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# **Resource Management on the Flight Deck**

Proceedings of a NASA/Industry Workshop  
Held at  
San Francisco, California  
June 26-28, 1979

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# **Resource Management on the Flight Deck**

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## PREFACE

The fostering of increased awareness and use of available resources by aircrews under high workload conditions is becoming a matter of greater concern to the airlines. New research and training programs to enhance aircrew capabilities are being developed, largely independently, by the various organizations involved. The timing appeared appropriate for an exchange of ideas and information to facilitate these activities, and, accordingly, a NASA-Industry Workshop devoted to Resource Management on the Flight Deck was organized by G. E. Cooper Associates for the Aviation Safety Research Office of Ames Research Center. The Workshop was held at the Jack Tar Hotel in San Francisco, California, June 26-28, 1979. Participants included senior officers of major airlines who are responsible for aircrew training; representatives of cognizant government agencies; and specialists in human factors work as it applies to aircrew operations.

This report presents the proceedings of the Workshop. In some cases the papers are taken from a verbatim transcript of the proceedings; in other cases, they represent formal submittals. John K. Lauber, Ames Research Center, NASA, and Capt. A. A. Frink, Pan American World Airlines, were cochairmen of the Workshop.

The Workshop comprised four sessions:

Session 1. Formal presentations by nonindustry representatives on the background and human factors aspects of the problem.

Session 2. Formal presentations by airline representatives describing current industry approaches to training for resource management.

Session 3. Small-group discussions and analyses by participants, aimed at developing conclusions and recommendations for effective resource management training. Results were reported to assembled participants by chairmen of the individual groups. A general discussion of working group reports is included.

Session 4. Summary of the Workshop.





## CONTENTS

	<u>Page</u>
PREFACE .....	iii
SESSION 1. BACKGROUND AND HUMAN FACTORS ASPECTS OF THE PROBLEM.....	1
Resource Management on the Flight Deck: Background and Statement of the Problem	
John K. Lauber.....	3
Social Psychology on the Flight Deck	
Robert L. Helmreich.....	17
Aviation Accidents and the "Theory of the Situation"	
Lee Bolman.....	31
SESSION 2. CURRENT INDUSTRY APPROACHES TO RESOURCE MANAGEMENT TRAINING.....	59
Flight Crew Selection at United Airlines	
Capt. William Traub.....	61
British Airways' Pre-Command Training Program	
Capt. L. F. J. Holdstock.....	76
Upgrade and Interpersonal Skills Training at American Airlines	
Capt. W. W. Estridge and J. L. Mansfield.....	87
Captains' Training at Swissair	
Capt. N. Grob.....	97
Line-Oriented Flight Training	
Capt. Berton E. Beach.....	107
Flight Manager and Check-Airman Training	
Capt. J. E. Carroll.....	119
Left Seat Command and/or Leadership? Flight Leadership Training and Research at North Central Airlines	
Capt. Gramer C. Foster and Michael C. Garvey.....	133
SESSION 3. THE WHAT, WHEN, AND HOW OF RESOURCE MANAGEMENT TRAINING — NASA/INDUSTRY WORKING GROUP MEETINGS.....	147
INTRODUCTION	
Capt. A. A. Frink, Chairman.....	149

## CONTENTS (Concluded)

	<u>Page</u>
GROUP REPORTS (in order of presentation)	
Group 5. Recurrent Training and Line Operation Capt. Ron Sessa.....	152
Group 1. Selection and Initial Training Capt. R. E. Crump.....	156
Group 2. Recurrent Training and Line Operation R. C. Houston.....	161
Group 3. Transition and Upgrade Training Capt. L. F. J. Holdstock.....	165
Group 4. Selection and Initial Training Capt. Berton Beach.....	169
Group 6. Transition and Upgrade Training Lawson White.....	173
PANEL DISCUSSION.....	178
SESSION 4. CONCLUDING REMARKS.....	193
SUMMARY OF THE WORKSHOP Charles E. Billings.....	194
CLOSING REMARKS Capt. A. A. Frink .....	203
APPENDIX A. WORKSHOP PARTICIPANTS.....	205
APPENDIX B. SUPPLEMENTARY WORKING PAPERS.....	207
Initial Upgrading from Copilot to Captain Capt. G. Grünewald.....	209
Training — Economic and Safety Considerations Capt. R. E. Norman, Jr.....	221
Calculated Risk or Blind Assumption? Gerard M. Bruggink.....	227
Managing Emergencies in Jet Transport Operations Gerard M. Bruggink.....	233
APPENDIX C. INSTRUCTIONS FOR WORKING GROUPS.....	245

SESSION 1

BACKGROUND AND HUMAN FACTORS ASPECTS OF THE PROBLEM

John K. Lauber, Chairman

Resource Management on the Flight Deck:  
Background and Statement of the Problem

John K. Lauber, Ames Research Center, NASA

Social Psychology on the Flight Deck

Robert L. Helmreich, University of Texas

Aviation Accidents and the "Theory of the Situation"

Lee Bolman, Harvard University



## RESOURCE MANAGEMENT ON THE FLIGHT DECK:

### BACKGROUND AND STATEMENT OF THE PROBLEM

John K. Lauber<sup>\*</sup>

### INTRODUCTION

The thesis presented in this paper is straightforward: one of the principal causes of incidents and accidents in civil jet transport operations is the lack of effective management of available resources by the flight-deck crew. It is further argued that present aircrew training programs could be augmented to improve flight-deck management. The purpose of this paper is to discuss previous research and other data that lead to these conclusions, and to present some concepts that help to define the problem and to suggest some possible approaches toward its solution.

### THE PILOT INTERVIEW STUDY

The present human-factors-in-aviation-safety research program at Ames Research Center was begun in 1973. In an effort to identify the most relevant and pressing research issues, and to learn more about the human factors problems encountered during routine line operations, NASA conducted structured, confidential interviews with airline crewmembers. This interview problem, which was conducted with the full cooperation of management and union representatives, resulted in a number of interesting issues being brought to the attention of the NASA research team. Of most direct interest here were issues related to crew training and, specifically, training for new captains. Generally, those pilots who mentioned training during the interviews expressed satisfaction with the training they receive in the technical aspects of flying and in flying skills. The difficulty related more to issues such as how to be a more effective leader, and how to achieve more effective crew coordination and improved communication within the cockpit. One new captain stated the problem as follows: "My company trains pilots very well, but not captains — command training is needed." A flight engineer felt strongly that "Pilots, particularly captains, ought to be given specific training in human behavior and human relationships...there is too much emphasis on the technical side of flying, and too little upon these 'softer' issues." Many other comments were received that pointed to a general feeling among flight crewmembers that there is a need for training in areas other than manual control and systems operations.

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## FULL-MISSION SIMULATION STUDY

The next major stimulus for conducting the resource management training research came from a full-mission simulation study conducted by Ruffell Smith and colleagues (ref. 1). That study, which made use of a B-747 training simulator, analyzed the frequency and kinds of errors committed by qualified line crews during a simulated routine line trip segment, and during a segment in which a mechanical problem was introduced that necessitated an engine shutdown and a diversion from the original flight plan. All normal communications were simulated, as well as other factors that are known to be distracting, but not inherently dangerous. For example, during the more difficult second segment, a cabin attendant frequently called the cockpit via the crew interphone to make various requests or ask questions of the flight crew. Other elements of the simulation included ATC services, weather, closed runways at the diversion airport, and an inoperative autopilot, which further increased pilot workload. The scenarios were constructed in such a way that good crew coordination, cockpit communications, decisionmaking, and planning skills were required, but not so complex as to preclude an entirely safe operation provided these steps were taken.

Twenty volunteer line crews flew these simulated trips. The variety of behavior observed was most illuminating. Problems were observed in communication, decisionmaking, crew interaction and integration, and in an area subsequently called "resource management." Specifically it appeared to Ruffell Smith and his colleagues that one of the major variables that influenced how effectively and safely a crew handled the problem situations presented them was their effectiveness in identifying and utilizing the various material and human resources available to them. The effects of strong leadership, or the lack thereof, were readily apparent, and greatly influenced the frequency and severity of the errors observed.

Events surrounding one particular section of the high workload scenario were particularly illuminating with regard to the resource management issue. Because of the forced diversion, it was necessary to dump fuel in order to reduce the aircraft gross weight to an acceptable value for landing. During the fuel dump procedure, which places a particularly heavy load on the flight engineer, the cabin attendant called the flight engineer with a request to call in a list of passenger names so that suitable connections to their destinations could be made. Many of the flight engineers attempted to comply with this request, and the subsequent diversion of attention from the fuel dumping procedure led to some interesting errors, including one instance of a 100,000 lb error in calculating the aircraft gross weight. Of particular interest here, however, were the various ways different captains managed the situation, and the effect of this on the kinds and frequencies of errors committed. In some instances, the captain played a very active management role by setting priorities and directing the flight engineer to postpone the call to the company until after the fuel dump and other more important operational requirements were met. In these instances, relatively few errors were observed. In other cases, however, the captain

either failed to note the request from the cabin attendant, or did nothing to intervene in the situation. Many errors were noted in these circumstances, and it was this specific series of observations that led most directly to the identification of resource management behavior as being a most important variable in flight-deck operations and to the subsequent effort to stimulate the development of improved training for resource management skills.

#### AIRCRAFT ACCIDENT DATA

In order to gain more insight into the resource management problem and to obtain resource material that might be used in a resource management training program, NASA project personnel undertook a review and analysis of jet transport accidents. On the basis of this review, more than 60 accidents in the period 1968-1976 were identified in which resource management problems played a significant role (see table 1 for a complete list). Some examples follow.

In December 1972, a wide-body transport aircraft crashed in the Everglades near Miami while the flight crew was attempting to replace a faulty nose gear light. The subsequent investigation revealed the following sequence of events as reported in the official accident report:

At 2336:04 the captain instructed the first officer, *who was flying the aircraft* [italics added], to engage the autopilot.

A minute later:

The first officer successfully removed the nose gear light lens assembly, but it jammed when he attempted to replace it.

At 2338:34, the captain again directed the second officer to descend into the forward electronics bay and check the alignment of the nose gear indices.

From 2338:56 to 2341:05, the captain and the first officer discussed the faulty nose gear position light lens assembly and how it might have been inserted incorrectly.

At 2340:38, a half-second C-Chord which indicated a deviation of +/-250 ft from the selected altitude sounded in the cockpit. No crew member commented on the C-chord. No pitch change to correct for the loss of altitude was recorded.

At 2342:12...the aircraft crashed into the Everglades.



The NTSB report continued:

The Board is aware of the distractions that can interrupt the routine of flight. Such distractions usually do not affect the other flight requirements because of their short duration or their routine integration into the flying task. However, the following took place in this accident:

1. The approach and landing routine was interrupted by an abnormal gear indication.
2. The aircraft was flown to a safe altitude, and the autopilot was engaged to reduce workload, *but positive delegation of aircraft control was not accomplished* [italics added].
3. The nose gear position light lens assembly was removed and incorrectly reinstalled.
4. The first officer *became preoccupied* [italics added] with his attempts to remove the jammed light assembly.
5. The captain *divided his attention* [italics added] between attempts to help the first officer and orders to the other crewmembers to try other approaches to the problem.
6. The flight crew devoted approximately 4 min to the distraction, with minimal regard for other flight requirements.

And finally:

The captain failed to assure that a pilot was monitoring the progress of the aircraft at all times.

In the same month as that in which the previous accident occurred, a B-737 crashed short of the runway at Midway airport in Chicago. As in the previous accident, a minor mechanical malfunction distracted the flight crew sufficiently so that position awareness was apparently lost. The aircraft crossed the Final Approach Fix 700 ft above the published minimum crossing altitude, with the aircraft not configured for the landing.

The official accident report states:

The preponderance of evidence indicates that the rush of cockpit activities during the final descent caused a breakdown of the safeguards inherent in the task-sharing of a crew. The error-provoking environment set the stage for the crew's failure to notice that the spoilers were still extended at level-off and to arrest the rapid deterioration of airspeed that followed.

Although a greater portion of this analysis deals with the events surrounding the level-off, the board wishes to emphasize that the accident sequence was triggered by *the captain's failure to exercise positive flight management earlier during the approach* [italics added].

In still another jet transport accident, the NTSB wrote:

Contributing causal factors were...the captain's failure to delegate any meaningful responsibilities to the copilot which resulted in a lack of effective task sharing during the emergency.

After a more recent accident in which a cargo liner crashed into high terrain while the flight crew was attempting to resolve a mechanical problem, the NTSB wrote:

Since this type of situation is dynamic because the aircraft must be flown while the malfunction is resolved, it follows that the captain *must manage the flight crew* [italics added] in a manner which will insure absolute safe operation of the aircraft during the interim...It remains that the captain's first and foremost responsibility is to insure safe operation of the aircraft. To achieve this objective, he must relegate other activities accordingly.

These accidents share some common factors, each of which is an element of the resource management problem. Listed below are the most frequently observed problems in these accidents.

- Preoccupation with minor mechanical problems
- Inadequate leadership
- Failure to delegate tasks and assign responsibilities
- Failure to set priorities
- Inadequate monitoring
- Failure to utilize available data
- Failure to communicate intent and plans

Collectively, the items listed above suggest a definition of "resource management" and also suggest some possible training objectives that should be addressed by any resource management training program. It is interesting to note that these factors were also observed in the Ruffell Smith study, and are also common features of the aircraft incident data discussed below.

## AIRCRAFT INCIDENT DATA

In addition to reviewing the transport accident record, a search of the Aviation Safety Reporting System data base was conducted. The objectives of this search were similar to the objectives of the accident analysis, namely, to obtain additional data that further refine our understanding of resource management as it applies to flight-deck operations, and to find material that may have educational value. At the time the search was conducted, the ASRS data base contained nearly 7,000 reports. The search, which covered jet transport operations only, recovered 670 incident reports that were relevant to the issue of resource management. Some typical examples of ASRS incident reports follow.

During the captain's PA talk to the passengers, we received a change of heading and altitude from 9,000 up to 14,000. The captain started the climb and changed power while talking. When he finished talking, the first officer said to turn left to 160°. The captain turned the aircraft and kept climbing--16,000 ft was in the altitude reminder window. We leveled off at 16,000 and called departure control and requested higher. We were advised that we should be on Center frequency. We called Center, and he asked if this was our first call. We said yes, and Center asked for our altitude. We replied 16,000, and Center said we should be at 14,000, but to climb instead to FL230. We did. We don't know who put 16,000 in the window of of the altitude reminder; we could not recall any conversation about changing to Center. I feel that it is possible that the captain misunderstood the 160 as an altitude instead of a heading and put 160 in the altitude reminder. First officer was busy with something else and didn't see the wrong altitude in the window. Neither the captain nor the first officer remember putting 160 in the window.

