's performance reflects a high quality, which is undoubtedly a result of LOFT and CRM.

Methods

LOFT and CRM are incorporated in type recurrent and type qualification training in such a way that the instructor will as little as possible interfere during the simulator session. During the (thorough) debriefing especially, the aspect of crew management is reviewed, for the two-man crew aircraft with the help of a video recording of the session. Furthermore, a special crew management course/workshop is scheduled for each pilot, in principle before his upgrading to captain.

Selection of flight crew training staff

Selection is carried out according to the following guidelines:

- knowledge
- skill
- personality
- ability to mix with people
- flexibility
- instructional capability
- motivation
- experience on type

Most of these items are self-explanatory. As far as the last one is concerned, captains with previous experience as instructors may be selected again after six months' experience on a new type, in all other cases a twelve-month period of line experience is preferably required.

7 Qantas Airways

In its reply this operator, with an accident-free record, stated:

Qantas Airways' Flight Training Department has been very aware of the problems associated with deficient cockpit resource management for many years, and have also noted the rising trends in human factors-related accidents in the world's airlines.

We are currently working towards the introduction of a formal CRM training course. The rationale behind the introduction of CRM training in Qantas and the general plans for the future are provided below. As you will see, we are not yet in a position to evaluate any results.

Background

The importance of effective cockpit resource management has always been stressed in programmes for promotion of second officer to first officer and from first officer to command. During the 1970s, a period of very slow promotion and very low levels of recruiting, the approach taken to this subject was generally to analyse reported accidents, decide whether the potential existed for a similar accident in Qantas and give the necessary training or instruction to crews. The company's accident-free record and the high levels of experience of all cockpit crew members (in 1980 a minimum of ten years for second officers, the third pilot), suggested that these measures were sufficient.

Extensive recruiting of minimum experience pilots in the early 1980s, along with sudden rapid promotion within the company, considerably diluted the experience levels in Qantas. This was a source of some concern within the company and, it is believed, was an important factor in producing increasing numbers of economic incidents which, although they raised no immediate safety worries, were costly and, upon analysis, amounted to a breakdown in efficient cockpit resource management.

The commercial pressures of the time also created another source of concern within the flight training organization. During times of slow promotion, the supply of candidates for command in Qantas far exceeded the demand and those who were not natural leaders and could not quickly acquire and demonstrate the necessary leadership skills were simply not promoted to command.

The rapid expansion of the early 1980s however forced the company into the situation where it had to accept something less than inherent perfection in management skills and it became apparent that more extensive management training for captains was an urgent necessity.

As management awareness of CRM issues became more extensive, further deficiencies amongst our crew members, notably subordinate crew members, became apparent. There was clearly a need for training of our captains in participative management but also there was a need for training of other crew members in communication skills, monitoring and what we, in Qantas, term "managing upwards".

Action

The Director of Flight Operations appointed a Flight Training Supervisory Captain to investigate ways of introducing CRM training in the company. After familiarization with industry progress in the field of CRM, a Steering Committee was formed, consisting of pilots and flight engineers representing both the company management and the pilots' and flight engineers' industrial associations.

The Steering Committee mapped out a programme for the introduction of formalized CRM training which involves a two-day live-in course for all technical air crew. The course is currently being produced and is expected to commence in July, 1988.

CRM training in Qantas

With experience of CRM courses run by other international operators and also Australian domestic airlines, the Steering Committee decided that CRM training in Qantas needed to be specifically tailored to our own operations. There appeared to be an "ethnic" quality to be approached to CRM training which seemed to require the tailoring of a course not only to suit the country involved but also the particular airline.

The Steering Committee further concluded that the CRM problem was, to a great extent, one of basic management principles applied to the air crew team environment. Accordingly, a leading Australian management consultancy company was engaged to assist in the construction of the CRM course.

It is expected that it will take approximately one year to roster all technical air crew for the course. As soon as a substantial number have received training, it is intended to introduce an annual LOFT exercise which, we believe, will considerably reinforce the training given in the two-day course.

An approach has been made to the Australian Department of Transport and Communications for a concession against Air Navigation Orders allowing the company to delete one route check from the current requirement of two for air crew members who have received CRM training and are undergoing continuing CRM training in the form of the short refresher course and the annual LOFT.

Conclusion

We believe that the introduction of a CRM programme, as discussed, will equip our crews to deal with the problems of aircraft management at a time of unprecedented rapid promotion in Qantas when the experience of our crews is significantly below that which we in Qantas are used to.

Chapter 5 Line-Oriented Flight Training (LOFT)

1 Introduction

- 1.1 LOFT refers to aircrew training which involves a full mission simulation of situations which are representative of line operations, with special emphasis on situations which involve communications, management and leadership. In short, LOFT means realistic, "real-time", full mission training. Most of the information in this chapter has been gleaned from NASA Conference Publication 2184, "Guidelines for Line-Oriented Flight Training, Volume II".
- 1.2 The assessed value of LOFT is such that several States' aviation administrations permit its use instead of the usual semi-annual proficiency checks, provided that certain specified conditions are met.
- 1.3 LOFT can have a significant impact on aviation safety through improved training and validation of operational procedures. LOFT presents to aircrews scenarios of typical daily operations in their airline with reasonable and realistic difficulties and emergencies introduced to provide training and evaluation of proper flight deck management techniques. The result is an appreciation by the air carrier of operational shortcomings on the part of line crews and an evaluation of the adequacy of flight deck procedures and instrumentation, as well as over-all crew training effectiveness.
- 1.4 LOFT scenarios may be developed from many sources, but accident reports provide a realistic and appropriate starting point. A properly conducted LOFT programme can provide great insight into the internal workings of an airline's operations and training programme for the following reasons:
 - a) If similar mistakes seem to be recurring among pilots, it may indicate a potentially serious problem as a result of incorrect procedures, conflicting or incorrect manuals, or other operational aspects.
 - b) It may reveal areas in aircrew training programmes which are weak or which need emphasis.
 - c) It may reveal problems with instrument locations, information being presented to pilots, or other difficulties with the physical layout of a particular flight deck.
 - d) Air carriers can use it to test and verify flight deck operational procedures.
- 1.5 LOFT should not be used as a method of checking the performance of individuals. Instead, it is a validation of training programmes and operational procedures. An individual or crew needing additional training after a LOFT session should be afforded that opportunity immediately with no stigma or recrimination.
- 1.6 A LOFT session should not be interrupted except in extreme and unusual circumstances. Repositioning the simulator and repeating problems is inconsistent with the principles of LOFT. Part of the benefit of LOFT is derived from an individual or crew being able to quickly appreciate the results, either positive or negative, of operational decisions. After completion of such a session, a thorough debriefing should be made of all aspects. This may be accomplished by an initial self-debriefing by the crew, followed by the LOFT co-ordinator's (check pilot's, instructor's) debriefing. This critique should include the use of such aids as voice and video recorders, as well as written notes.