Another report which illustrates another aspect of the problem was received from an airline captain:

Our aircraft arrived in Omaha. I went into the operations office to check the weather. On returning to the aircraft I asked the first officer if we had an ATC clearance. He replied that we did. I asked him what it was. He said, "Cleared as filed, maintain 5,000, expect 11,000 10 min after departure." Our flight plans are all Center-stored and I asked him how we were filed so that I could verify the routing I had on my Center-stored flight plan. The first officer's "as filed" was the same as mine, namely, V159 STJ direct MCI. The departure went normally. We were handed off to Center (Minneapolis) as I flew the aircraft on the previous routing to 11,000 ft. We crossed OMA VOR and proceeded on course V159. Approximately 25 miles from OMA

VOR, Center asked if we were flying the Omaha 1 Arrival. I answered that we weren't, that it was my understanding we were cleared V159. He said that we weren't, but that we could work it out with Kansas City. Handoff was effected, and Kansas City turned us to 165° and vectored us to the approach gate at MCI. I again asked the first officer for the clearance that he copied. He said that it was his mistake, that he did not know what an "Omaha 1 Arrival" meant, that he checked my approach plates and his, and that neither of us had an Omaha SID by that name, so he ignored it but read the clearance back without mentioning the SID and that clearance delivery accepted the read-back. Furthermore, he said that he did not think to ask me about the Omaha 1 arrival when I returned to the aircraft. I felt like I had been sold down the river by an otherwise very trustworthy, competent first officer. Clearly, he made a serious mistake, as I suppose I did in not checking the clearance with clearance delivery. To do so, however, would surely leave your first officer with the feeling that "This guy doesn't trust me," which is now the case. But on the other hand, trust and coordination are definitely necessary for a safe operation. While cross-check is a healthy worthwhile cockpit activity, it becomes counter-productive when one crewmember feels that "I'm getting a check ride" from the other crewmembers. For this reason, I probably won't question the next clearance I get from this or any other first officer, but I'll be uneasy. The nagging fear that he may have miscopied or misunderstood will be in the back of my mind. Many of our days require 14 hr in the cockpit, and the physiological needs of crewmembers necessitate that all are not going to be present in the cockpit at all times.

One other element of the problem was observed in both the full-mission simulation study and in the accident data. The following report illustrates problems that can stem from personality clashes in the cockpit:

The ceiling was below minimums, reported as 200 ft, 3/4 miles visibility. Winds were variable from a crosswind to a tailwind (possible wind shear), and there were thunderstorms, rain, and turbulence. We were holding about 20 miles out of Boston. Because the visibility was legal, approach control was clearing airplanes for approaches. A couple did get in, but with all things considered, I decided not to make an approach. Now, my copilot is a very experienced pilot (which most of them are nowadays) — he became a cockpit lawyer. He wanted to get home, he questioned all my decisions, actually trying to intimidate me, demanding explanations of everything I said. We were very busy changing holding points, altitudes, changing alternates, refiguring fuel, etc. He was making the whole job harder. I decided an approach was not the best thing, and went to the

alternate. There seem to be a lot of copilots taking over the cockpit. Now there must be captains allowing this, because I see a lot of my copilots trying to run my cockpit lately. I do think that there are captains who allow the copilot to intimidate them.

Miles Murphy, one of the NASA project personnel, undertook a detailed analysis of a sample of 250 of the 670 reports. On the basis of these data, Murphy developed the analysis of skills, organization and process variables, and resources summarized in table 2. It can be seen that these categories could be applied to the jet transport accident data discussed above or to the data obtained by Ruffell Smith. It is also apparent that the information in the table might provide the foundation for an approach to developing effective resource management behavior — these are the skills that should be trained.

#### APPROACHES TO THE PROBLEM

Training, which is the focus of this workshop, is only one of several possible approaches to the problem. Others, which could be undertaken separately or in tandem with the training approach, include safety awareness publications and programs, and the adoption of some operational procedures that might help to avoid situations such as those seen in incidents and accidents. Some of these alternatives are briefly discussed below.

It is possible that a major step forward may be taken by programs that create an awareness of the problem by flight-deck crewmembers. Aviation has traditionally used "hangar flying" as an informal but important source of operational and safety related information. Flight operations newsletters, flight safety bulletins, and similar material may be very effective in creating more understanding of the problem and developing effective solutions. Much of this material could be developed from incident data reported to the ASRS and from aircraft accident data. It is difficult to assess the effectiveness or completeness of this approach because of its voluntary nature (on the part of individual pilots). However, these programs are relatively inexpensive and probably cost effective.

Another approach that might be used is the adoption of some operational guidelines or rules that if applied properly by crewmembers might assist the crew in exercising proper flight-deck resource management. Listed below are some examples of operating rules that could be applied to flight operations. These are presented as examples only, and it must be understood that they have not been reviewed or evaluated. They are intended to provoke discussion and to stimulate the development of new ideas and approaches.

1. In any abnormal situation, positive delegation of flying and monitoring responsibilities must be the top priority action item.

2. Positive delegation of monitoring responsibilities is as important as positive delegation of flying responsibilities.

3. The pilot flying must not attempt to perform secondary tasks (e.g., PA announcements) during dynamic flight situations (e.g., climbing, descending, turning).

4. Whenever there are conflicting interpretations of fact, for example, clearances, external sources of information must be used to resolve the conflict. Never rely on the "confidence" of yourself or a fellow crewmember to resolve ambiguities or conflicts.

5. Whenever there is conflicting information from two sources, or information of questionable validity from one source, cross-checking from an independent source is a necessity.

6. If any crewmember has a doubt about a clearance, procedure, or situation, he or she must make that doubt known to the other crewmembers.

#### SUMMARY AND CONCLUSIONS

This paper has attempted to define a specific problem, namely, that there is a demonstrated requirement to improve the abilities of flight-deck crewmembers to identify and utilize or manage the resources that are available to them. Furthermore, the paper has attempted to identify some of the specific skills required, and to suggest, in general terms, the directions which might be taken to address the problem. All of this material is intended to serve as background, to set the stage for the remainder of this conference. Much remains to be done to develop specific recommendations for what skills need to be trained and how such training should be conducted; these are the objectives of this workshop, and each of you will play a major role in achieving those objectives. To assist you, we have arranged for the following presentations — two conceptual papers from the academic world, and a series of presentations from your industry, describing various approaches currently being taken to develop leadership and management skills in line pilots. The material presented in these papers is intended to serve as additional fuel — to stimulate the flow of ideas and concepts that might be applied to the problems described in this paper. We have thus far only defined a problem — the solutions must come from you.

TABLE 1. - AIRLINE ACCIDENTS

Date	Operation	Site
U.S. airline accidents		
1. 06/22/68	JL DC-8	San Francisco, CA
2. 01/20/70	TI DC-9	Harlingen, TX
3. 02/01/70	NC CV-580	Detroit, MI
4. 07/27/70	FT DC-8	Okinawa
5. 09/08/70	DL DC-9	Louisville, KY
6. 09/08/70	TV DC-8	Jamaica, NY
7. 09/29/70	BN B-720	Dallas, TX
8. 12/28/70	TQ B-727	St. Thomas, V.I.
9. 01/11/71	DL DC-9	Jackson, MS
10. 02/17/71	SO DC-9	Gulfport, MS
11. 03/19/71	UA B-727	Denver, CO
12. 06/06/71	RW DC-9	Duarte, CA
13. 06/07/71	AL CV-500	New Haven, CT
14. 07/19/71	UA B-737	Philadelphia, PA
15. 07/23/71	UA B-747	Chicago, IL
16. 07/30/71	PA B-747	San Francisco, CA
17. 08/04/71	CO B-707/CNA	Compton, CA
18. 09/04/71	WC B-727	Juneau, AK
19. 12/21/71	EA B-727	Atlanta, GA
20. 03/03/72	MO FH-227B	Albany, NY
21. 05/18/72	EA DC-9	Ft. Lauderdale, FL
22. 06/14/72	SO DC-9	Chicago, IL
23. 09/01/72	TW B-747	Jamaica, NY
24. 12/08/72	UA B-737	Chicago, IL
25. 12/12/72	TW B-707	Jamaica, NY
26. 12/19/72	EA L-1011	Miami, FL
27. 12/20/72	NC DC-9/DL CV-880	Chicago, IL
28. 01/12/73	EA L-1011	Miami, FL
29. 04/10/73	EA B-727	Toledo, OH
30. 07/31/73	DL DC-9	Boston, MA
31. 09/08/73	WO DC-8	King Cove, AK
32. 12/17/73	EA DC-9	Greensboro, NC
33. 01/16/74	TW B-707	Los Angeles, CA
34. 01/17/74	TW B-707	Indianapolis, IN
35. 01/30/74	PA B-707	Pago Pago, Samoa
36. 07/03/74	DL L-1011	Atlanta, GA
37. 09/11/74	EA DC-9	Charlotte, NC
38. 12/01/74	TW B-727	Berryville, VA
39. 12/01/74	NW B-727	Thiells, NY
40. 03/31/75	WA B-737	Casper, WY
41. 06/24/75	EA B-727	Jamaica, NY
42. 12/12/75	EA B-727	Raleigh, NC
43. 04/27/76	AA B-727	St. Thomas, V.I.
44. 12/12/76	WC B-727	Ketchikan, AK

TABLE 1. - Concluded

Date	Operation	Site
Foreign airline accidents		
1. 01/05/70	Spantax CV-990	Stockholm, Sweden
2. 09/15/71	AZ DC-8	Jamaica, NY
3. 01/22/72	PK B-720B	Ankara, Turkey
4. 01/29/71	CP/TN DC-8/B-727	Sydney, Australia
5. 06/14/72	JL DC-8	Delhi, India
6. 06/18/72	BE Trident	Paris, France
7. 11/28/72	JL DC-8	Moscow, USSR
8. 03/12/73	WO/SN DC-8/CRV	Land's End, England
9. 03/05/73	IB DC-9/Spantax CV-990	Nantes, France
10. 06/23/73	LL DC-8	Jamaica, NY
11. 07/11/73	RG B-707	Paris, France
12. 08/13/73	AO CRV	Coruna, Spain
13. 06/17/73	IB DC-10	Boston, MA
14. 06/06/74	Brit. Air Tours B-707	Crete
15. 06/21/74	DX B-727	Luton, England
16. 09/05/74	BA B-747	Nairobi, Kenya
17. 12/04/74	Martinair, DC-8	Sri Lanka
18. 05/11/76	BA B-747	Kuala Lumpur



TABLE 2. - CLASSIFICATION OF IDENTIFIED PROBLEMS

- I. Social and communication skills
  - Strained social relations
  - Assertiveness
  - Nonverification of communications
  - Unnecessary communications
  - Withholding communications
  - Assumptions about other understanding
  - Assumptions about meaning
  - Assumptions about message
- II. Leadership and management skills
  - Delegation of authority
  - Erosion of authority
  - Captain's trust-doubt dilemma
  - Lack of decisive command
  - Discipline and leadership in applying regulations
  - Casualness in cockpit
  - Crew coordination
  - Time structuring, priorities
- III. Planning, problem solving, and decision skills
  - Inadequate planning
  - Information retrieval
  - Quality and timeliness of information
  - Credibility of information
  - Problem solving strategies
  - Staying ahead of the problem (crises prevention)
  - Decision under stress
  - Group think
- IV. Role
  - Definition/understanding (pilot-copilot)
  - Command responsibility of captain when first officer flying
  - Responsibility of 1st officer when captain deviates from safe or legal practices
  - Reduced command options
  - Workload
  - Task allocation
  - Monitoring
  - Backup
  - Callouts

TABLE 2. - Concluded

V. Resources

Human

Individual differences in  
knowledge, proficiency,  
experience, motivation,  
stress reaction

Fatigue

Material

Facilities

Availability

Adequacy

Human engineering

Equipment

Availability

Access

Adequacy

Human engineering

Automatics vs manual

Textual information

Availability

Access

Adequacy

Human engineering

Environmental information

Availability

Adequacy

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## Social Psychology on the Flight Deck

Robert L. Helmreich\*

### Abstract

Social psychological and personality factors that can influence resource management on the flight deck are discussed. It is argued that personality and situational factors intersect to determine crew responses and that assessment of performance under full crew and mission conditions can provide the most valuable information about relevant factors. The possibility of training procedures to improve performance on these dimensions is discussed.

NASA research has developed a strong case for the need to understand and improve resource management on the flight deck. Examination of data from full mission simulations, as well as from transcripts of accident reports and ASRS incident reports, convincingly documents how less than optimal management and utilization of human resources in the cockpit can lead to disastrous outcomes. Considering flight crews as small groups, a number of social psychological factors can be isolated that are relevant to crew performance. These would certainly include leadership, group relations, and communications patterns. I hope today to look at the flight deck from the perspective

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\* University of Texas at Austin.

of a personality and social psychologist

Much of my own research over the past 15 years has dealt with situational and personality determinants of crew performance under conditions of high stress. My research activities have dealt largely with the Navy and NASA's space program rather than commercial aviation, but I hope to argue convincingly that the psychological factors involved are highly similar.

By way of preface, I would like to say a few words about psychology's contribution to understanding crew performance. Everyone, of course, is aware of the contribution human factors research has made to technical performance. Personality psychology has concentrated on the development of psychometric instruments for personnel selection and for the prediction of performance and/or adjustment. Social psychology has focused on group processes relevant to individual and crew performance. Before attempting to argue that social and personality psychology can contribute to this area, it might be worthwhile to explore some of the reasons why it has not been heavily utilized.

One problem with personality assessment has been a strong emphasis on screening out unlikely or psychopathological candidates rather than selecting in prospects with optimal psychological characteristics. Part of the problem comes from a lack of consensus regarding just what an optimum psychological profile consists of. Further, one must decide what the criteria for validation of selection procedures should be. Should one look at successful line operation over an extended period or at performance in emergency situations, or at some weighted combination of these and other measures? I will return to the question of reactions

in different situations later.

Social psychologists, on the other hand, have tended to ignore personality variables and to concentrate on tightly controlled laboratory experiments. Such studies may have great scientific rigor, but the consumers of research have rightly questioned the generality of such research to the complexities of real world problems such as combat or aviation.

But perhaps the most serious failing in our approach to complex problems of crew performance comes from ignoring the fact that behavior is a function of the interaction of personality and situational factors. What I mean is the realization that behavior in any given situation is jointly determined by an individual's personality and by the nature of the situation. The personality type associated with the best performance in one setting could be associated with failure in another. As I have noted, personality psychologists have concentrated on personality typologies rather than the implications of personality types in a range of situations while social psychologists have been equally cavalier in ignoring the impact of personality in situations, focusing almost completely on specifying the aspects of the particular situation associated with behavioral outcomes.