2 Development of Scenario Designs

- 2.1 Different operators, different operations and different pilots within an operation have different training needs. Legislation and regulations governing the use of LOFT must allow flexibility to permit the fulfilment of these different needs for training. If a minimum number of simulation training hours is specified, an operator should be permitted to divide these hours among LOFT and the training of other skills in order to accomplish the objectives deemed most important by that particular operator.
- 2.2 Full-mission simulation may be used for purposes other than LOFT. Many of the following guidelines for scenario development may also be appropriate for the design of other full-mission simulation tasks. The primary factor which must govern the use of full-mission simulation is the specific objective for which it is being used and the specific context in which it is being applied.
- 2.3 All LOFT scenarios and flight segments should be designed on the basis of a detailed statement of specific objectives. These objectives must state what kind of situation is to be addressed and why.
- 2.4 The origin, routing and destination of a particular scenario should be dictated by the specific objectives for that scenario or leg. Other factors to be considered are the weather, operational and equipment problems, etc. Simulator visual systems, as well as other capabilities and limitations must be considered at a very early stage of scenario design. The simulator navigation area must be appropriate and must coincide with current charts. Similarly, current manuals and other operational documentation must be available to preserve realism.
- 2.5 Other factors to be considered are alternate airports, fuel, and air traffic control. The specifics of location choice will depend on the operator's needs. For example, if a situation is to be constructed around an air traffic control problem, one must choose a route where that problem is likely to occur.
- 2.6 Problems and anomalies should be chosen in terms of the specific objectives. Both simple problems (those that have no impact on the flight once they have been diagnosed and corrected) and complex problems (those that exert an influence on the remainder of the flight) may be used. Problems should not be compounded. The simultaneous presentation of multiple problems should not result from scenario design, although it may occur as a result of inappropriate crew action. LOFT scenarios should not be designed to "bury" or overload the crew. An accident should never be inevitable, although it is an outcome that may occur.
- 2.7 Sub-scenarios should be designed in order to anticipate crew actions as much as possible. It is wise to limit the crew's options to some extent. The LOFT co-ordinator (check pilot, instructor) should be in a position to follow alternative branches to a reasonable conclusion in many cases. The use of problems that cannot be corrected is permissible if those problems are appropriate to the objectives of the scenario. An example would be a failure of the landing gear to extend, resulting in a gear-up landing.
- 2.8 The pacing and tempo of a scenario must be appropriate to certain factors such as the location, the departure time, and the phase of flight. Most importantly, it must be appropriate to the specific objectives of that scenario. Designers should avoid totally filling a flight period. They should leave some time for lulls and periods of relative inactivity. The pacing of anomalies and other events must not detract either from the realism of the scenario or from the training potential of the situation.

- 2.9 Scripts should be designed in as much detail as possible in order to simulate the real world. A lack of detail requires the LOFT co-ordinator to improvise, which takes considerable time away from observation and evaluation of the crew. Such improvisation may also fail to accomplish the specific objectives of the scenario.
- 2.10 Communications under the control of the LOFT co-ordinator should be specified verbatim. The pacing and timing should be built in. Problem timing and input should be specified. Whenever a problem is injected, all anticipated crew actions should also be included in the scenario. Alternatives should also be specified where appropriate to modify the timing of a scenario. For example, if the crew executes an unexpected missed approach, an alternative course of action for the next leg may be necessary in order to stay within simulator time constraints. The LOFT co-ordinator may not add to or modify a scripted situation, but if the crew is observed to be so overloaded that further learning is impossible, reasonable judgement should be exercised to prevent further compounding of the crew's situation.
- 2.11 In the area of scenario revision and quality control after development, the scenario must be tested. Revisions will almost always be required. Even after further testing and, when required, approval by the aviation authorities, use of a scenario may reveal details that require further revision based on input from LOFT co-ordinators and line flight crews.
- 2.12 All scenarios must be kept current with respect to navigation, communications, regulations, company procedures and aircraft modifications. Accuracy of the scenarios with respect to hardware and software is essential to the credibility of LOFT.
- 2.13 Procedures and practices in the flight operations manuals or flight crew operating manuals that are known to be frequently misunderstood should be considered for inclusion in a LOFT scenario. For this purpose, also consider accident and maintenance reports, as well as incidents taken from information exchanges and confidential reporting systems, such as the NASA Aviation Safety Reporting System.
- 2.14 Under operational problems, include pre-flight, dispatch release, hazardous cargo, fuelling options, NOTAMs, etc.
- 2.15 Minimum equipment list (MEL) items, as well as cabin/passenger problems, ATC problems, and mass and balance problems are all good sources for LOFT scenarios.
- 2.16 Under environmental problems include weather, wind, temperature, runways that are wet, icy or closed and runway and touchdown zone lighting problems, as appropriate.
- 2.17 In the equipment problems category include, as appropriate, airborne equipment problems and ground equipment problems such as support equipment and ground-based radio aids.
- 2.18 Under crew problems include cabin crew problems, flight crew problems including incapacitation, either obvious or subtle.
- 2.19 Also consider other uses of full-mission simulation. It offers promise for several applications in training and other areas of interest to operators. The design of such simulations will depend on the specific objectives to be attained. Examples of the areas in which full-mission simulation can be of value are: initial training of new pilots, upgrade and transition training, some check-rides and evaluation of new procedures.

3 Performance Evaluation and Assessment

- 3.1 There is an apparent conflict inherent in the purpose versus the application of LOFT. To be effective, it must be accepted by the crew members and administered by the instructors as pure training. There is no such thing as a "no jeopardy" training exercise, since operators are charged with the responsibility of continuing training for those who require it. It is, however, essential that an atmosphere be created which allows the crew members to enter the training with a feeling of freedom, openness and enthusiasm. Reserve or defensiveness because of concern for "failure" must not inhibit participation.
- 3.2 To a considerable extent, conflict can be minimized by the manner in which the co-ordinator sets the scene during the pre-flight briefing, when it should be emphasized that:
- a) it is a purely a learning experience;
 - b) it is a training concept designed to emphasize crew command, co-ordination, communication, and full management of the available resources;
 - c) the co-ordinator will not interfere regardless of developments;
 - d) apparent mistakes may be made, but the crew should carry on since there is no one book solution to a LOFT exercise;
 - e) there will be an opportunity for a full self-analysis during the debriefing; and
 - f) the co-ordinator will take notes during the exercise and will assist in the debriefing.
- 3.3 The role of co-ordinator is not that of an instructor in the traditional sense. For example, realism considerations dictate that the co-ordinator will not intervene or intrude in any way into the LOFT scenario. Thus, for purposes of the debriefing, it is crucial that the co-ordinator serve primarily as a moderator.
- 3.4 In the experience of operators who use LOFT to good advantage, crews tend to debrief themselves. Self-criticism and self-examination are normally much more effective than a critique led by the co-ordinator. In fact, crews are often much harder on themselves than the co-ordinator would ever consider being. The co-ordinator should do everything possible to foster such self-analysis.
- 3.5 When serving as moderator, the co-ordinator can guide the discussion to points that need attention. Questions about certain procedures, mistakes, and so forth, should be asked whenever possible, and unless absolutely necessary, "lectures" about what is right and what is wrong should be avoided. A suggested format for the debriefing should include:
- a) a positive general statement opening the discussion;
 - b) a short review of the scenario, including the human factors and training objectives;
 - c) a discussion by crew members of the operation as a whole and in part;
 - d) coverage of all aspects of the flight, not permitting any one feature to dominate the debriefing;
 - e) reference to possible alternatives and better ways of accomplishing the objectives; and
 - f) further development of the discussion through the use of questions to each crew member, such as, "what if you had done ...".