Examination of the field suggests that a healthy awareness of these problems has developed along with much more sophisticated methodologies, that enable the examination of complex situations in a rigorous manner. Unfortunately, we have only begun to demonstrate what we can do with our newly-gained expertise. In the remainder of my presentation, I will discuss some of the personality and situational variables that I see as

crucial for resource management in aviation. As an aside, let me note that I am aware of the severe constraints that operate on any large organization involved with selection and maintenance of high level personnel. The person with the best psychological profile may be deficient physically or may lack technical expertise on any combination of the above. Once selected, a rigid seniority system can over-ride other considerations in crew composition. The challenge is to obtain the optimal outcome within these constraints.

A large number of personality dimensions have been specified through research, many with considerable overlap. Obviously, one must choose by some means the subset of characteristics deemed relevant to the situation at hand. In our research, we have begun with performance and group adjustment and have worked toward the isolation of relevant trait clusters. Let me describe the possible implications of two trait dimensions across several hypothetical situations. We have found two dimensions to be strongly and widely related to group and individual reactions. The first cluster can be called instrumentality or goal orientation. The second cluster can be called expressivity or group orientation. Persons high on this dimension tend to be sensitive to the feelings of others and interpersonally warm.

How theoretically should these dimensions relate to flight-deck performance? In routine flying one would expect a moderate relationship between performance and goal orientation and a minimal relationship between performance and group orientation. One could predict, however, that those high in group orientation would establish warmer and more effective working and personal relationships with all co-workers.

In the case of individual performance in emergencies, I would expect the highly goal oriented individual to excel. In general, instrumentality would seem a good candidate as a selection measure and expressivity a nice, but non-essential factor. Validation using line performance and simulator performance in emergencies should verify the relevance of goal orientation and the lesser importance of group orientation.

However, from the perspective of resource management and the contention that a significant proportion of accidents involves a failure to work optimally as a team, a different approach is suggested. Validation of predictors of crew performance, to the best of my knowledge, typically does not involve assessing the reactions of a complete crew during conditions of work overload or other in-flight crises. It is my thesis that validation under these conditions might suggest a different constellation of optimal personal characteristics. I would argue that when total crew response to crisis is examined, the best outcome (operationally defined as optimal responses to the situation by all crew members) might be in crews where the captain in particular was high in both goal and group orientation. Such individuals might be expected to be both competent in dealing with the technical aspects of the problem and attuned to the reactions and performance of others.

My interest here is not to develop an argument for the adoption of a new set of personality measures. Rather, I am trying to stress that if the premise that resource management and associated group performance are important contributing factors to efficient line operation, then the



evaluation of individual performance may fail to capture the crucial dimensions of crew behavior in stressful situations.

I cannot resist an aside on the personality issue, however. In discussing resource management and flight crew performance with a number of experts, one of the major points which emerged spontaneously was the "problem of the macho pilot." This has also been an issue of some importance with astronauts, particularly in the reluctance to accept females and to shift to a different mode of operation with the space shuttle. I won't get into trying to define "macho" because I think definitions of this type of individual are widely shared. We have been concerned with this personality type in our research, especially in evaluating relations between the sexes and their relation to performance. Suffice it to say that the personality constellation which most closely approximates the macho image is the highly instrumental-low expressive one.

Turning to more general social psychological factors which may influence crew performance, let me first define the social environment of the flight deck. Although the primary group of interest consists of the Captain, First Officer and Flight Engineer, the critical social network is larger and more complex. In thinking about social interaction it is essential to include those in voice communication and intermittent direct contact. Thus the system should include Air Traffic Controllers, Company Operations, the Cabin Crew and indirectly, the passengers.

The Air Traffic Controller is a central figure in the social network and his role in flight deck operation should be considered. For

example, take the recent study of potential accidents by NASA around which there has been controversy (as written up, for example, recently in Science). One interpretation of the data is that there may be a greater risk of collision, as measured by incident reports, when under direct control. Without becoming embroiled in arguments about the need for control and differences in risk at various locations, it seems worth noting that a line of social psychological research would predict decreased vigilance under positive control. This research has to do with diffusion of responsibility. This series of investigations was stimulated by the observed phenomenon of individuals failing to take action in emergencies or redefining the situation as non-threatening when others are present and capable of taking action. The most widely cited example is the murder of Kitty Genovese outside her apartment. She was stabbed repeatedly over a 30 minute period while 38 people watched and none called the police. Individuals in such situations may have a diminished sense of responsibility, feeling, perhaps unconsciously, that others will handle the incident. It is possible that being under positive control leads to reduced vigilance on the part of crews, even though they are fully aware of their responsibility for the aircraft.

Indeed, the increasing automation of aircraft functions may serve the undesired function of reducing the crew's sense of autonomy and personal responsibility. In a recent interview, a senior Captain made the following comments: "We are the best trained instrument pilots in the world, but we're not training to look out the window any more. It's easy to go cross-country on radar, and have somebody else do everything

for you. Sometimes we say to each other up there that the janitor could fly the plane as well as we do!"

In a similar vein, consider the social psychological ramifications of data from the full mission simulation study conducted by Ruffell Smith. The data suggest a higher error rate when a particular crewmember is in a state of work overload. In many continuing abnormal situations or emergencies, such as engine failure, in addition to dealing with the operation of the aircraft, it is necessary to coordinate the actions of the cabin crew and to communicate with the passengers. In several instances, for example, the assumption of control of the aircraft by the Captain while attempting to make important overall decisions concerning the flight was associated with serious errors.

I find no reason to question the authenticity of these findings. Indeed, I would expect such outcomes to be more frequent in emergencies during line operations than during simulations because of the objective danger.

What are some of the implications of overload on pilots during non-routine flying conditions? From a psychological viewpoint, the leader, decisionmaker is the least appropriate person to be overburdened. Given that research shows a narrowing of perceptual attention under stress, one can argue that it is probably not optimal to involve the Captain in multi-processing a variety of tasks--such as flying the plane, coordinating the activities of the flight and cabin crew, and making the ultimate decisions regarding actions to be taken. It is likely that the quality of each of these activities will be

degraded if all are undertaken simultaneously.

Another psychological factor can add to the burden on the Captain. This is increased dependency of crew members on the Captain under stress. In our research on groups under stress and in a number of other studies, group members are seen to become increasingly dependent on the leader under high stress conditions. Thus, the Captain is likely to bear additional responsibility for monitoring and directing the performance of the crew. Conversely, by failing to monitor the responsibilities of other crew members during the critical period, the Captain may seriously overload other crew members. An example of the negative effects of overload on the flight engineer was nicely shown in the Ruffell Smith study.

Along with increased dependency under stress, crew members may also experience a diminished sense of responsibility in an emergency, placing more of the responsibility on the leadership of the Captain. This could be intensified if the Captain relieves the First Officer of flying responsibility. Indeed, the exercise of leadership by the Captain in critical situations probably represents a clear example of a personality by situation interaction. As an hypothesized example, the authoritarian type of individual may be generally disliked as a Captain in normal operations. Such an individual may, on the other hand, take charge very effectively in emergencies and be well suited to coping with the dependency of crew members. The democratic, socially concerned leader might be highly valued during routine operations, but find it more difficult to assume a strong leadership role when the situation demands it. It is possible that specific training in role performance conducted

with groups under simulated routine and emergency conditions could improve performance markedly.

Another social psychological aspect of emergency situations which warrants attention is the management of communications. Given a perceptual narrowing and a high density of necessary internal and external communications in critical situations, it is quite possible that breakdowns in the processing of important communications could play a significant role in crew errors. An important task of the Captain would appear to be maintaining close supervision of all communications, eliminating unnecessary communications and ensuring that all critical data are understood. This is obviously an implicit part of the Captain's role, but I would bet a tank of gas that a significant number of communication breakdowns can be observed under high workload and emergency situations.

Another type of person-situation interaction that I think is likely to emerge concerns situations involving crews with a female member. From my own research assessing the performance of women in demanding roles under high stress, I have every reason to believe that the individual performance of female flight crew members will be equal to that of men in every respect. I further suspect that normal, line operations involving female flight personnel should show no differences. However, in work overload and emergency situations where male crew members have reservations about the competence of females, crew performance may be seriously impaired. The recommendations and/or actions of the female may be questioned or not accepted. Male crew members may take over some of the female's responsibilities, creating

further work overloads. In the case of a female Captain, the junior male crew may attempt to usurp the Captain's responsibilities. If this sounds far-fetched, it can be pointed out that such occurrences were noted among several all-male crews in the Ruffell Smith study. A similar complaint about attempted take-over of Captain's responsibilities by a very senior First Officer can be found in the ASRS reports. In any event, I would argue that as women become more widely integrated into crews, the question of crew coordination under stressful conditions should be investigated with high priority. Our friend the "macho pilot" is likely to play the pivotal role in such scenarios. The following relevant views were attributed to a pilot in a recent story in the Washington Post. "He did say that even though the men pilots don't slander their female co-workers when flying, most would rather not fly with a woman. He added that being a pilot calls for and attracts a very powerful, if not 'macho', personality."

On a more negative note, I would like to mention a line of research that has been quite influential in organizations. This is the examination of the relationship between group cohesiveness (defined as the mutual attraction of group members and their sense of group membership) and performance. In general, it has been noted that highly cohesive crews also show superior performance. This has led to a number of attempts in organizational settings to institute training programs to improve group climate and cohesiveness with the assumption that improved group relations will lead to improved performance. The results have been distinctly mixed. Our research with well-motivated professional crews (in this case with Aquanauts working underwater in a very

structured environment during Project Tektite) suggests a rather different sequence of courses. In looking at performance and group climate over extended periods of time we found that positive changes in crew performance led to more group cohesiveness while positive changes in cohesiveness had no influence on performance. This suggests that many training programs have been dealing with effects rather than causes. In other words, training efforts could more profitably be directed toward facilitating group performance, in which case group relations should be quite good. A part of such training might include emphasis on how personality types influence group performance in different types of situations.

I have only touched on a few instances where I feel social psychological factors may have a significant impact on flight deck performance. I feel strongly, though, that a case is developing for the importance of human resource management for safety in flight operations. I would suggest that a two-tiered approach to the issue might be optimal.

First, I feel that additional data on the influence of social factors on performance during work overload and emergency situations are needed. Controlled data of this sort can best be obtained during full mission simulations. However, an important additional source of data would be the social psychological analysis of cockpit and flight recorder data from accidents where NTSB investigation has concluded that crew error has played a significant part.

Assuming that unequivocal evidence can be amassed showing decrements in performance and less than optimal reactions to abnormal

situations as a function of social psychological factors, it should be quite feasible to develop training procedures to help crews cope with such situations more effectively and even to improve person/situation fit. In my opinion, mission simulations with extensive critiques of group as well as individual performance would be the most impactful means of implementing this. I also believe that highly effective training tapes could be developed highlighting the types of deleterious resource management isolated in such research.

As a final note, I would stress that from a social psychologist's viewpoint, a program in resource management will only be successful if it is apparent to line personnel that it has the complete and unequivocal support of management. The implementation of such a shift in training must also be done with some delicacy regarding the self-images of crew members. I think an example from the merchant marine is highly instructive. One of the major oil companies which operates a large tanker fleet did a careful analysis of Captain's duties and concluded that the Captain's job definition really consists primarily of the management of complex resources, both human and material. It was therefore decided that the job description should reflect this. Accordingly, all of the fleet captains were informed that, effective immediately, they were no longer Captains of their vessels but instead were Shipboard Managers. Somewhat to management's surprise, the reactions of these managers was distinctly hostile. Their title somehow failed to capture the image of salt-spray and rolling seas which they had spent years acquiring.

I doubt if the title Aircraft Manager would find much acceptance



among your Captains even though it may reflect the reality of today's operations. On the other hand, I feel that concrete demonstrations of the need for crew coordination and careful management of resources will lead to rapid acceptance of the concept. The Ruffell Smith study provides a good starting point. The very favorable reactions of the crews involved suggest that awareness of a problem area can come rapidly under the proper conditions.

Our case is not proven, but I hope that time will bear out the importance of dealing with social psychological factors on the flight deck. I feel that we can demonstrate quite conclusively that a significant contribution can be made to your operations. If we convince you of this, social psychology can assume a place as a significant resource in commercial aviation.

AVIATION ACCIDENTS AND  
THE 'THEORY OF THE SITUATION'<sup>1</sup>

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## ABSTRACT

Flight crews can never be entirely certain that they know for sure the situation of their flight. Inevitably, they develop 'theories of the situation'--a set of goals, beliefs, and behaviors that provides a coherent picture of what is happening and what action is appropriate. In many routine situations, those theories accord so closely with reality, that there is little stimulus to be concerned about the validity and appropriateness of the theory. In more complex and difficult situations, the chances of error in the theory become much higher. The skills and willingness of a flight crew to be alert to possible errors in the theory become critical to their effectiveness and their ability to ensure a safe flight.

The paper identifies several major factors that determine the likelihood that a faulty theory will be detected and revised:

1. The 'theories of practice' that pilots have developed through training and experience--and particularly the degree to which those theories build in inquiry and testing in situations of confusion, anomaly, and crisis.
2. The abilities of crew members to combine skills in advocacy and inquiry.
- 3.. The management skills and style of the captain.
4. The degree to which the role system in the cockpit is well understood, and procedures for role-modification are mutually shared.

All of this has implications for the training of pilots. It is, of course, critical that they receive training in all of the technical aspects of flying an airplane. But it is equally critical that they learn to recognize their own historic patterns for learning, for relating with others, and for managing. They need to understand how to combine

authority with learning, fast response time with flexibility, precision and clarity with willingness to modify. They need to understand the dynamics of role systems, how to create an effective and mutually understood set of role relationships, and how to modify those relationships quickly without creating confusion, overlaps and gaps.

---The captain of a 727 believes he is cleared to an altitude of 1800 feet, even though his approach chart indicates that the altitude is unsafe. Even after noting the problem and discussing it with the crew, he takes no action because he believes ground control would not have cleared him if there were a problem. The plane crashes, and 92 people die.

---An airline crew is having a problem with their plane's landing gear. They neither consult the manual nor ask for help from ground support, either of which might have shown them how to solve the problem. At landing, part of the landing gear collapses and the plane skids off the runway, causing considerable damage to the plane (but no injuries to passengers).

---The crew of a 1011 discovers during an approach that the light on their nose gear is not on, and begin to circle while attempting to correct the problem. The crew apparently assume that altitude is being monitored, but fail to detect an unintended descent. The plane crashes on a clear night. 99 people are killed, and 77 others are injured.

In each case, the captain (or the entire crew) was operating on the basis of a 'theory of the situation' -- a set of beliefs about what was happening and what actions it was appropriate to take. In each case, there was data available to indicate that the theory of the situation was in error. In the first case, the contradictory data was assumed away. In the second case, the crew did not seek data that might have alerted them to their error. In the third, the crew focused so heavily on one element of the situation (the nose gear light), that they inattended to easily available data that would have alerted them to a serious problem. In each case, the error in the theory of the situation led to erroneous action, and in turn to accident or disaster.

If an erroneous 'theory of the situation' (TOS) can lead to serious errors, it become important to explore several related questions:

1. How do pilots (and other humans) create a TOS?

2. What are the factors in background and experience which influence the TOS that a pilot is likely to use?
3. How can education and training activities reduce the probability of errors in a TOS?
4. What are the situational factors that increase the likelihood that pilots will recognize errors in their TOS?

A. What determines the theory of the situation?

The TOS is a short-term theory used by an individual to analyze and make decisions about the immediate environment. As individuals move through different situations, their TOS's change continually. The TOS 'I am in the supermarket buying food' is very different from the TOS 'I am landing a 727 under very difficult weather conditions'. Human effectiveness depends heavily on the degree of correspondence between a TOS and the environment. Error occurs when a TOS and the environment are mismatched. An example is the case in which the crew assumed that the altitude must be safe because they had already received approach clearance from ground control.

The TOS that an individual uses in any given situation is determined by long-term characteristics of the person, short-term characteristics of the situation, and by the interaction between the two.

We can divide the long-term characteristics of the person into two major categories: (1) fundamental cognitive and behavioral parameters in humans; (2) the 'theory of practice' that informs the behavior of a particular individual. The latter may be viewed as a long-term theory (i.e., a theory which is relatively stable, and evolves only through relatively slow, developmental processes). The 'theory of practice' is used by the individual to design, test and implement 'theories of the

situation'. Without a theory of practice, the individual could not have any coherent understanding of a situation.

### 1. Cognitive and Behavioral Parameters

There are very important limits on human cognition. Humans can attend to only a very limited number of discrete phenomena at any one time, and have very severe limits on short-term memory. What constitutes a 'discrete phenomenon' is heavily dependent on prior learning. I am not a pilot, and when I look at the controls on an airplane (even a very small, propellor plane), I find the entire thing confusing. I have never learned a set of 'patterns' that would enable me to organize a large number of discrete bits of information into a single, organized concept. A trained pilot could look at the instruments for a few seconds, and would know a great deal about the situation of the plane. I could look at the same instruments for several hours, and still know almost nothing. Patterns or concepts are stored in long-term memory, and require time and effort to learn. Once learned, however, they can be used with enormous speed and accuracy. The pilot who 'seems to have a sixth sense for knowing just what's happening at any given moment' is a pilot who has acquired over time an unusually powerful set of cognitive patterns. While a pattern is being learned, the pilot needs to spend a considerable amount of time consciously and explicitly attending to the information subsumed by the pattern. It is a slow, self-conscious process of organizing discrete bits into a coherent pattern, and storing the pattern in long-term memory. Once the pattern is well-learned, however, it can be used quickly and with no conscious attention at all. The individual

can use the pattern without thinking about it, and may not be able to identify what pattern he is using.

The behavioral equivalent to a pattern is a 'skill'. Just as a pattern is built up through the organization of a number of discrete bits of information, a skill is built up through the organization of a number of discrete, molecular behaviors into a molar pattern. Learning a skill requires time, effort, practice, and thought. But once the skill is learned, it can be used in the same way as a well-learned pattern - quickly, effortlessly, and tacitly. It is in fact essential to skilled performance that it become tacit -- that the individual is no longer conscious of the individual components of the skill. Consciousness of those components would retard or even disrupt the execution of the skill. A simple example is typing skill. I can type much more rapidly than I can write longhand, but my typing rate slows down by about 90% if I try to think about which finger I will use to type each letter. My speed will also decline (and I will make more errors) if I try to type a text consisting of nonsense syllables or written in an unfamiliar foreign language. Either of those conditions is outside of my skill range. With practice, I could learn to type nonsense syllables or Swedish texts with high efficiency, but as yet I have felt no need to develop either skill.

The major implications of these parameters for piloting an airplane are:

1. The capacity of a pilot to cope with increasing complex situations will depend on the patterns and skills that the pilot has developed.
2. When situations occur which go outside of learned patterns and skills, the pilot's performance will slow markedly, and the risk of cognitive or behavioral overload will increase



markedly. (This is supported by the work of Ruffell Smith, 1979.)

## 2. Theories of Practice

Earlier, I introduced the notion of a TOS, which is short-term and situational, and a theory of practice (TOP), which is more general and longer-term. A pilot's TOS changes continually during a single flight; the pilot's TOP (i.e., concepts and skills for flying an airplane) changes very little during a typical flight.

The TOS and TOP are both examples of 'theories for action' (Argyris and Schon, 1974; Bolman, 1974). Humans always operate in environments that are so complex that it is difficult or impossible to attend to everything. The question arises: how do they select? The action-theoretic proposal is that individuals develop theories for action: cognitive and behavioral frameworks that guide them in deciding what variables to attend to, what information to seek, what causal relationships to expect, and what actions to take. The pattern and regularity in any individual's behavior is seen as stemming from a learned program that informs the individual's choices and, if accurately described, can be used to predict the individual's behavior.

That program, or theory for action, can be viewed as containing four major components:

1. Core values: basic criteria for making choices.
2. Beliefs: beliefs or hypotheses about the experienced world, including beliefs about oneself, about one's professional role, about people, about situational contingencies, etc.
3. Skills: learned behavior patterns.
4. Outcomes: consequences of behavior, which feed back to influence (confirm, modify, disconfirm) existing core values, assumptions, and skills.

Argyris and Schon (1974) distinguish two versions of the theory that informs an individual's behavior. The espoused theory represents an individual's own explanation or account of his or her behavior; it is the conscious, cognitive map that an individual uses to explain and to predict his or her own behavior. The theory-in-use is the theory that validly predicts what an individual will do; it is the implicit program that guides an individual's choices.

The distinction between espoused theory and theory-in-use is vital because the two are often different or discrepant. The espoused theory is necessarily incomplete for one reason already discussed: it is essential to skilled behavior that consideration of details become tacit and subsumed under a cognitive pattern or behavioral skill. More troublesome than incompleteness of the espoused theory is irrelevance or direct contradiction between espoused theory and theory-in-use. Under those circumstances, individuals are unaware of important elements of their behavior, and are unreliable in describing and predicting their behavior.

A basic reason the two theories are often discrepant is that they were learned in response to somewhat different environmental contingencies. Espoused theory is often shaped as much or more by considerations of positive self-presentation as by accuracy of self-presentation. Theory-in-use is shaped by environmental responses to specific behavior. I learned as a child to espouse honesty as a general value, and was not taught to say about myself, "Sometimes I lie." But I was also taught that there were certain situations in which I was expected to lie. I was further taught not to talk about the possible discrepancy between the general value of honesty and the specific situations in which I was expected to

be dishonest. Under those conditions, it is relatively easy for me to develop an espoused view of myself as honest, and a theory-in-use that is only partly consistent with the espoused theory.

The distinction between espoused theory and theory-in-use implies an epistemological distinction among three different kinds of knowing. Knowledge is 'intellectual' when it exists in the espoused theory but not in the theory-in-use: the individual can think about it and talk about it, but cannot do it. Knowledge is 'tacit' when it exists in the theory-in-use but not the espoused theory: the person can do it, but cannot explain how it is done. Knowledge is 'integrated' when there is synchrony between espoused theory and theory-in-use: the person can both think it and do it.

Different forms of education are likely to produce different forms of knowledge. 'Academic education' -- in which learners think about and discuss the practice environment, but do not perform within it -- is likely to produce changes in espoused theory, but no corresponding changes in theory-in-use. The result is intellectual knowledge, but the knowledge may be useless or even harmful if the knowledge is abstracted at a level too far removed from practice, if application requires skills that the learners have not developed, or if successful application is blocked by the learner's lack of self-awareness. In the extreme, the education may help the learner to become more inconsistent and self-contradictory, rather than more effective.

'Field education' places the learner directly in the practice environment, and requires the learner to perform within it. But the field may not require, and may prevent, the learner's reflection on their performance. Thus, the field is an ideal setting for the acquisition of

'tacit' knowledge. The learners develop skills which enable them to cope in the practice environment, but may not be fully aware of the skills they have developed, and of possible deficiencies in their skill repertoire.

It is considerations like these that have led many training organizations to attempt to integrate academic, field, and 'simulator' training so as to develop practitioners who are self-conscious and self-reflective about their practice, and who also have the skills needed for effective performance.

But such programs do not always pay adequate attention to the distinction between espoused theory and theory-in-use, the possibility of inconsistency between the two, and the effectiveness problems which may result. When individuals are unable to describe accurately significant aspects of their theory-in-use, any of several processes are often at work:

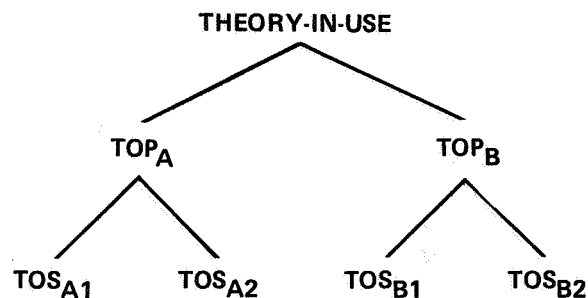
1. The individual is unable to acknowledge the discrepancy (because of the anxiety that the discrepancy creates), and will defend against any information suggesting that a discrepancy exists.
2. The gaps between espoused theory and theory-in-use may generate learning errors, particularly self-fulfilling and self-sealing processes. (If, for example, I believe I am being pleasant and friendly when others perceive me as cool and aggressive, there is a good possibility that I will misinterpret their responses to me as evidence of their personal deficiencies, rather than as appropriate responses to my behavior.)
3. There may be contradictions in the theory-in-use that the individual does not recognize, but which create confusion for others. (Suppose that I am continually sending to the same person the following two messages: (1) you should get out and take more initiatives in life; (2) you are too weak and incompetent to get anywhere. If I fail to recognize the contradiction (because I feel there is a consistent message that says 'get out and do more to overcome your weaknesses'), I may create double-binds for the other person, yet blame the other person for not responding in a more positive way to my efforts to help.)

The implication is that any educational program which aspires to

produce successful practice must help learners to understand their espoused theories and their theories-in-use, and the interdependence between the two.

An individual's theory-in-use is the overall program for the design of behavior, from which all other theories (including the espoused theory) are derived. The theory-in-use is a long-term program, which begins to develop at birth, and gradually evolves through the individual's life. A program learned over so long a period of time is heavily overlearned, and can be altered only through learning experiences which extend over considerable periods of time. In any short-term learning experience (e.g., an experience of a few hours), the theory-in-use is just short of unalterable.

I have discussed theories for action at three different levels: the theory-in-use, the theory of practice, and the theory of the situation. The relationship among the three is hierarchical, and can be illustrated by the figure below:



My theory-in-use consists of the core values, beliefs, and strategies which provide direction, meaning, and uniqueness to everything that I do. The theory-in-use is my 'executive program'. It incorporates a number of TOPs for different practice arenas. For example, I have a TOP for driving an automobile, and another for giving lectures. My TOP for automobile driving incorporates a number of different TOS's (e.g., 'I am parking my

car', 'I am driving 5 miles above the speed limit').

Since a TOP is usually learned after an individual's theory-in-use is well-established, the theory of practice will be significantly influenced by the previous theory-in-use. The nature of that influence is likely to be different for different elements of the practice environment. Some areas of the practice environment--particularly the highly technical areas--are likely to be relatively unfamiliar to the individual. They represent problems for which the theory-in-use has not developed established routines. Learning in such areas is more a question of adding new elements to the existing theory than of altering elements which are already present. Other areas of the practice environment -- particularly those dealing with communications, interpersonal influence, and management of human resources -- represent areas in which overlearning has already occurred, and the existing theory-in-use is relatively difficult to alter. This can lead to misleading assumptions like, "You can teach a man to fly, but you can never teach him to lead. He's either got it, or he doesn't." The problem is not that the individual cannot learn about leadership; it is just that new leadership skills are difficult to acquire because they require extensive revisions in a theory which is already overlearned.

The question then becomes under what conditions will an individual revise a theory. To understand this issue, it is important to recognize a dilemma that is always present. Revision of a theory that is already developed is always costly--it requires time, energy, effort and, often, emotional stress.

Marris (1975) calls the tendency to hold on to our existing theories the 'conservative impulse', and argues that it is intrinsic to the human capacity to survive and learn from experience:

(The conservative impulse) is a condition of survival in any situation, even for the most radical innovator. We cannot act without some interpretation of what is going on about us, and to interpret it, we must first match it with something familiar... Each discovery is the basis for the next, in a series of interpretations which gradually consolidate...into an understanding of life. Hence, there is a deep-seated impulse in all of us to defend the validity of what we have learned, for without it we would be helpless. (Marris, p. 10)

(T)he experience of psychoanalytic treatment suggests that it is slow, painful and difficult for an adult to reconstruct a radically different way of seeing life, however needlessly miserable his preconceptions make him. In this sense, we are all profoundly conservative, and feel immediately threatened if our basic assumptions and emotional attachments are threatened. (Marris, p. 12)

So we find innumerable examples of situations in which an individual, a group, or a nation clings desperately to a theory which is no longer working, rather than to risk the uncertainty, ambiguity and loss of meaning that would come from abandoning a familiar way of interpreting the world. A teacher who has been teaching the same grade in the same way for many years is asked by his superiors to adopt a new pedagogy. If his sense of himself and his effectiveness as a teacher is attached to his old ways, the change is profoundly threatening. It would take great effort and time for him to learn a new approach, and he is not at all sure that he will feel comfortable and effective even if he can learn it.

The example illustrates a pervasive dilemma - it is often difficult to know in advance whether it is useful in a given situation to continue to use the theory I have (and save the costs associated with re-design), or to re-design (and save the costs associated with error in my present theory). Taking account of this dilemma, we can assert several propositions about factors that affect an individual's willingness to engage in theory-

#### revision:

1. The more central a theory is to the individual's self-concept and self-esteem, the less likely that the individual will revise. (Returning to an earlier example, viewing myself as 'honest' has become so central to my valuing of myself, that I find it difficult even to consider modifying that part of my theory about myself.)
2. The more a theory is 'overlearned' (i.e., the more that I have learned the same thing through iterations of the same or similar experiences), the less likely is the theory to be revised.
3. The more that inquiry and learning are built into the existing theory, the more likely is revision. (For example, many of the theories of practice used by scientists incorporate inquiry as a central value, and increase the likelihood of theory revision.)
4. The more the situation makes disconfirming evidence available, the more likely is revision of the theory. (In other words, if my theory is inaccurate, but I get no feedback from the environment to alert me to the problem, I may interpret the experience as further confirmation of the theory's validity.)
5. The greater the amount of ambiguity, confusion, information overload and stress that an individual is experiencing, the less likely is revision of the operating theory. (Anything that overload an individual's cognitive and performance capabilities increases the incentive to solve problems in the simplest possible way--usually by relying on a theory that is well-learned, rather than searching for new ones.)