- 3.6 With respect to evaluation and assessment, everything should be done to assure crews participating in LOFT that their jobs are not in jeopardy every time they enter the simulator for a LOFT session. While "satisfactory completion" is an inescapable aspect of LOFT, at the same time it is hard to imagine "unsatisfactory training". In some cases, LOFT may underscore areas which need extra attention, but often even serious mistakes made during LOFT are obvious and need no further attention. Note that a session which results in a "crash" may be a "satisfactorily completed" LOFT exercise, if the learning provided by the experience cannot be improved upon. However, in some cases, mistakes may indicate deficiencies that need additional work. The way that this is conveyed to a crew member is of vital importance and represents a challenge to the operators and their instructors.
- 3.7 During debriefing, both total crew performance and individual performances should be openly discussed and assessed by the co-ordinator. Critical assessment of an individual must be mentioned in the presence of the full crew, but remedial details should be handled separately. Tact is required to maintain the proper training atmosphere.
- 3.8 LOFT is, first and foremost, a learning experience. The success and acceptance of a LOFT programme depends in great measure on its planning and preparation. Scenarios must emphasize realism. Co-ordinators should be carefully selected and trained in the art of briefing, conducting the programme and debriefing.
- 3.9 Additional training for crew members, when indicated, must be handled in a low-key, non-threatening manner. If these factors are carefully handled, the evaluation/assessment chore will not necessarily detract from the pure training atmosphere, and will result in full acceptance.

4 Co-ordination Training and Qualifications

- 4.1 Each co-ordinator should have completed a specific training course on LOFT training. Generally, co-ordinators are selected from line pilots or check pilots flying the type of aircraft on which the LOFT training is given.
- 4.2 Some airlines are successfully using former pilots who have extensive airline experience but who are no longer current. In this case they should receive the ground and simulator part of the type-rating training course for the applicable type of aircraft. They should also be familiar with the current line operational procedure and should regularly ride the jump seat on typical line segments to observe operating procedures.
- 4.3 Where LOFT training involves a crew of three, the airline should have the flexibility of conducting the LOFT training with one co-ordinator appropriately trained for all crew positions.
- 4.4 **The role of the co-ordinator.** The role of the co-ordinator should be confined to the following:
- a) pre-flight briefing;
 - b) accurate conduct of a prescribed scenario in a realistic manner;
 - c) monitoring, recording, and assessing crew performance for the debriefing; and
 - d) performance of an objective debriefing, encouraging the use of self-critique to its maximum advantage.

- 4.5 **Specialized training for co-ordinators.** Instructors and check pilots selected to conduct LOFT exercises should receive training in the concepts and conduct of LOFT. Such training would include but not be limited to:
- a) the conduct of the crew briefing and complete familiarity with all pre-flight procedures, including flight plans, weather reports, minimum equipment lists, aircraft performance data, aircraft loading procedures, etc.;
 - b) observation and understanding of resource management, including the crew concept and crew co-ordination;
 - c) the pacing and selection of items in the LOFT scenario and the introduction of abnormal and emergency procedures or situations;
 - d) an in-depth understanding of observational, communication, command and leadership skills, as well as related psychological aspects;
 - e) development of the individual's own skills in interacting appropriately with the flight crew during the briefing, the LOFT exercise and the debriefing; and
 - f) training in assessment skills with appropriate guidance in specific areas such as the exercise of command responsibilities, planning, organization, interpersonal communications, problem solving, decisiveness, judgement, knowledge of aircraft systems and performance, knowledge of and compliance with aviation regulations and ATC procedures, sensitivity, leadership, assertiveness, smoothness and flying skill, work standards and crew co-ordination.
- 4.6 **Standardization of LOFT.** Standardization of LOFT will be achieved if co-ordinators are given a complete training programme at the outset, followed by periodic monitoring. Additionally, a feedback and critique programme using flight crew members is essential if such a programme is to work. Co-ordinator standardization is improved if LOFT co-ordinators monitor each other. Standardization can be more easily achieved if the LOFT co-ordinator group is small and works almost exclusively on the LOFT programme. LOFT should not be conducted by anyone other than a properly qualified co-ordinator, but the co-ordinator can perform other functions within a training department if necessary. Regular co-ordinator standardization meetings should be scheduled. During these sessions, LOFT scenarios can be assessed and re-evaluated for improvement.
- 4.7 **Other uses of full-mission simulation.** The following is a list of other uses:
- a) transition training or initial training;
 - b) developing familiarity with special airports;
 - c) format for check flights;
 - d) remedial training;
 - e) wind shear problems;
 - f) accident and incident investigations;
 - g) introduction to communications, clearances, checklist duties and route flying of new pilots;
 - h) evaluation of cockpit controls and flight instruments, and the assessment of human factors in the cockpit;
 - i) first officer training, such as VFR approach and departure techniques, traffic patterns and so on;
 - j) fuel management and assessment;

- k) developing techniques and procedures;
- l) developing take-off and landing skills;
- m) accident and incident scenario reviews;
- n) engine-out ferry training and qualifications;
- o) pre-mission reviews for special operations; and
- p) special handling training, such as high altitude stalls.

Appendix A LOFT Scenario Examples

1 Introduction

This appendix presents an example of how one airline views the conduct of LOFT, including written communications to all concerned and flight scenarios. This documentation was provided by the International Air Transport Association, courtesy of Pan American World Airways.

2 Notes

- 2.1 The scenarios comprise three versions of an A-310 flight from Washington Dulles International Airport to New York JFK International Airport.
- 2.2 There are subtle differences in the three scenarios when combined with the LOFT problem menu. The normal routing scenario is indicated by the code at the bottom of the page, LFT31011. The reroute scenario is annotated LRR31011. The turnback scenario is LTB31011. The 11 after the 310 is an indication of winter weather conditions.
- 2.3 The operator's "LOFT Problem Menu" for the A-310 aircraft, referred to in the scenarios, is described in the last two pages of the appendix.

October 5, 1988

Note to: All Training Captains
All Check Flight Engineer Officers
All Flight Engineer Instructors
All Operations Training Instructors

From: Senior Training Captain - Standards

Subject: The conduct of LOFT

It seems to have been only yesterday, but it has been a year since we first started annual training. Airmen will start returning for their annual training in October. Our work-load will increase noticeably and you will find yourself doing LOFT/PT periods where you may not have been for some time. The purpose of this letter is to discuss with you some thoughts and ideas as this annual training phase is about to begin.

It is becoming more and more obvious that flight safety is directly related not only to the technical and procedural aspects of what we do, but to the way we interact with others; in getting what we do safely accomplished. [Over the last decade, an increasing amount of evidence has accumulated suggesting that between 60 and 80 per cent of air carrier incidents and accidents have been caused, at least in part, by a failure of the flight crew to make use of readily available resources.]¹

With this in mind, let's review what LOFT is - what it is all about. Simply put, LOFT is Line-Oriented Flight Training. It is a simulator training period. But it is more than that. It is an opportunity for the crew and the instructor to **evaluate** how well the crew performed from a FORM (Flight Operations Resource Management) perspective.

LOFT is an opportunity for airmen to take a look at themselves through the eyes of others. The tools used are a video camera, fellow crewmembers, and a facilitator. The objective is to review how well each individual performed the various flight manoeuvres from a human factors point of view. How well were resources managed and utilized? Did the crew work together to solve the problems, or were one or more crewmembers excluded? Could the result have been better with team participation? It is a chance for **self-evaluation**. But even more importantly, it is an opportunity for the **crew** to critique how well they did as a unit. Could one member of the crew have done something else or more to enhance the crew's performance? If so, how could it have been made to happen? Could the atmosphere have been better - or could that person have been more assertive?

Each crew will be different - and therefore made up of different personalities and styles. How these different styles interact and perform together is the meat of FORM/LOFT training.

While it is true that we should know what FORM/LOFT is, we should also know what it is not. Quite clearly it is not the same as a new manoeuvre which must be practised all by itself. It is not an end unto itself. Much like a salad dressing, which you would not consider eating all by itself, Resource Management should not be looked at all by itself, but rather as an integral part of the whole flight operations effort. In the past we have looked at technical proficiency plus policy and procedural adherence. Now we look at Resource Management too.

1. Advisory Circular (Draft 1.1), CRM/LOFT Working Group, Training Subcommittee, Joint Government/Industry Task Force on Crew Performance - October 30, 1987

Our responsibilities, as conductors of LOFT, are many-faceted. Probably one of the most important things we can do is believe in the benefits of Resource Management, for only then can we effectively support the concept. Secondly, it is important for us to realize that we are an integral part of the FORM process. [For a CRM programme to produce more than short-term insight, it must be **reinforced** and **integrated** into a recurrent training programme.]¹ Regardless of how good our FORM Seminars are, one dose is not going to be enough. It is up to us to integrate and reinforce at every opportunity.

A properly conducted LOFT period starts with the briefing. The trainees should be briefed in general terms about what LOFT is (the NASA Line/LOFT Worksheet is a good guide). The crew should be informed that LOFT is an opportunity for them to practise and evaluate what they have learned from the FORM seminar and recurrent training. Our attitude here should not be one of "ask a lot of questions and I'll give you a high score on inquiry". We and the trainee **need** to evaluate **real** behavior, not something that's put on for just two hours of LOFT.

We should make the flight as realistic as possible. It should not resemble a "normal" training period with one problem or emergency after another. [LOFT is by definition a group performance training exercise that is undeniably relevant to any crewmember's job. In a properly designed LOFT scenario successful crew performance will **require** the co-ordinated efforts of all crewmembers.]² So let's stick with the script. If the scenario does not accomplish what it is supposed to, make a suggestion on how to improve it.

It is important to note that LOFT has equal importance with the PT portion of the training period. There are those who feel that it is even more important. Their argument stems from the fact that **every single air transport airplane that has crashed in recent history has been flown by a crew who has successfully completed PT and a PC within the preceding six to twelve months.**

Our conduct of the debriefing (critique) is critical to the effectiveness of the LOFT training. On one hand we don't need or want to watch the entire videotape, but on the other, we must resist the temptation to not use any of it. Our job is to help (facilitate) the trainees critique their performance. We should have paid close attention to their performance during the period and made notes of what we feel are examples of good or bad communication, assertion, critique, etc. (In particular, we should be aware of the impact the crew's use of Resource Management had on the conduct of the flight.) We should use the NASA Line/LOFT worksheet as a guide. Rewind and then replay those portions of the video where your notes indicate. Since reinforcement of FORM is the most critical phase of the learning process, let's remember that it will work if we do.

It is vital that the airmen see for themselves, by looking at their own performance, how important Resource Management is for efficient and safe flight operations. Remember, if we just **tell** them about FORM, they will forget. If we **show** them FORM, they may remember. But, if we **involve** them in the principles of Resource Management, they will understand it. And that's the first step in the process called FORM.

It is also important that we be able to correctly identify what is happening within the crew from a statistical point of view. It is from our observations that NASA will determine if our cockpit culture is changing. We are a very important part of the validation effort. Let's do our best!

1. Advisory Circular - October 30, 1987
2. Advisory Circular - October 30, 1987

General information regarding annual training which may be of interest to you follows:

1. Trainees will receive two days of ground school with a FORM refresher included (you may wish to review this material yourself).
2. Trainees who are incomplete or unsatisfactory due to proficiency on the PT or PC will be required to return in six months (this return will not change their anniversary date).
3. If we use three hours of the PT/LOFT period for PT and only one hour for LOFT, we are being unfair to the entire training process. Here's why: First, we cheat the airman of valuable training. Second, we are a part of the validation process. Part of our job is to find out if annual training, as it is presently constructed, works. We should do all we can within the framework as it exists to provide the airmen with the training they need. However, be aware that we skew the data we need to validate or invalidate annual training if we make up our own programmes.
4. LOFT will now precede PT. Most of us feel it's the best way and now the FAA goes along with us.
5. Airmen may request voluntary training six months after their Annual Training package. The procedure has not changed. The request must be in writing and once assigned, attendance is mandatory.
6. Please leave the video camera running after the LOFT period until the airmen actually get out of their seats. This will allow any post-mission critique to be captured for later review.
7. We have included the Charlie Plum video, "Building Prison Walls" in the FORM seminar. Anyone who would like a copy of this video, please contact Dave Jenkins or Bernie Lyons. Cost is yet to be determined, but will be less than \$10.00 we think.

David H. Jenkins

cc: System Director Flight Training
Director Flight Training - Resource Management/LOFT
Director Flight Training - A300, A310, A320
Director Flight Training - B727, B707, B737, B747
Director Flight Engineer Training

September 26, 1988

Note to: All Training Captains
All Check Flight Engineer Officers
All Flight Engineer Instructors

From: Director Resource MGT/LOFT

Subject: LOFT scenario revisions

October starts the second year of annual training. For the last six months very little LOFT/PT/PC has been conducted. Since that time there have been ATC changes which affected our LOFT scenarios. We have corrected our LOFT scenarios to reflect those changes and have modified the structure slightly. The changes are listed below.