#### To summarize:

1. Individuals develop over the course of their lives theories for action, including a theory-in-use which informs all of their behavior, and an espoused theory, which guides the individual's perception of self.
2. An individual's theories for action may contain errors and gaps, but be designed in such a way as to prevent the person from recognizing the problems.
3. Even if the individual does recognize problems in the theory-in-use, s/he can alter the theory only with considerable effort and time.
4. In order to perform in specified practice domains, individuals develop 'theories of practice'. In some areas--usually areas that are highly technical or unique to the practice domain--those theories represent additions to rather than revisions in the pre-existing theory-in-use. In other areas--particularly issues of how an individual relates to and works with others--learning is likely to be much more difficult because it requires



revisions to pre-existing patterns. In the former areas, the theory of practice is more likely to be dominated by the standards prevalent in the practice domain. In the latter, the individual's theory of practice is likely to be dominated by the standards of the individual's theory-in-use.

5. The theory of practice will interact with situational factors to produce a 'theory of the situation'--a short-term set of goals, assumptions, skills and outcomes for use in a specific situation.
6. There is always a dilemma associated with the decision to revise a theory (at any of the three levels): is it more economic and efficient to continue to implement the present theory, or is it more efficient to revise the theory in order to correct its errors and deficiencies.
7. Revision is more likely under conditions of (a) low stress and overload, (b) accessibility of relevant feedback, (c) inquiry skills built into the existing theory.
8. Theory-revision is less likely when a theory is central to an individual's self-esteem, when it is overlearned, and in crisis situations which overwhelm the individual's cognitive and performance capacities.

#### B. The Problems of On-Line Theory Revision

The air accident cases cited above--like many other cases in which crew errors occur--all occurred in situations where the captain (or the entire crew) was operating on a faulty theory of the situation, and was overlooking data that raised questions about the validity of that theory. I have already suggested that the TOS arises from the interplay between the pilot's theory of practice (TOP) and situational factors. When the TOS is in error, we can argue that the answers to two basic questions determine whether the TOS will be revised:

1. Is information showing the TOS error available in the environment? (E.g., if a faulty instrument is producing error, is there other data available that would alert the crew to the misinformation? If the crew needs information that they do not have, is it possible for them to obtain the information?)
2. Do pilots' theories of practice lead them to use the information that is available?

The availability of information to detect error is necessary, but not sufficient. Many questions about availability of information go to design issues - the design of aircraft and aircraft instrumentation, the design of air controller systems, the availability of accurate and useable manuals and check-lists, etc. But some questions go to issues of management and interpersonal relationships. Take the following conversation, which occurred in a DC-8 shortly before it crashed into a mountain:

First officer: We should be a little higher here, shouldn't we?

Captain: No, 40 DME, you're all right.

The first officer was correct; the captain was wrong. Both were killed because the captain continued to rely on his faulty TOS. The captain's TOP did not lead him to test the possible validity of the first officer's suggestion. The captain was following a time-honored precedent: leaders in all sorts of organizations reject subordinate questioning of their beliefs day in and day out. It enables them to get on with implementing their current TOS, rather than having to delay and test its validity.

A considerable body of research on the theories-in-use held by managers and professionals suggests that it is normative for them to respond to questioning or confrontation of their TOS by defending it rather than inquiring into the possibility of error. Even in situations where the stakes are not so high nor so irrevocable as in air traffic safety, the costs can be serious. In the cockpit of an air carrier, the costs are unacceptable. That suggests two important implications for the TOPs that training programs should seek to produce in flight crews:

1. Whenever a member of a flight crew senses the possibility that the crew's operating TOS may lead to significant error, that member has a positive obligation to raise the issue and request that the TOS be tested.

2. Whenever a member of a flight crew is challenged by another about the possibility that his/her operating TOS is leading to significant error, that member has a positive obligation to seek information to test the validity of the TOS.

Those propositions may seem reasonable enough, but they are difficult to implement, for two reasons:

1. The propositions are much easier to adopt at the level of espoused theory than theory-in-use, because they require willingness and skill in confrontation, inquiry, and conflict-management that crew members may not have.
2. There is a problem of how to design a management system which insists that the captain has a positive obligation to inquire when challenged, but also has the authority to make binding decisions.

The problems are related, because both require that flight crew members have a set of management and interpersonal skills which are rarely observed in any organizational setting. Basically, they require the ability to combine advocacy (behavior which advocates one's beliefs, values and opinions) with inquiry (behavior which seeks to test the validity of one's beliefs, behavior, and values). Advocacy and inquiry are often perceived as polar opposites--with the implication that it is impossible to do both at the same time. Empirical observation of managers is consistent with the polar opposite theory--it is rare to find managers who are good at both. But there are some. And both skills are essential in a cockpit. It is essential that all members of a flight crew be willing to express their beliefs and advocate their view of the situation. The first officer of the DC-8 engaged in very weak advocacy when he asked, "We should be a little higher here, shouldn't we?" The captain's response (No, 40 DME, you're all right.") showed no inquiry at all, and the first officer did not push the issue (perhaps fearing that he might seem insubordinate, or might upset the captain, or might

make himself appear foolish by questioning the judgment of an experienced pilot who was familiar with the area). Suppose that each had an operating TOP which led them to combine advocacy and inquiry. An alternative conversation might have been:

First officer: I'm really concerned about whether our altitude is safe. What leads you to think we're o.k.?

Captain: I think we're o.k. at 40 DME, but what's your concern?

Theories of practice, pilot skills and cockpit norms that favor high levels of advocacy and inquiry can help to ensure that crewmembers communicate effectively whenever someone in the crew senses error. An additional step is to train crewmembers to develop TOP's which call for testing and inquiry whenever there is ambiguity or anomaly in their current TOS. That is, whenever the crew recognizes that something is happening that does not completely fit their theory of the situation, they need to begin asking questions like, 'Could we be mistaken?' 'Is there some other explanation for what's happening?' 'Is there any information we have (or can obtain) to help us understand the situation?'

For example, consider the case of a 727 which crashed because the flight crew did not recognize the nature of their problem. They had inadvertantly failed to turn on the pitot heaters. When the pitot heads became blocked by atmospheric icing, they gave erroneously high airspeed readings. The crew was very surprised by the high airspeeds, but attributed them to unusual weather conditions and the fact that the plane was flying light. They did not consider the possibility that the airspeed indicators were erroneous, although the plane's altitude should have alerted them that such high airspeeds were improbable or impossible.

The sounds of a stall warning were mistaken for a Mach buffet (partly because the crew had just heard an erroneous overspeed warning). In this situation, a disaster might have been prevented if anyone had thought to question the puzzling result by asking, "Could the airspeed indications be wrong?"

### C. Theory-revision and Management of Human Resources

Anomalous or confusing situations tend to overload flight crews. Overload increases the likelihood of error. The optimal use of available human resources becomes a critical factor in aviation safety. It is precisely in crisis situations that the demands on both information-processing and performance skills are highest. In those situations, a flight crew needs to ensure that each member of the crew is performing effectively and working on the right set of tasks for the situation. The way in which tasks are defined and allocated constitutes a set of role definitions for a given moment (and those role definitions are one aspect--often implicit--of the crew's theory of the situation).

The flight situation makes very high demands on the role system--simultaneously demanding high levels of role clarity (so that everyone is clear about their tasks) and role flexibility (so that tasks may be shifted or re-allocated as changes in the situation warrant).

A role is a set of activities or performances that are defined by the expectations of 'role-senders'--persons who have expectations about how a role-occupant will perform in the role. Role-senders for an airline captain include the captain himself, other members of the flight crew, the passengers, airline management, air controllers, other airline pilots, etc. Each role-sender has expectations for how a captain is to behave (although those expectations vary greatly in breadth, specificity and clarity among

different role-senders) and has the potential to exert influence on the captain (the amount varying greatly among different role-senders: the captain usually pays much closer attention to air controllers than to passengers). Role clarity exists when the expectations are well-defined and there is agreement among those role-senders who are significant for a particular situation. If the expectations are vague, then role ambiguity exists. If the expectations conflict with one another, there is role conflict. To avoid role ambiguity and conflict in the cockpit, the members of the flight crew need to have mutual role expectations that are clear and mutually understood. When this does not occur, a variety of role problems can lead to serious errors. Those problems include excessive role restriction, inappropriate role differentiation, errors in managing interdependence, and problems in managing role boundaries.

#### 1. Role restriction

Excessive role-restriction is the common result of over-controlling management styles. Many individuals have great difficulty making the transition from 'doing it themselves' to 'getting it done through managing others'. In many cases, they doubt that anyone else can do it as well as they. In others, they are fearful that subordinates will make errors unless closely controlled. The result is a controlling style of management which creates a very restrictive role for subordinates. Managers who try to succeed through over-control often fail, because their subordinates are unable to accomplish very much. Warwick (1975) describes in vivid, if depressing detail how such a management style pervades the U.S. State Department and helps to produce enormously slow and cumbersome performance. The subordinates are 'disempowered' and prevented from making optimal use

of their skills and capacities. The manager's primary task is not to do it himself/herself, but to make the best possible use of available human resources.

Ruffell Smith's (1979) simulator study of crew response to overload found that one source of errors in many crews was the captain's tendency to do too much by himself, and to overcontrol his crewmembers. For example, some captains attempted to fly the plane and command during a difficult, emergency condition. They became overloaded, while other members of the crew were underloaded. In other cases, the captain gave so many discrete orders that other crewmembers never finished important tasks because of constant interruptions.

## 2. Role differentiation and management of interdependence

Role differentiation refers to the degree to which different roles are clearly distinct from one another. It is possible to under-differentiate or over-differentiate. Under-differentiation leads to excessive overlap (too many people doing the same thing), which often coincides with significant gaps (some activities that no one is doing). A clear example is the crew which permitted their 1011 to crash because everyone was worrying about the nose gear light, but no one was monitoring the plane's flight performance. The under-differentiation (too many people focusing on one problem) led easily to gaps (significant problems that no one focused on). Under-differentiation often leads to conflict--as people trip over each other, or resent one another's intrusions into their turf. In the DC-8 which crashed into the mountain, the captain had apparently taken over the navigational role by developing his own personal approach plan, which he did not share with anyone else. Shortly before the accident, the first

officer asked the captain if he was planning to make a procedure turn. The captain replied, "No, I ... I wasn't going to." But the captain did not say what he was planning to do. The first officer asked about the terrain, and the captain said, "Mountains everywhere." The first officer then asked, "We should be a little higher, shouldn't we?", but he did not have enough information about the captain's plan to be sure.

Overlap can have one advantage--redundancy can reduce the likelihood of error. A number of such redundancies are planned into aircraft and into the roles of air pilots. What is important is that crews be clear about the areas in which redundancy is expected and needed, and the areas in which overlap is wasteful and hazardous.

Over-differentiation occurs when different roles are so completely distinct, that different individuals have great difficulty knowing what one another is doing. The risk is that they make erroneous assumptions about one another, and fail to communicate enough to test those assumptions.

In the airline setting, that risk is particularly high between pilots and flight controllers, whose roles are highly differentiated. Many of the interdependencies between the roles have been worked out over time and have achieved high levels of precision and reliability. But some areas are not completely resolved (e.g., the responsibilities of pilots and controllers with respect to detecting and communicating possible conflicts among aircraft). An example of pilot-controller misunderstanding occurred in the case (discussed earlier) of the 727 which crashed on an approach. The captain believed that the controller had cleared him to an elevation of 1800 feet. Even though his approach chart suggested a possible problem, the captain relied on the assumption that it was the controller's responsibility



to be sure that an approach is not given unless it is safe. The crew had plenty of time to re-check the charts or to check again with ground control, but did not do so. The plane crashed, killing everyone aboard.

### 3. Boundary Management

A role is a set of tasks defined by the expectations of role-senders. Those expectations can be seen as defining a 'boundary' around the role. Tasks inside the boundary are part of the role; tasks outside of the boundary are not part of the role. Role boundaries are never completely precise, and role-flexibility requires that individuals be able to re-define boundaries. Many of the role problems discussed above occur because the boundaries are ill-defined, or because there is little agreement on the process for re-defining boundaries. Under-differentiation, for example, is very likely to occur when roles are ambiguous and boundaries are ill-defined.

For a flight crew to be effective under anomalous or crisis conditions, they need to be conscious of the need for boundary clarity, and clear about the legitimate ways in which role boundaries may be redefined. The latter is critical, because emergencies will often require very rapid role shifts; the crew needs a way to accomplish this without producing confusion, role restriction, or inappropriate gaps and overlaps. One obvious approach to the problem--'role boundaries are whatever the captain says they are'--is effective in producing rapid shifts, but does not always guarantee correct shifts. On the other hand, a system in which anyone has the right at any time to resist or appeal the captain's decisions would make rapid shift very difficult to achieve. It might lead to good decisions in the long-run, but that is no help if the plane crashes in the short run.

What is needed is a system that preserves the captain's authority to

make binding decisions, but places a positive responsibility on other crew members to raise questions or suggest alternatives when they perceive that the captain's strategy might lead to significant error. Captains, in turn, need to value such input as part of the help they expect from their flight crew, rather than rejecting it out of hand or seeing it as a threat to the command structure.

#### D. Training in Human Resource Management

The arguments in this paper imply a need to devote more attention to topics that have been largely neglected in pilot training. Pilots need to understand the interaction between situations and their own theories for practice. They need to appreciate the distinction between espoused theory and theory-in-use, and be able to explore the possibilities of discrepancy in their own theories. They need to understand the importance of skill in inquiry and on-line learning, and they need to learn theories of piloting that emphasize those skills. They need a conceptual understanding of the interpersonal processes and role issues that are critical to the flight deck situation, and they need practice and skill in implementing those concepts.

We have begun to develop educational approaches to accomplish similar goals in working with other professionals, including managers (Argyris, 1976, Bolman, 1976), lawyers (Bolman, 1978), educational administrators (Bolman, 1976), and ministers (Bolman and Gallos, 1979). All of the methods emphasize the importance of integrating theory, self-reflection, and practice. The design of such training varies with the learning context, but always includes some version of the following elements:

1. Presentation of relevant theory (e.g., theory about inquiry

and learning, interpersonal skills, role dynamics, communication in small groups, etc.)

2. Discussion of case examples from the learner's experience (e.g., discussion by pilots of particularly challenging situations that they have faced), as a way to apply the theory and to encourage learners to reflect on their own practice.
3. Simulation of practice problems, with the chance for discussion, feedback, and repeated practice. (As an example, a crew could work through a crisis situation in a full-mission simulation. They would then discuss the experience with assistance from faculty. Next they would practice the same situation again.)

The design of such training is a challenging but exciting task.

Part of the challenge is creating effective training experiences. Another part of the challenge is integrating new experiences with existing training. A significant part of the challenge is that the training must begin to question traditional assumptions about management and superior-subordinate communications. Those questions go beyond the flight deck--the same questions can be raised about the entire training activity, and about the management of the airline. If the management patterns that lead to pilot error are the same patterns used at every level of management in an airline (where they presumably also lead to error), then the question of training pilots in effective management of human resources is closely tied to the larger questions of organizational climate and human resource management for the entire system.

Those are large and difficult questions, and many of the answers remain to be discovered. But I believe that the air transport industry has little choice--sooner or later those questions will have to be confronted. Personally, I would prefer to fly with the airlines that do it sooner.

# NOTES

1. This is a working paper prepared for the NASA Workshop, "Resource Management on the Flight Deck," San Francisco, June 1979.

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## SESSION 2

### CURRENT INDUSTRY APPROACHES TO RESOURCE MANAGEMENT TRAINING

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## FLIGHT CREW SELECTION AT UNITED AIRLINES

Capt. William Traub\*

Poor decisions in pilot selection can be very expensive and in today's environment of sophisticated equipment and increased competition, decisions do have a significant bearing on an airline's success or failure.

Looking only at training expense, we at United Airlines estimate a mistake in pilot selection could cost upwards of \$250,000 over a 30-year pilot career.

On the other hand, good decisions in pilot selection pay off handsomely in terms of training requirements, whether we are discussing resource management skills, flying skills, or a composite of all of those talents that go into the makeup of an outstanding employee and ultimately in an outstanding captain.

In the past 25 years, United Airlines has hired more than 6,000 pilots. To do this it has been necessary to process over 90,000 applicants. As a result, in those 25 years we believe we have developed some skills in pilot selection.

As shown in figure 1, our qualifications for pilot employment have varied over the years from 1954, when we required a high school diploma and 165 hours of flight-time experience, to 1970, when we required a college degree and 500 hours of flight time.

There was also a period in the late 1960's during which we processed applicants with a private pilot license; if the applicant passed all of our tests we guaranteed him a job if he was able to obtain a commercial license within 1 yr.

The current qualifications shown in figure 1 came about as a result of a court decree. For those of you who don't know, United Airlines was challenged by the Equal Employment Opportunity Commission for discriminatory hiring practices in pilot selection.

This resulted in a court case and the signing of a court decree. Included in that decree were these minimum employment qualifications.

With the exception of the current hiring program, the changes we made in minimum employment qualifications were motivated primarily by applicant supply rather than any dissatisfaction with the quality of the pilots previously hired.

This is not to say we didn't make some mistakes. However, the effects of the mistakes were minimized largely due to the quality of applicants rather than any really scientific selection procedure.

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In 1975, United Airlines did something it had not attempted to do before, at least in any important detail. Looking ahead to the later 1970's and early 1980s, we could foresee a period of significant hiring. We would recall approximately 500 furloughed pilots and hire more than 1,000 new pilots.

To be sure we would pursue the proper hiring philosophy, United management formed what we call a pilot new-hire committee. The first challenge of the committee (fig. 2) was to evaluate past selection processes used at United Airlines. Further, we would expand our expertise in the methods of pilot selection by studying the state of the art and the hiring processes used by other airlines throughout the world. And finally, we would develop recommendations for future new-hire pilot selection, new-hire training, and the probationary year evaluation.

The committee pursued these matters for some 18 months and developed a philosophy of pilot selection. This philosophy forms the basis of United's present hiring and training program which is to date proving to be the most successful in our history.

Before reviewing our current philosophy, allow me to share with you several considerations that shaped the committee's development of philosophy and its recommendations (fig. 3).

First was the signing of the Equal Employment Opportunity Commission versus United Airlines Consent Decree, which reduced some of our previous hiring standards and set goals for employment of minorities and females as airline pilots.

As a result of the court decree, formal education and flight time could no longer be used as primary selection criteria in our hiring program.

Second, the committee was influenced by the heavy attack our previous standards were subjected to during the Equal Employment Opportunity Commission-United Airlines case, and our lack of proof that these standards related to any criterion of job performance. In the future we would be required to validate each step of the selection process we intended to use.

Third, and very importantly, a thorough study was undertaken of the psychological characteristics of our most successful and least successful pilots. This led to the development of what we call a criteria profile identifying those attitudes and personality traits possessed by our most successful pilots.

This profile was compared with a high degree of correlation to personality inventories developed by other airlines throughout the world.

Our study showed that although, at the time of hire, there were significant differences in personality characteristics between our most successful and least successful pilots, there were essentially no differences in education or flight time.

A large battery of psychological tests was administered to a sample group of pilots. The result of these tests was compared to flight management ratings of pilot's performance and the individual's report of job satisfaction. Again there was a high correlation between certain psychological traits and job performance of our most successful employees.

The committee also identified pilots who without significant additional periods of training apparently did not possess the necessary psychomotor skills to perform consistently at the high standards expected of a United Airlines pilot. In most cases they were not required to complete a thorough pilot training and evaluation program as part of new-hire training.

And finally, the committee identified pilots who were highly qualified at the time of hire, but who appeared to be psychologically unsuited for a career as an airline pilot. These men do not necessarily have proficiency problems, but do have personality and attitudinal characteristics that are costly in terms of supervisory time, employee morale, passenger relations, and cockpit harmony.

As a result of this research and study, the new-hire committee developed this philosophy of pilot selection (fig. 4): Select pilots who have basic flying skills plus the appropriate attitude and personality traits that make an outstanding employee and ultimately an outstanding captain.

To implement and conform to this philosophy we developed the following multi-step selection and training process (fig. 5):

First we developed a computerized pilot applicant tracking system that permits a completely centralized selection procedure whereby we are able to select for processing the best candidates regardless of where (geographically) they make application.

Second, a series of psychological tests was selected and validated by testing part of our incumbent pilot group. This allowed us to develop a profile to be sure applicants possessed the required attitude and personality traits.

The attitude and personality traits we at United consider important are listed in figure 6. I think we generally agree with Mr. Webster, but let me in any case tell you what we mean by each of these terms:

The individual must be *motivated* by a career in aviation itself, not by the high pay or other advantages.

The pilot must have a congruent *interest* pattern. Divergent interests are a negative characteristic. Interests should be predominantly in technical areas but with some interests in interacting with people.

Pilots should be *confident* of their ability and capability to control their environment, but not to the point of overconfidence.

A *realistic* outlook on life, free from abnormal anxiety reactions, is important. A pilot must make decisions based on facts and not be overly impatient.

By *conscientious* we mean someone who exhibits good goal-directed behavior.

*Cooperative* — accepts authority and procedures, and questions when appropriate — not a maverick.

*Consistency* — not always looking for ways to do things differently; willing to follow a consistent habit pattern.

And finally, *startle threshold*. An individual's ability to think logically and quickly under stress. Individuals who freeze or respond to inappropriate stimuli under stress have a low *startle threshold*.

Third (fig. 5), we designed a simulator evaluation to appraise an applicant's pilot skills and provide some additional insight into several attitude and personality traits. *Startle threshold* and self-confidence are assessed in addition to the basic psychomotor and information processing skills. This evaluation is computer-administered and computer-graded under the supervision of a flight training manager. The applicant flies a DC-10 simulator approximately 1 hour, performing seven carefully selected and highly structured maneuvers.

Fourth, an in-depth interview designed to assess the applicant's technical qualifications, and probe his attitude toward flying and his motivation for applying for the position of airline pilot.

We believe that interest in flying and attitude may be more important than education and flying experience if they are combined with the pre-requisite intelligence, psychomotor skills, and personality traits. The interview is structured to verbally explore the attitude and personality traits just mentioned. To conduct the interviews we have carefully selected and thoroughly trained a group of flight managers from around our system.

The air crew selection test, or STANINE as it is more commonly known, is administered to obtain an indication of pilot aptitude and is a predictor of success in training. Additionally we feel this provides a useful measure of an applicant's cognitive skills, those skills we consider so important in the transition to a new aircraft.

Finally, an extensive medical assessment is accomplished. This step is designed to measure current health and also to predict long-term physical suitability for an airline career.

This multi-step selection process allows us to create a profile on each applicant (fig. 7). The profile is then presented to a board of review

composed of representatives from Flight Operations, Personnel, and Medical departments. The board makes a final decision on pilot selection based on a careful review of each profile.

After selection by the board, the pilot enters a 6-8 week new-hire training program followed by a 1-year line probationary period. The selection procedure is not finished until the probationary year is successfully completed.

New-hire training includes the following three parts (fig. 8). First, the use of individualized computer-managed and computer-assisted instruction. This training is criterion-based and is designed to ensure adequate aeronautical knowledge and knowledge in other areas appropriate to the job of being a flight crewmember.

Second, a pilot-skills training and evaluation program is provided, based on the premise that the new-hire will not function as a captain or copilot for some time. It is therefore imperative that an early flight-skills assessment be provided.

Third, a flight engineer transition training program is included in new-hire training, since initial line assignment will be as second officer.

Finally, an extensive probationary year line-evaluation program has been implemented to provide a continuation of the total evaluation philosophy and to ensure the new pilot meets the criteria profile established for a United Airlines pilot.

This program (fig. 9) consists of a line check each quarter of the first year given by a flight manager; a home study course on four flight-operations related subjects; and an oral examination on the equipment to which the pilot is assigned.

And finally, there is an additional pilot evaluation at the training center, if pilot skills during new-hire training are in any way marginal.

Although it is still early to reach totally definitive conclusions, all the indications are that 1978 was one of our most successful years of pilot employment. In that year over 6,000 applicants progressed through some phase of the selection process described earlier.

From those 6,000 applicants, 494 pilots were hired in 1978. They possess an average of 16.2 years of education, 3,300 hours of flight time experience, and this in spite of the fact that education and flight time were not primary considerations in selection. The group includes 21 women and 47 members of minorities, some with education and flight time well below the average.

The attrition rate in new-hire training was less than 2%, and reports from line flight operations management indicate that these people are outstanding in terms of job performance, motivation, and attitude.

Our work of examining, validating, and refining applicant criteria may never be finished, but overall we feel optimistic about the results of our process so far and expect to benefit even more in the future.

We also feel it has significant implications in the context of flight-deck resource management, since this precision approach to pilot selection provides us with a well-defined, predictable starting point. But it's only a beginning.

We may know through initial selection that we have a diamond in the rough. The shaping, polishing, and setting of this gem to meet our needs comes next. This explains my interest and the interest of United Airlines in this particular conference.

Thank you. Do you have any questions or comments?

#### DISCUSSION

CAPT. JOHANNESSEN, Scandinavian Airlines: You mentioned you had a psychological test of your most successful and most unsuccessful pilots in your course. Could I have the criteria for how you deem a pilot to be successful and/or unsuccessful, please?

CAPT. TRAUB: I can provide you with the names of the tests that we used. I'm not completely familiar with how the tests were scored. If that addresses your question.

CAPT. JOHANNESSEN: How do you say that the pilot is successful?

CAPT. TRAUB: It was based on flight management assessment of the pilot's performance and also the individual's feeling of job satisfaction.

CAPT. JOHANNESSEN: Was that subjective evaluation of the man by himself and by management?

CAPT. TRAUB: Yes.

UNIDENTIFIED: Did you hire any of the 350-hour types?

CAPT. TRAUB: Yes, we did hire some with very low experience, right about 350 hours.

CAPT. SIMONS, Pan Am: How do you maintain the flight engineer's piloting skills during his tenure as flight engineer?

CAPT. TRAUB: Over the years, we have made simulator time available to these people that they can use voluntarily when they go through a pilot or flight engineer training program. We also provide some pilot training

during that period of time. It is very limited but we do provide simulator experience and until recently airplane experience as well.

CAPT. SIMONS: This volunteer simulator, do you have a flight instructor with them or just let them fly the simulator?

CAPT. TRAUB: Most of the time not. It is set up with a tape program and they're free to use the tape in the simulator without an instructor.

CAPT. SIMONS: What's your recovery rate on flight engineers? We've got flight engineers flying for 8 or 10 years and they are now just becoming first officers and we're very concerned about the success of getting their pilot skills back after being off that long a time. Of all your flight engineers that have flown as flight engineer for quite a while, were all successful in coming back as a pilot?

CAPT. TRAUB: I can't say that all have been successful. The vast majority of them have been successful with varying degrees of training.

CAPT. SIMONS: We've already found that we have to give them a lot of excess training when they come back after being flight engineers for quite a long time, and I don't know what kind of support you get from a pilot group. When you say volunteer, it's like saying, you know, come up on your birthday. Plus, you're in Denver and you've got your pilots all over the system.

CAPT. TRAUB: We have recently introduced a new program. When a flight engineer upgrades to first officer, he must come to Denver several weeks to a month before transition training to go through what we call Initial First Officer Training, which is really ground training.

But during that period we also offer them — well, volunteer, if you will — pilot experience in the simulator. This is with an instructor and has been used by almost everyone recently.

CAPT. SIMONS: One other thing that you could use is a basketball court. You can tell a pilot by his physical coordination playing basketball. You get rid of the dumb ones right there.

CAPT. TRAUB: Maybe we should incorporate that into our pilot selection procedure.

UNIDENTIFIED: Do you do any explicit intelligence testing or do you infer the intelligence level from how they behave on all these other tests?

CAPT. TRAUB: Mostly the latter. The STANINE is, to some extent, an intelligence test, or the standard intelligence test is included in the STANINE.

MR. GERSZEUSKI, FAA: How do you define an unsuccessful pilot?

CAPT. TRAUB: We don't say unsuccessful; we say not as successful as others. Again, through flight management evaluation of that pilot and his record in training. Some pilots traditionally take more time in transitioning to new airplanes. Cockpit harmony and relations with crew members become known over a period of time.

CAPT. SIMONS: One other item. After your year of probation, it's my understanding you have fall-back privileges for anybody trying to upgrade in any manner. How do you like that system?

CAPT. TRAUB: What do you mean by fall-back privileges?

CAPT. SIMONS: Say, a flight engineer is going up to first officer. If he doesn't do it successfully, he's allowed to go back and fly as flight engineer. Or first officer trying to upgrade to captain, he's unsuccessful, he falls back to being a first officer. In other words, you don't have up-or-out, you have up-or-back. Has that been successful? Are you happy with that kind of training requirement — to fall back to a previous position?

CAPT. TRAUB: Yes, I think we are happy with that procedure.

CAPT. SIMONS: How do you get rid of the person you really want to get rid of?

CAPT. TRAUB: I'm sure the same way you in Pan American do. It's a case of decision, a corporate decision by the individual's manager, and supported by his director.