1. The PT/LOFT simulator period has been **reversed**. LOFT will follow the briefing and precede the proficiency training as we had originally requested. LOFT periods will be conducted as before with video feedback in the debriefing. The PC is the second day.
2. The scenarios between IAD and JFK have been modified to reflect your input along with ATC changes. We have also changed the weather from a summer to a winter operation in this sector. The FRA/LHR scenario will remain the same with ATC corrections. It will be further modified during the next few months.
3. Additional problems have been added to the problem menus to give us an opportunity to exercise new dilemmas. We can always use some of your ideas to expand this list even more. Our goal is to provide the maximum potential for human factors exchange between crewmembers while keeping the blue side up.
4. We ask you to provide each airman with a "LOFT Survey Form" that you will pick up with the PT/PC worksheet in the records room. This will give the airman a chance to voice comments in a completely confidential manner. This form will be processed by the University of Texas in Austin under a NASA validation programme. It will help us determine the effectiveness of LOFT. Ask the airmen to deposit the completed surveys in the "LOFT Survey Box" located in the service center.

We can't stress enough how important each of your observations are during the LOFT part of the period. The debrief supported by the video feedback provides each crewmember with an opportunity for self-critique as an individual airman and more importantly as a team member. Please adhere as closely as possible to the scenarios you select and note the time of those interpersonal exchanges during the LOFT period for debrief in conjunction with the video feedback. Your **realistic** presentation of this simulated activity is a key to the success of the LOFT programme.

We would like to think that the material we have presented is error-free. In reality we know better, given our limited clerical capabilities. **We need your help to proof this material.** Please return any portion of the new (and old) material that needs correction. Utilize the hard copy for your correction. It will be easier to find on the computer disk. The quicker we correct these errors the easier it will be to convince our airmen that there is no "gotcha" in the paperwork. We will attempt to correct the material as soon as possible.

The "LOFT Co-ordinators" on each aircraft will be responsible for the paperwork supply that is required for the airmens' LOFT. Make sure that a reasonable supply is available

in each briefing room. The B-727 will need both the U.S. and the European scenarios for the 235 and the 2D4 simulators. We will make the initial distribution.

As the users of this material, you have the best perspective of how to make the LOFT more realistic. We solicit your ideas and expect you to critique this material as if it were a line trip. If it doesn't work as designed we need to fix it. You are the main source of that feedback. Please let us hear from you. Thanks!

Bernie Lyons

cc: System Director Flight Training
Director Flight Training A-300/310, B-727/737/747
Director Flight Engineering Training

PAN AM LOFT PROBLEM MENU (A-310)**REVISED (9-26-88)****Problems and/or situations**

- 1 Engine potential hot start
- 2 Engine stall
 - EGT exceeds 644 degrees
 - Engine shut down
- 3 Engine oil low pressure
 - Engine shutdown
- 4 Green hydraulic system failed
- 5 Bravo Whiskey Direct
 - "Clipper 594, New York, contact your company immediately on frequency_____." (Company frequency)*
 - (When contacted)
 - "Clipper 594, flight control, we have just been notified by Security of a Bravo Whiskey Direct for your flight. Security has confirmed the threat to be valid. We advise you to land immediately at_____ (Planned destination airport)."*
 - Provide assistance as requested.
 - Provide priority ATC handling.
 - Any runway available for landing.
- 6 Passenger threat
 - Flight attendant reports that a passenger has barricaded himself in an aft lavatory; he claims to have a gasoline bomb device (or hand grenade) which he continually threatens to detonate; he is demanding that the flight divert to _____ (Nicaragua, Beirut, Tehran, etc. as appropriate).
- 7 Communication failure
 - Crew loses all communications with air traffic control on normal VHF frequencies; also unable to establish contact on 121.5 or receive on VOR frequencies; maintain loss of communications as long as possible; attempted communications with approach control are successful; instructions are for the flight to *"continue last assigned clearance"*; give holding instructions if requested.
 - NOTE:** Reason for loss of all radios is massive explosion in the air traffic control building.
- 8 Passenger incapacitation (or intoxication)
 - Flight attendant reports that certain individual has suffered massive seizure of unknown type (or is extremely unruly and is purposely obstructing cabin crew duties).
- 9 Brake explosion/green system hydraulic failure
 - Brakes hot indication (any wheel) followed shortly thereafter by a green system hydraulic failure; flight attendant reports loud noise below floor; possible damage in the wheel well.

10 Suspicious object

Flight attendant finds device in lavatory area which resembles a bomb; device looks like two sticks of dynamite with ticking object attached with tape.

LOFT profile codes: LFT = Normal route between airports

LRR = Abnormal route between airports

LTB = Turnback or diversion

PAN AM LOFT SCENARIO (9-26-88)
CLIPPER 594 "HEAVY" IAD-JFK (A-310)
Problems 1, 5, 6, 7 (See problem menu)

1) SIM setup		Dulles runway 01R (#), Gate #3, taxi weight 233 900 lb, fuel 22 500 lb, take-off CG 29.2%, ceiling 1 000 ft, cloud tops 3 000 ft, visibility 10 000 RVR, OAT 30F (-2C), altimeter 29.59 Hg (1 002 mb), wind 020/8, QXI/OCI #1: Green-to-blue hydraulic PTU INOP. QXI/OCI #2: Left inner fuel tank pump 1 INOP. Insert Problem 1.
2) Dep ATIS	134.85	<i>"This is Washington Dulles departure information ZULU. Ceiling measured 900 overcast, visibility 2 miles in light snow, temperature 30, dew point 28, wind 020 at 8, altimeter 29.59. Departures expect runway 01 right. Inform clearance or ground control on initial contact that you have received information ZULU."</i>
3) Clearance delivery	127.35	<i>"Clipper 594 "Heavy", cleared to JFK, capital two departure as filed, maintain 4 000 ft, expect 17 000 ft ten minutes after take-off. Departure control frequency is 125.05, squawk 0523, contact ramp control on 129.55 prior to taxi."</i>
4) Routing		Radar vectors direct Baltimore, V-44, V-229 MORTN, V-44 CAMRN, direct JFK.
5) Ground support		Clearance to pressurize hydraulics, remove external electric (as appropriate). Clearance to start engines when requested. Remove external connections when directed. <i>"Standby for hand signals on your left."</i>
6) Ramp control	129.55	Receive pushback request. <i>"Clipper 594 "Heavy", cleared to push back, face east."</i> Receive taxi request. <i>"Clipper 594 "Heavy", taxi eastbound to taxiway Echo-1, turn right and taxi south, then contact Dulles ground control frequency 121.9."</i>
7) Ground control	121.9	<i>"Clipper 594 "Heavy", continue taxi and hold short of runway 01 right."</i>
8) Atlanta flight support	130.9	Receive blocks departure message.
9) PANOPS	129.7	Receive off blocks time and gallons of fuel added.
10) Load control	129.7	<i>"Clipper 594 "Heavy", load control. Your zero fuel weight is 210.6 with a CG of 27.2; your take-off weight is 233.1 with a CG of 29.2. Passenger load is 12 first class, 21 clipper, and 103 coach. Stabilizer setting is 0.1 up."</i>
11) Ground control	121.9	(Approaching runway 01R) <i>"Clipper 594 "Heavy", contact Dulles tower, frequency 120.1."</i>
12) Tower	120.1	<i>"Clipper 594 "Heavy", wind 330 at 15 maintain runway heading, cleared for take-off."</i>
13) Tower	120.1	<i>"Clipper 594 "Heavy", turn right heading 080, vectors on course, contact departure control frequency 125.05."</i>