CAPT. SIMONS: I understand you haven't fired a pilot in many years.

CAPT. TRAUB: That's not correct; we have.

CAPT. SIMONS: The unsuccessful pilot you were talking about a while ago was the one you'd like to get rid of, but you can't?

CAPT. TRAUB: I think we all have that problem.

CAPT. CRUMP, United Airlines: If you establish any kind of a norm for a pilot, obviously you're going to have pilots that are superior to the norm and pilots that are inferior to that norm. I think a very careful, thorough study of the background of a number of pilots carried out by some of our personnel in Denver has given us a real good idea of a group of pilots we don't want to get rid of at all, but who are not performing in training to the same level of proficiency that other pilots do, and those are the pilots we use as a measure of this \$250,000 in a career. And it's not necessarily the case of poor performance on the line. In many cases it's inability to take airline-type training in the same manner that other pilots are able to do.

CAPT. SIMONS: Well, you know training that poor performer can really get expensive. You well know that, I'm sure.

CAPT. TRAUB: Measured in about 1975 dollars we indicated about \$250,000 over a 30-year career. Like you said, very expensive, and that's just in extra training attention during the career.

CAPT. WASTMAN, Flying Tigers: Have you had any difficulty in terminating a pilot during his probationary period?

CAPT. TRAUB: No.

CAPT. BORN, North Central: Did I understand you correctly to say that those new hires that might be questionable at the end of the probationary year were returned to Denver for further evaluation? Or all second officers?

CAPT. TRAUB: That's prior to the conclusion of the probationary period. We provide a pilot skills assessment during new-hire training, and also there is a pre-simulator evaluation that the applicant goes through. If either one of those is in any way marginal, then during the probationary period we bring the individual back and provide equivalent of first officer training or copilot training in one of our simulators. That includes a management check similar to what would have to be passed when the individual upgrades to first officer. We are trying to avoid the problems that the gentleman from Pan American was alluding to later on in the career, after 5 or 10 years as a flight engineer and now upgrading to copilot. We are trying to determine as best we can that they do have the skills and capability to make that transition.

CAPT. TURLINGTON, Pan American: I haven't been in this business as long as some, but I'm curious — in your 25 years it seems like motivation and desire were something we presumed a long time ago. Do you see a real difference now in how deeply you get into those aspects in your selection process?

CAPT. TRAUB: We're trying to test that now. I think you're right, we presumed that before. If somebody was applying for the job, and they had a good background, we presumed they had the motivation and desire. We're not assuming that any more — we're trying to test for it.

CAPT. ESTRIDGE, American: Would you describe to us the startle-threshold technique you use in the simulator? Is it a distractability element or a division of attention?

CAPT. TRAUB: Both, I guess. Without telling you too much about the simulator evaluation — before the last maneuver that they are required to perform in the simulator, we tell the applicant that this is the most important part of the evaluation. It really isn't, but we tell them that. We tell them that they will experience a critical emergency during this maneuver, and then we introduce that emergency at some period during the



maneuver. So we try to, I guess, overload them to some extent by telling them that it is a very important evaluation, and that it's also the most difficult maneuver that they are required to perform during the simulator evaluation.

CAPT. SCLIFO, Texas International: How do you get a guy with 350 hours and put him in a DC-10 simulator? It seems like that would be a little unfair.

CAPT. TRAUB: We don't fly it necessarily as a DC-10 simulator; we fly it just as an instrument-based trainer. And all applicants are well briefed on what they're required to perform in that simulator. We do to some extent, expect a little bit less of the 350-hour individual as opposed to the 3,000-hour applicant. Does that answer your question?

CAPT. SCLIFO: I just can't imagine how you get a guy with 350 hours and put him in a DC-10 simulator and, say, with the startle threshold — it seems like it would be almost impossible.

CAPT. TRAUB: I think we are amazed at how well some of the low-time applicants do. If they have a basically good instrument background and some information-processing skills, they handle it quite well. They are graded against each other so we develop a pretty good data base to make a judgment on that individual.

CAPT. SIMONS: One other area, Bill. Log book entries are hard to verify and you know you're getting people that say they have 350 hours and it's quite well known, you know, they don't. Is there any way you people verify their log books?

CAPT. TRAUB: I mentioned that we provided a pretty thorough training program for the flight managers that are participating in the interviews, and we point out to the managers that it's their responsibility to the best of their ability to make that verification. Now, I'm sure that some people do slip by, but I don't think that many do, in that they do have to fly a DC-10 simulator and they answer some very technical questions based on their level of experience in the interview situation.

CAPT. SIMONS: The reason I say that is that pilots who have been with us for 15 years will say "Gee, I really only had 40 hours when I hired on." I hear that all the time.

CAPT. TRAUB: We found that to be more true early in the hiring program. About a year ago we found people who had made errors in their logbooks. It's not turning up nearly as frequently now.

CAPT. SIMONS: I bet they had more motivation though.

CAPT. TRAUB: Right.

MR. SMITH, ALPA: To get back to the question having to do with the subjective assessment of the flight managers as to successful or not so successful compared to the norm. Was the flight manager required to rate the individual on a single scale of, let's say, 1 to 9, which was correlated with some psychological test? Or was it broken down into certain categories, for example, trainability, 1 to 9; interpersonal relationships, 1 to 9; and then cross-correlated with these different psychological tests? And if in fact it was, do you have any idea what some of these correlation values in fact are or were?

CAPT. TRAUB: Our group in Chicago that had that responsibility felt very comfortable with the high degree of correlation, and they did use both the 1-9 evaluation, numerical evaluation, plus the written evaluations. And our psychologists on the staff had that information available to them.

MR. SMITH: You mean the psychologists determined the scale or the flight manager determined the scale?

CAPT. TRAUB: No, the psychologists set up the evaluation questionnaire. So, in effect, they determined the scale, and then it was adequately explained to the flight managers. Not so subjective is the training record of the same people. By training, I don't mean just in our training center in Denver, but their line checks and so forth, which were also included in the evaluation. Hopefully, we were able to minimize the errors by testing a large enough group of people.

MR. SMITH: But the directions to the management people who then evaluated the individuals were fairly specific as to the nature of the things that they were actually scoring?

CAPT. TRAUB: That's correct.

CAPT. JOHANNESSEN: How do you score a man's motivation? What criteria do you use?

CAPT. TRAUB: Well, we provide a word description of what a highly motivated pilot is versus a low motivation. And I would suppose such things as abuse of sick leave. An individual who really puts out nothing extra, and maybe has problems with proficiency checks, might have low motivation.

CAPT. JOHANNESSEN: But in the applicants?

CAPT. TRAUB: Oh, applicants. We try to look at their background to judge the motivation, to see how they prepare themselves for this job that they're trying to obtain. Some of the same qualities that we looked for in our own pilots we try to see in the applicants. How they have applied themselves in their academic training and their aviation training.

CAPT. JOHANNESSEN: Wouldn't it be very easy to fake motivation?

CAPT. TRAUB: That's correct. It is easy to fake. We just felt that with a multi-step process like ours, not too many would slip through.

CAPT. JOHANNESSEN: More specifically, for instance a man who has been, or a boy who has been a model aircraft pilot in his youth, is that a good motivation or ---.

CAPT. TRAUB: I think that, coupled with adequate training and performance as he was educated, would mean that he was highly motivated.

UNIDENTIFIED: To what extent, what value does prior military flying experience carry in your total selection criteria?

CAPT. TRAUB: We don't think that it's particularly important. The military does provide very good training and we recognize that, but beyond that training and how they perform in that training we give no particular credit for military versus nonmilitary. In fact, about 35 percent of the pilots we hired the first year were nonmilitary.

MR. McEMBER, Eastern: As a pilot-selectee flows through this program, does he get some indication at certain stages that he's doing well or doing poorly, or does it all wait 'til the end?

CAPT. TRAUB: Unfortunately, it really goes to the end. The applicant knows that through being invited back to the next stage, he's still in the process. Of course, if he's not successful at any step, we don't provide any feedback as to why, and we don't give any indication, as far as I know, ever in their career as to how they did during new-hire selection.

DR. LAUBER: Thank you, Bill. The task of selection is very interesting. Given current patterns of career progression, it poses an interesting problem, because the ideal selection characteristics for a subordinate crewmember may, in fact, be different from the ideal selection characteristics for the individual who is in command, or who plays the primary management role in the cockpit.

And yet, because of the way the system operates, you are, in the short run, selecting for subordinate crewmembers who will not upgrade to captain for many years. How do you select for both roles?

**1954 – HIGH SCHOOL GRADUATE  
COMMERCIAL PILOT LICENSE  
MINIMUM 165 FLIGHT HOURS**

**1966 – 2 YEARS COLLEGE  
PRIVATE PILOT LICENSE**

**1970 – 4 YEAR COLLEGE DEGREE  
COMMERCIAL PILOT LICENSE  
MINIMUM 500 FLIGHT HOURS**

**1978 – HIGH SCHOOL GRADUATE  
COMMERCIAL PILOT LICENSE  
MINIMUM 350 FLIGHT HOURS**

Figure 1.- Pilot applicant qualifications.

- 1. EVALUATE PAST UNITED AIRLINES SELECTION PROCESSES**
- 2. GAIN EXPERTISE IN PILOT SELECTION METHODS:**
  - STATE OF THE ART
  - PROCESSES USED BY OTHER AIRLINES
- 3. DEVELOP RECOMMENDATIONS FOR:**
  - PILOT SELECTION
  - NEW-HIRE TRAINING
  - PROBATIONARY YEAR EVALUATION

Figure 2.- Pilot new-hire committee.

- 1. EQUAL EMPLOYMENT OPPORTUNITY COMMISSION (EEOC)  
vs UNITED AIRLINES – CONSENT DECREE**
- 2. VALIDATION OF SELECTION CRITERIA**
- 3. PSYCHOLOGICAL CHARACTERISTICS OF OUR MOST  
SUCCESSFUL PILOTS**
- 4. LACK OF NECESSARY PSYCHOMOTOR SKILLS**
- 5. PSYCHOLOGICALLY NOT SUITED**

Figure 3.- New-hire committee considerations.

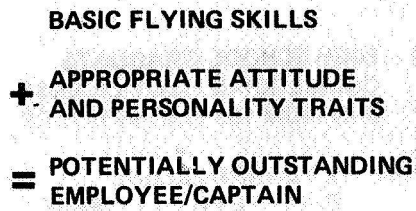


Figure 4.- Pilot selection philosophy.

1. COMPUTERIZED PILOT APPLICANT TRACKING SYSTEM
2. PSYCHOLOGICAL TESTS
3. SIMULATOR EVALUATION
4. INTERVIEW
5. AIRCREW SELECTION TEST – PILOT APTITUDE
6. MEDICAL ASSESSMENT

Figure 5.- Pilot selection.

- **MOTIVATION**
  - **INTERESTS**
    - **SELF-CONFIDENCE**
    - **EMOTIONAL STABILITY**
    - **REALISTIC**
      - **CONSCIENTIOUS**
      - **COOPERATIVE**
      - **CONSISTENCY**
      - **STARTLE THRESHOLD**

Figure 6.- Attitude and personality traits.

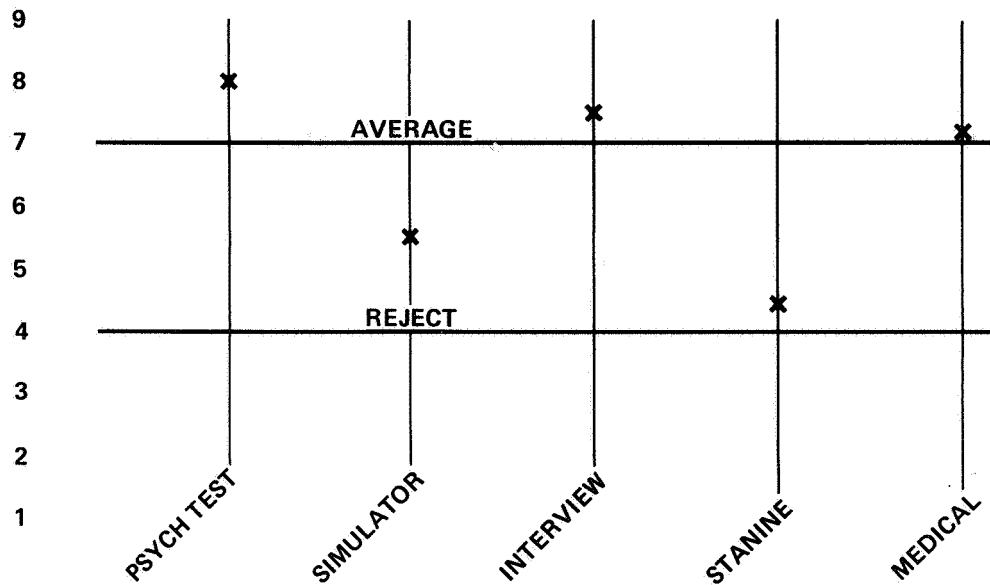


Figure 7.- Pilot selection profile.

1. INDIVIDUALIZED COMPUTER MANAGED INSTRUCTION
2. PILOT SKILLS TRAINING AND EVALUATION
3. FLIGHT ENGINEER TRAINING

Figure 8.- New-hire pilot training.

1. LINE CHECK EACH QUARTER
2. HOME STUDY COURSE
3. ORAL EXAMINATION
4. PILOTING SKILLS EVALUATION

Figure 9.- Probationary year program.

## BRITISH AIRWAYS' PRE-COMMAND TRAINING PROGRAM

Capt. L. F. J. Holdstock\*

Some time ago there was a radio program at home known as The Brain Trust. There was a character who used to appear quite regularly by the name of Professor Jode. An interesting man — it didn't matter what question he was asked, he always started off by saying "Well, it depends upon what you mean by ..." and then he would answer about 14 different questions before he got back to the one he was asked.

I feel that way rather about pre-command training because it really depends on what you mean by pre-command. I'm rather old-fashioned in my outlook, and it's my opinion that pre-command training starts on the day you first get into an airplane for instruction. From that day on everything is learning, everything is preparing for command in some form. Maybe it's just command of your first solo, but eventually for the commercial pilot it's command of the multi-crew aircraft.

For the purposes of this paper I just want to explain what we do for our pilots to help them to meet the big day.

Perhaps I ought to break off at this point just to explain our pilot source. In 1958 we suddenly realized that the supply of RAF pilots was dwindling. That the input numbers that we could get compared with what we thought was going to be our growth would not meet demand, and we took steps to meet that deficiency by opening up a college of air training. Into that college we put young men who had never flown an airplane. They were 18 year olds. We had a selection problem, we are still learning, but we put into the college young men and we taught them to fly and, in fact, from that day on, from 1960, we have relied upon the college for our pilot strength.