14) Departure control	125.05	<i>"Clipper 594 "Heavy", radar contact, continue heading 080, vectors to Baltimore, climb to and maintain 6 000 ft, receiving Baltimore cleared direct."</i>
15) Departure control	125.05	(Approximately 20 miles west of Baltimore VOR) <i>"Clipper 594 "Heavy", continue climb, maintain 17 000 ft, contact Washington Centre on 133.9."</i>
16) Washington Centre	133.9	<i>"Clipper 594 "Heavy", radar contact, maintain 17 000 ft and cleared via flight plan route."</i>
17) Atlanta flight support	131.25	Receive airborne message.
18) Washington Centre	133.9	(Approximately 41 miles west of Sea Isle) <i>"Clipper 594 "Heavy", contact Washington Centre on 127.7."</i>
19) Washington Centre	127.7	<i>"Clipper 594 "Heavy", radar contact, maintain 17 000 ft."</i>
20) ARVL ATIS	115.4"	<i>"This is Kennedy International Airport information WHISKEY. Sky condition 800 overcast, visibility 1 and 1/4 mile in snow. Temperature 29, dew point 27, wind 310 at 3 knots, altimeter 29.75. Arrivals expect VOR/DME approach runway 22L. Notice to airmen, ILS 22L out of service. Departures expect runway 22R. Inform New York approach control on initial contact that you have received Kennedy arrival information WHISKEY."</i>
21) Washington Centre	127.7	(Overhead Atlantic City) <i>"Clipper 594 "Heavy", descend and maintain 10 000 ft, Kennedy altimeter 29.75 Hg (1 007.5 mb)."</i>
22) Washington Centre	127.7	(5 miles northeast of Atlantic City) <i>"Clipper 594 "Heavy", contact New York Centre on 128.3."</i>
23) New York Centre	128.3	<i>"Clipper 594 "Heavy", radar contact, maintain 10 000 ft, cleared CAMRN one arrival JFK."</i>
24) SIM setup		JFK runway 22L (#), ceiling 800 ft, cloud tops 6 000 ft, visibility 8 000 RVR, temperature 29F (-6C), altimeter 29.75 Hg (1 007.5 mb), wind 210/04.
25) Problem		(10 miles northeast of Atlantic City) Insert Problem 5 or 6 or 7.
26) PANOPS	131.37	(Receive in-range message) <i>"Clipper 594 "Heavy", you can expect gate number 3, enter via taxiway KILO."</i> Provide assistance as requested.
27) New York Centre	128.3	(5 miles southwest of CAMRN) <i>"Clipper 594 "Heavy", contact New York approach control on frequency 127.4."</i>
28) New York approach control	127.4	<i>Clipper 594 "Heavy", radar contact, fly heading 040 and descend to 3 000 ft. Vectors for the VOR final approach course runway 22 left."</i> (on final vector) <i>"Clipper 594 "Heavy", cleared for the approach, contact Kennedy tower on frequency 119.1."</i>
29) Kennedy tower	119.1	<i>"Clipper 594 "Heavy", wind 210 at 4 knots, cleared to land on runway 22 left."</i>

30) Kennedy tower	119.1	(During rollout) <i>"Clipper 594 "Heavy", turn right first available taxiway, hold short of runway 22 right, remain this frequency."</i>
31) PANOPS	131.37	Provide assistance as requested.
32) Kennedy tower	119.1	(Approaching runway 04 left) <i>"Clipper 594 "Heavy", cross runway 22 right, left on the inner, contact Kennedy ground control on frequency 121.9."</i>
33) Kennedy ground	121.9	<i>"Clipper 594 "Heavy", taxi via the inner to your gate."</i>
34) Atlanta flight support	131.25	Receive blocks arrival message.

LOFT profile codes: LFT = Normal route between airports

LRR = Abnormal route between airports

LTB = Turnback or diversion

Alternate Weather Reports (If Requested)

Newark: 300 obscured. Visibility 1/2 mile, snow, fog. Temperature 30, dew point 29, wind 350 at 5 knots, altimeter 29.72.

Philadelphia: 400 obscured. Visibility 1/2 mile, snow, fog. Temperature 31, dew point 29, wind 010 at 4 knots, altimeter 29.70.

Boston: Measured 800 overcast. Visibility 3 miles, snow. Temperature 15, dew point 11, wind 010 at 7 knots, altimeter 29.58.

Bradley: Measured 400 overcast. Visibility 3/4 mile, snow. Temperature 20, dew point 17, wind 020 at 5 knots, altimeter 29.68.

Baltimore: Estimated 400 overcast. Visibility 1 mile, snow, fog. Temperature 30, dew point 27, wind 020 at 7 knots, altimeter 29.59.

Andrews AFB: Measured 400 overcast. Visibility 1 mile, snow. Temperature 31, dew point 27, wind 020 at 5 knots. Altimeter 29.60.

PAN AM LOFT SCENARIO (9-26-88)
CLIPPER 594 "HEAVY" IAD-JFK (A-310)
Problems 1, 2, 3, 4 (See problem menu)

1) SIM setup		Dulles runway 01R (#), Gate #3, taxi weight 233 900 lb, fuel 22 500 lb, take-off CG 29.2%, ceiling 1 000 ft, cloud tops 3 000 ft, visibility 10 000 RVR, OAT 30F (-2C), altimeter 29.59 Hg (1 002 mb), wind 020/8, QXI/OCI #1: Green-to-blue hydraulic PTU INOP. QXI/OCI #2: Left inner fuel tank pump 1 INOP. Insert Problem 1.
2) Dep ATIS	134.85	<i>"This is Washington Dulles departure information ZULU. Ceiling measured 900 overcast, visibility 2 miles in light snow, temperature 30, dew point 28, wind 020 at 8, altimeter 29.59. Departures expect runway 01 right. Inform clearance or ground control on initial contact that you have received information ZULU."</i>
3) Clearance delivery	127.35	<i>"Clipper 594 "Heavy", cleared to JFK capital two departure as filed, maintain 4 000 ft, expect 17 000 ft ten minutes after take-off. Departure control frequency is 125.05, squawk 0523, contact Dulles ramp control on 129.55 prior to taxi."</i>
4) Routing		Radar vectors direct Baltimore, V-44, V-229 MORTN, V-44 CAMRN, direct JFK.
5) Ground support		Clearance to pressurize hydraulics, remove external electric (as appropriate). Clearance to start engines when requested. Remove external connections when directed. <i>"Standby for hand signals on your left."</i>
6) Ramp control	129.55	Receive pushback request. <i>"Clipper 594 "Heavy", cleared to push back, face east."</i> Receive taxi request. <i>"Clipper 594 "Heavy", taxi eastbound to taxiway Echo-1, turn right and taxi south, then contact Dulles ground control frequency 121.9."</i>
7) Ground control	121.9	<i>"Clipper 594 "Heavy", continue taxi and hold short of runway 01 right."</i>
8) Atlanta flight support	130.9	Receive blocks departure message.
9) PANOPS	129.7	Receive off blocks time and gallons of fuel added.
10) Load control	129.7	<i>"Clipper 594 "Heavy", load control. Your zero fuel weight is 210.6 with a CG of 27.2; your take-off weight is 233.1 with a CG of 29.2. Passenger load is 12 first class, 21 clipper, and 103 coach. Stabilizer setting is 0.1 up."</i>
11) Ground control	121.9	(Approaching runway 01R) <i>"Clipper 594 "Heavy", contact Dulles tower, frequency 120.1."</i>
12) Tower	120.1	<i>"Clipper 594 "Heavy", wind 020/8, fly runway heading, cleared for take-off."</i>

13) Tower	120.1	<i>"Clipper 594 "Heavy", contact departure control frequency 125.05."</i>
14) Departure control	125.05	<i>"Clipper 594 "Heavy", radar contact, continue heading 080, vectors to Baltimore, climb to and maintain 6 000 ft, receiving Baltimore cleared direct."</i>
15) Departure control	125.05	(Approximately 20 miles west of Baltimore VOR) <i>"Clipper 594 "Heavy", contact Washington Centre on 133.9."</i>
16) Washington Centre	133.9	<i>"Clipper 594 "Heavy", radar contact, maintain 17 000 ft and cleared via flight plan route."</i>
17) Atlanta flight support	131.25	Receive airborne message.
18) Washington Centre	133.9	(Approximately 41 miles west of Sea Isle) <i>"Clipper 594 "Heavy", contact Washington Centre on 127.7"</i>
19) Washington Centre	127.7	<i>"Clipper 594 "Heavy", radar contact, maintain 17 000 ft."</i>
20) ARVL ATIS	115.4"	<i>"This is Kennedy International Airport information WHISKEY. Sky condition 800 overcast, visibility 1 and 1/4 mile in snow. Temperature 29, dew point 27, wind 310 at 3 knots, altimeter 29.75. Arrivals expect VOR/DME approach runway 22L. Notice to airmen, ILS 22L out of service. Departures expect runway 22R. Inform New York approach control on initial contact that you have received Kennedy arrival information WHISKEY."</i>
21) SIM setup		JFK runway 22L (#), ceiling 800 ft, cloud tops 6 000 ft, visibility 8 000 RVR, temperature 29F (-6C), altimeter 29.75 Hg (1 007.5 mb), wind 210/04.
22) Washington Centre	127.7	(10 miles southeast of Atlantic City) <i>Clipper 594 "Heavy", radar contact lost due to Centre computer failure. We have a routing change for you when ready to copy"</i> <i>"Clearance limit is the "ZIGGI" intersection. Proceed direct Atlantic City. Depart Atlantic City on V-184 to "ZIGGI" intersection. Expect possible hold at "ZIGGI". Slow to 250 kt, then descend to 8,000 ft. The Atlantic City altimeter is 29.69. Read back."</i>
23) Washington Centre	127.7	(5 miles northeast of Atlantic City) <i>"Clipper 594 "Heavy", contact New York Centre on 128.3."</i>
24) New York Centre	128.3	<i>"Clipper 594 "Heavy", radar contact, maintain 8 000 ft, cleared V-184 "ZIGGI" direct JFK."</i>
25) Problem		(10 miles northeast of Atlantic City on V-184) Insert Problem 2 or 3 or 4
26) New York Centre	128.3	(Approaching "ZIGGI" intersection) <i>"Clipper 594 "Heavy", contact New York approach control on frequency 127.4."</i>
27) New York approach control	127.4	<i>"Clipper 594 "Heavy", depart "ZIGGI" heading 040, vectors for the VOR final approach course runway 22 left. Descend to 7 000 ft, Kennedy altimeter is 29.75 Hg (1 007.5 mb)."</i> Provide vectors for the approach.

28) PANOPS	131.37	(Receive in-range message) <i>"Clipper 594 "Heavy", you can expect gate number 3, enter via taxiway KILO."</i> Provide assistance as requested.
29) New York approach control	127.4	(on final vector) <i>"Clipper 594 "Heavy", cleared for the approach, contact Kennedy tower on frequency 119.1."</i>
30) Kennedy tower	119.1	"Clipper 594 "Heavy", wind 210/04 knots, cleared to land on runway 22 left."
31) Kennedy tower	119.1	(During rollout) <i>"Clipper 594 "Heavy", turn right first available taxiway, hold short of runway 22 right, remain this frequency."</i>
32) PANOPS	131.37	Provide assistance as requested.
33) Kennedy tower	119.1	(Approaching runway 04 left) <i>"Clipper 594 "Heavy", cross runway 22 right, left on the inner, contact Kennedy ground control on frequency 121.9."</i>
34) Kennedy ground	121.9	<i>"Clipper 594 "Heavy", taxi via the inner to your gate."</i>
35) Atlanta flight support	131.25	Receive blocks arrival message.

LOFT profile codes: LFT = Normal route between airports

LRR = Abnormal route between airports

LTB = Turnback or diversion

Alternate Weather Reports (If Requested)

Newark:	300 obscured. Visibility 1/2 mile, snow, fog. Temperature 30, dew point 29, wind 350 at 5 knots, altimeter 29.72.
Philadelphia:	400 obscured. Visibility 1/2 mile, snow, fog. Temperature 31, dew point 29, wind 010 at 4 knots, altimeter 29.70.
Boston:	Measured 800 overcast. Visibility 3 miles, snow. Temperature 15, dew point 11, wind 010 at 7 knots, altimeter 29.58.
Bradley:	Measured 400 overcast. Visibility 3/4 mile, snow. Temperature 20, dew point 17, wind 020 at 5 knots, altimeter 29.68.
Baltimore:	Estimated 400 overcast. Visibility 1 mile, snow, fog. Temperature 30, dew point 27, wind 020 at 7 knots, altimeter 29.59.
Andrews AFB:	Measured 400 overcast. Visibility 1 mile, snow. Temperature 31, dew point 27, wind 020 at 5 knots. Altimeter 29.60.

PAN AM LOFT SCENARIO (9-26-88)
CLIPPER 594 "HEAVY" IAD-JFK (A-310)
Problems 1, 8, 9, 10 (See problem menu)

1) SIM setup		Dulles runway 01R (#), Gate #3, taxi weight 233 900 lb, fuel 22 500 lb, take-off CG 29.2%, ceiling 1 000 ft, cloud tops 3 000 ft, visibility 10 000 RVR, OAT 30F (-2C), altimeter 29.59 Hg (1 002 mb), wind 020/8, OXI/OCL #1: Green-to-blue hydraulic PTU INOP. OXI/OCL #2: Left inner fuel tank pump 1 INOP. Insert Problem 1.
2) Dep ATIS	134.85	<i>"This is Washington Dulles departure information ZULU. Ceiling measured 900 overcast, visibility 2 miles in light snow, temperature 30, dew point 28, wind 020 at 8, altimeter 29.59. Departures expect runway 01 right. Inform clearance or ground control on initial contact that you have received information ZULU."</i>
3) Clearance delivery	127.35	<i>"Clipper 594 "Heavy", cleared to JFK capital two departure as filed, fly runway heading for vectors on course, maintain 4 000 ft, expect 17 000 ft ten minutes after take-off. Departure control frequency is 125.05, squawk 0523, contact Dulles ramp control on 129.55 prior to taxi."</i>
4) Routing		Radar vectors direct Baltimore, V-44, V-229 MORTN, V-44 CAMRN, direct JFK.
5) Ground support		Clearance to pressurize hydraulics, remove external electric (as appropriate). Clearance to start engines when requested. Remove external connections when directed. <i>"Standby for hand signals on your left."</i>
6) Ramp control	129.55	Receive pushback request. <i>"Clipper 594 "Heavy", cleared to push back, face east."</i> Receive taxi request. <i>"Clipper 594 "Heavy", taxi eastbound to taxiway Echo-1, turn right and taxi south, then contact Dulles ground control frequency 121.9."</i>
7) Ground control	121.9	<i>"Clipper 594 "Heavy", continue taxi runway 01 right."</i>
8) Atlanta flight support	130.9	Receive blocks departure message.
9) PANOPS	129.7	Receive off blocks time and gallons of fuel added.
10) Load control	129.7	<i>"Clipper 594 "Heavy", load control. Your zero fuel weight is 210.6 with a CG of 27.2; your take-off weight is 233.1 with a CG of 29.2. Passenger load is 12 first class, 21 clipper, and 103 coach. Stabilizer setting is 0.1 up."</i>
11) Ground control	121.9	(Approaching runway 01R) <i>"Clipper 594 "Heavy", contact Dulles tower, frequency 120.1."</i>
12) Tower	120.1	<i>"Clipper 594 "Heavy", wind 020/8, fly runway heading, cleared for take-off."</i>
13) Tower	120.1	<i>"Clipper 594 "Heavy", turn right heading 080, vectors on course, contact departure control frequency 125.05."</i>

14) Departure control	125.05	<i>"Clipper 594 "Heavy", radar contact, continue heading 080, vectors to Baltimore, climb to and maintain 6 000 ft, receiving Baltimore cleared direct."</i>
15) Departure control	125.05	(Approximately 20 miles west of Baltimore VOR) <i>"Clipper 594 "Heavy", contact Washington Centre on 133.9."</i>
16) Washington Centre	133.9	<i>"Clipper 594 "Heavy", radar contact, maintain 17 000 ft and cleared via flight plan route."</i>
17) Atlanta flight support	131.25	Receive airborne message.
18) Problem		(Approximately overhead Baltimore) Insert Problem 8 or 9 or 10.
19) Washington Centre	133.9	(When requested) <i>"Clipper 594 "Heavy", for vectors back to Dulles, turn right heading 250, descend to 10 000 ft, Dulles altimeter 29.59 Hg (1 002 mb)."</i> Provide information as requested. Provide return (or diversion) vectors.
20) ARVL ATIS	135.85	<i>"This is Washington Dulles arrival information CHARLIE. Ceiling measured 900 overcast, visibility 2 miles in light snow, temperature 30, dewpoint 28, wind 020 at 8, altimeter 29.59. Arrivals expect ILS approach runway 01 right, departures runway 01 right. Notice to airmen, ILS runway 01 right glideslope out of service. Inform Dulles approach control that you have received arrival information CHARLIE."</i>
21) PANOPS	129.7	Receive in-range message. Provide assistance as requested.
22) SIM setup		IAD runway 01 right (#), ceiling 800 ft, cloud tops 3 000 ft, visibility 10 000 RVR, OAT 30F (-2C), altimeter 29.59 Hg (1 002 mb), wind 020/8, Glideslope 01 right inoperative.
23) Washington Centre	133.9	(Approximately 20 miles east of Dulles) <i>"Clipper 594 "Heavy", contact Dulles approach control on frequency 120.45."</i>
24) Approach control	120.45	<i>"Clipper 594 "Heavy", radar contact, maintain heading 250, descend to 3 000 ft, vectors for the ILS final approach course runway 01 right, Dulles altimeter is 29.59 Hg (1 002 mb)."</i> Provide assistance as requested. Any runway available upon request. (on final vector) <i>"Clipper 594 "Heavy", contact Dulles tower, frequency 120.1."</i>
25) Tower	120.1	<i>"Clipper 594 "Heavy", wind 020/8, cleared to land runway 01 right."</i> (During rollout) <i>"Clipper 594 "Heavy", contact Dulles ground control frequency 121.9."</i>
26) Dulles ground	121.9	<i>"Clipper 594 "Heavy", taxi to your gate." (or to remote parking)</i> Provide assistance as requested.
27) PANOPS	129.7	Provide assistance as requested.

LOFT profile codes: LFT = Normal route between airports

LRR = Abnormal route between airports

LTB = Turnback or diversion

Alternate Weather Reports (If Requested)

Newark: 300 obscured. Visibility 1/2 mile, snow, fog. Temperature 30, dew point 29, wind 350 at 5 knots, altimeter 29.72.

Philadelphia: 400 obscured. Visibility 1/2 mile, snow, fog. Temperature 31, dew point 29, wind 010 at 4 knots, altimeter 29.70.

Boston: Measured 800 overcast. Visibility 3 miles, snow. Temperature 15, dew point 11, wind 010 at 7 knots, altimeter 29.58.

Bradley: Measured 400 overcast. Visibility 3/4 mile, snow. Temperature 20, dew point 17, wind 020 at 5 knots, altimeter 29.68.

Baltimore: Estimated 400 overcast. Visibility 1 mile, snow, fog. Temperature 30, dew point 27, wind 020 at 7 knots, altimeter 29.59.

Andrews AFB: Measured 400 overcast. Visibility 1 mile, snow. Temperature 31, dew point 27, wind 020 at 5 knots. Altimeter 29.60.