In the late 1960's we fell a little short because, of course, we always asked planning people to look about 3 years ahead, considering both the selection and the training. They seldom get their numbers right, and there was this period when we had to fall back on military pilots.

So, as far as command is concerned, we had a group of pilots, some of whom were ex-service people. They had usually experienced command in some degree regardless of what aircraft they had come off. We also had young men with a total of 225 hours in whom we had to instill some idea of what we meant by command.

It was something new to nearly all of them. Now, I should say that the instructors at our college are pretty good. The source is changing now, but in the past they have been mainly ex-RAF instructors, and they have had the

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\* Chief Training Pilot, British Airways.

facility of recognizing command potential. I know if we start trying to describe that we're going to get into deep water, but I'm sure that experienced training captains will know what I mean when I say you can sense it, and these people did. So that if we had a young man that we had put into Hamble who the selection people had thought was right, but who along the way showed a total lack of command potential, then it's most unlikely that young man would reach the airline.

I'd like to make one other point here, and that is that it was our experience, right at the beginning, that about a year after these young men arrived with us they relaxed. They had been through their school life, they had been picked up from school, they had been put into our college, and suddenly you could sense that they had a feeling that they had it all made. After a year we had to pick them up, take them back into the school, put them with a training captain and just polish them up, remind them that they had a job to do and make sure that they did it properly.

Having got that out of the way I think we can now look at what we do to try and help this man toward the command.

We have four inputs. We have an initial command potential assessment, and I'll come back to that in a moment. We have a pre-command management studies course, we have a pre-command course, and we have a command course itself.

About 5 years after the young man enters Hamble, that is about 3 years after he joins the fleet and becomes a line copilot, we make this initial command-potential assessment. It's a long-winded name, but that's what we do, so that's what we call it.

What we do is arrange for a period of group flying consisting of a minimum of 12 sectors with a training captain. During this period not only is the copilot checked in his normal duties but he is also checked and assessed in his ability in command. He's being supervised, of course.

Little training is given. What we really want the training captain to do at this stage is to just look at the young man as he is. Not as you can make him, but as he is performing on this day. And at the end of these periods, this period of line sectors, the training captain makes a preliminary assessment as to whether that young man will get a command or not.

In the event that the assessment is unfavorable, then we arrange a course of training. Obviously, the training captain will say where the deficiencies are in his mind, and we arrange a course of training in an effort to eradicate them. If, of course, there are no problems, well, all right, that's straightforward.

Our copilots are upgraded to senior first officer after approximately 8 years. And at that point we make a final assessment as to whether the copilot is command material or not.



It currently takes about 12 years to command in British Airways. The lowest we have ever seen was 8 years, that being 5 or 6 years ago. At the moment it's nearer 15 years. So over the years you can say we have had an average of about 12 years to command.

This command assessment is made in the light of all the material that's available to a board, not just one individual. The flying manager will set up a board. There will be a training manager included in a board of about four or five people to look at these individuals. In the assessment one can feed in the original reports from the ab initio course at Hamble, you can feed in the training captain's assessment which has been made earlier on, the current line record, the training record, and the individuals' qualities.

If satisfactory at this point, then we merely put a note in the training files and the personnel files, and the young man then follows a normal path toward the command course.

If at this stage an unsatisfactory assessment is made — either because the original assessment was never changed, was a poor one then and never upgraded, for personal reasons, or for current operational reasons which have come to light — then we merely tell the young man.

There's no loss of seniority involved. We point out his deficient areas. We don't plan any training for him, but we will give him all the training he needs if he comes to us. We will provide for simulator training, we will provide line training, but it's up to him really to approach us and say, "Well, what can I do, and how can you help me to achieve command?" And if he manages to do something about it, then, of course, he can be recategorized and put into the command stream.

The next step is about 2 years before the anticipated command course. As I said earlier, planners are seldom right, so sometimes we miss. But we aim at about 2 years to give a man a management course. I don't want you to misunderstand that term. We are not teaching him at that stage to be a manager, but we do have a lot of input from managers in various sections, and the objectives of the course are laid down. They are to communicate information on a wide range of activities and systems in our own airline, in the British Airports Authority, Civil Aviation Authority, and any other agencies, safety groups, anyone with whom they are likely to come in contact later on. By close participation in a number of project exercises, they are to give him some experience in managerial functions. And third, they are to create a climate of knowledge and understanding for all concerned.

What we are really trying to do is to relieve this young man of some of the peripheral flight-deck problems. If he has an insight of the work of his airline and what's going on around him, he's less likely to be taken by surprise when problems do occur. The course itself lasts for 2 weeks. It's residential apart from the middle weekend. And like most workshops there's quite a lot of evening work. We divide the course into syndicates of four or five people depending on the number.

We usually have 16 to 18 in the course. During the 2 weeks, we have lectures and talks by representatives of flight operations, fire service, cabin crew, medical service, ramp services, corporate planning, public relations, operations planning, customer relations, security, personnel, and our computer services. This gives a pretty broad picture of the airline. Flight managers make evening trips to the hotel, and we then have periods of informal discussion with them.

The course also includes visits to our main London passenger terminal, the engineering base and the air traffic controller center for the London area. Our own general training staff gives lectures on law as it affects the pilot, and on manpower effectiveness.

There are some talks on management styles and some help with project preparation. We always ask the pilots to fill in a questionnaire afterwards, so we are constantly changing the content of the course in the light of the feedback. We also ask for free and honest opinions, and generally it's very well received.

When we first tried the course we did it immediately before the command course, and it wasn't well received. The young man knew that just around the corner was a command course, and what he wanted to do was get in the left-hand seat, get four rings on his arm and get flying the airplane. He didn't want to know about anything else. But by giving it to him about 2 years ahead we find the interest is there. He's not really thinking about command, and you can instill in him some of these little bits and pieces just to help.

The third input we make is just before the command course, therefore named pre-command. The length of the course is tailored to the individual. If you've got a good operator, his checks have been good, his standard is known to be good, line flying when he's been acting in command under supervision is good, then you don't need to give the young man very much.

On the other hand, if he is trailing a little then we brief the training captain, we brief the planners, and we give him a slightly extended course. One has to be careful about this, of course, because if you give one chap 2 days and another one 3 weeks, then immediately they start assessing themselves.

At any rate, we know a fair amount about the chap. The course itself is not mandatory and has no bearing on the command course. We never fail a man at this stage. The training captain is briefed that he is there to help, he's there to guide.

All the training is carried out with the young man in the right-hand seat. It's carried out during revenue flights, and both the training captain and the trainee are encouraged to talk. Now, don't get me wrong, I don't want them to talk about the night out they had the previous night and the football results. I want them to talk about the operation.

We want them to progress with the flight, to think about the flight. Where they are, what's beneath them, what the weather is like, what the destination weather is like, what they're going to do if it does turn nasty. We like to involve them in passenger problems, to remind that they do have people behind them paying their wages, and they ought to be looking after them. They need to look after the cabin crew. So we need him to consider these commercial aspects.

On the other hand, obviously the operational aspects of the flight are the most important, and we just foster this awareness all the way through the operation. Even the handling of the aircraft is of secondary importance, because the command course itself is going to check his flying ability. Also, it could well be that the pre-command course is being given in an aircraft that he won't operate, because we are cursed with a number of aircraft types, and, therefore, there's a fair amount of switching goes on. But it doesn't matter — you can give a pre-command course on any aircraft, and give the command course on the aircraft he's going to operate.

Now, I will move on to the command course. I'm not going to go into it in depth because I note someone is following me talking about command courses, and I know from the returns that there are no really major differences between the upgrading training in the major airlines. But it is possible that perhaps one or two of our policies and philosophies are different and, therefore, I would like to just mention them.

One thing about which I am absolutely insistent, and that is that any course must be as realistic as possible. I am opposed to people playing musical chairs, sitting in on details, pretending they are something other than that which they are. And when a trainee is trying to learn, I think the least we can do is give him the benefit of qualified crew members in the other seats.

Apart from one or two periods on the simulator when we are really familiarizing the young man with the aircraft drills and emergency procedures, the whole of the simulator service is planned on a real-time basis. The trainee is constantly aware that the aircraft is being operated between two points, and the flight has to progress regardless of the problems. Obviously, there's a freeze switch, and it is used, but the use of it is not encouraged. When discussion is necessary, we insist that someone has to be looking after the shop. I think the expression used earlier was "the store."

We are well placed in respect to planning of details because we have a number of sectors — London-Paris, London-Brussels — all of which take about an hour in normal time. So that one can plan one of these details into a 1-hour session.

Normally we do 2-hour sessions in the simulator, so it's the easiest thing in the world to start building in diversions and utilizing the 2-hour period. I don't think any flight is normal, I'm talking now about training flights in the simulator. Weather and technical problems are constantly

being faced, but at no time is it suggested that we are trying to overload the pilot. I think one can load him up to a point, but there is a limit.

We occasionally build in exercises from our knowledge of incidents in other airlines and our own airline, but we only build these incidents in if we are able to show that the incident could have been avoided. The last thing we want to do is to demonstrate an incident that finishes up with an accident, and then pat him on the back and say, "But you couldn't have done anything anyway." That's only going to ruin his confidence, and at this stage, of course, that's the one thing you don't want to destroy.

We encourage our training captains to think about this young man as someone who has had fairly good training, periodically assessed, and by the time he gets to a command course he should be able to become a captain. If he's not looking good, then the first thing the training captain does is look at himself and make sure that he's all right, that he is not the problem. Then if all is well, obviously, the young man will succeed.

From what I've said it looks as though we are going out of our way to insure that everyone passes. That's not true; we do have a failure rate, albeit a very small one. Amongst the Hamble cadets we have, in fact, a failure rate on the command course itself of 1 percent. That figure might be misleading because I'm talking about the command course itself. We may have lost quite a lot along the way because of the various assessments we have made and the courses we have given, but on the command course itself 1 percent.

With the military pilots that we had to take in the 1960s, their failure rate, having been given the same facilities, was much higher. In fact, we lost about 7 percent there. The Hamble cadets are not just pushed on to the lighter aircraft. It may be of interest to know that these young men who went into the school in 1958 or 1960, they now have ... well, we have an ex-Hamble trained pilot in command of all aircraft in our fleets including Concorde. Admittedly only one, but one young man has made Concorde.

In concluding, can I just say a few words about the failures. Because we do, as I've tried to explain, a tremendous amount to make sure we don't get failures. The point has already been made that it's worth about \$250,000 in costs. It is interesting that we came out with exactly the same figure when we were looking at it a while ago. The only difference is we were talking in pounds.

But when I talk about these failures I think it comes into the area in which we are going to be spending a lot of time in the next few days. It's a topic in which I have a lot of interest but very little knowledge, because the prime factor in the failures we have had is the inability of perfectly good pilots to manage as well as fly. They become overloaded. And to use an expression that as I say, we're going to hear a lot about, they seem to have no ability to lead. They have no leadership at all.

I know that there are widely divergent views on this matter from those who consider that leadership is born in people, and there are those who think that it can be trained into people. I would agree that some people do appear to be natural leaders, and some quickly acquire the ability when given the opportunity. But when we have a failure in this area, I'm sure that it's too late for training to help.

I don't think you can teach leadership in a week. I think you've got to pick up this lack of leadership as early as you possibly can in a young man's career. Given time, yes, I think you can encourage it. I'm not convinced that if the man is completely lacking in that ability that you can put it in. I don't know, time will tell. And I'm not too sure what I really mean by leadership. I think we all know what we mean by the military leaders, history is full of them. We know too about leaders in management, and I think some of this can be taught — certainly there are very successful management courses. But I think our leader falls somewhere between these two. We are looking for a young man who can extract the maximum skill from the other members of his crew, who has the ability to influence them, and who quite naturally earns their respect through his ability. I'm sure this can't be taught quickly. It must be fostered, encouraged, and eventually, I think, you will find it in most of the people who are pilots. After all, we are a big-headed group. Most of us are confident and given the help I think that confidence can be used.

Just to end, I think we are probably doing all we can to assist our pilots to become captains, commanders, aircraft managers, call them what you will. If we're falling down, I think it's because we have yet to find out how to teach leadership.

We have tried; I'm not sure that we're successful. Thank you.

#### DISCUSSION

MR. FELL, FAA: In the portion you showed on initial command training, the very first portion on training, you divided it into 8 or 12 what you called sectors. Is that what I'm thinking of as a flight leg?

CAPT. HOLDSTOCK: That's right, a leg from A to B.

MR. FELL: Is all that training conducted under the supervision of one pilot-training captain, or are there various....

CAPT. HOLDSTOCK: We try to confine it to a maximum of two. It's almost a minimum and a maximum because if you only involve one person, you can always have a personality clash. You can have a young man whose career was totally ruined because he had more success on the night stop with somebody or other. These things happen in life, so it would be wrong to ask one training captain to really assess a young man for the rest of his life.

But on the other hand, you don't need to involve too many. If you get too many people involved the recipient gets fed up, he's not sure what's going on, and, also, you could well get conflicting assessments. But if we can involve two people, we find they usually get together and they talk, and what goes into the file is an initial assessment, an agreed assessment of two people.

MR. FELL: Are these sectors given over a specified period of time?

CAPT. HOLDSTOCK: No, but once you start they are continuous. You'll work for 2 or 3 weeks just to complete them.

DR. BILLINGS, NASA: Is the young man always aware on the first go at this that this is a pre-command assessment, I believe you called it?

CAPT. HOLDSTOCK: Yes, he knows. When they first come to the airline we tell them what we're going to do, what their career structure is. They are aware that these things will happen and as each one comes up, of course, he's thoroughly briefed so he knows what it's all about.

MR. DANAHER, NTSB: Would you address selection criteria for entry into Hamble?

CAPT. HOLDSTOCK: Yes. We have two selection teams. We have some trained selectors based at Hamble. They are ex-RAF people, people who have spent years doing RAF selection, finished their period in the service, and then we take some of them on.

Very briefly, we get about 12,000 applications a year. We're looking for about 120 on average. Those people at Hamble are responsible for whittling down the 12,000 to something like 600 to 700 who are looked at, and the selectors at Hamble look at them and reduce the number by about a half. So you are then down to, say 350, perhaps 400 likely individuals. The selectors at Hamble are then joined by two airline people who have been trained in selection, and there is a board then of three people, one from Hamble, two from the airline. They spend the day with these young men and at the end of the day you come out with an assessment, make or break, looking for about 120 out of the original 12,000. To go through the actual criteria of how's and when's would take a long time, I'm afraid, but I'll give you some time afterwards.

MR. DANAHER, NTSB: What is the disposition of the very few, the 1 percent or so, that fails the command course?

CAPT. HOLDSTOCK: They go down one of two roads. We find occasionally — we'll write and a young man will shrug his shoulders and say "Well, I knew I should never have made it anyway," and he'll go back to running the bank or the garden or what have you. In fact, there are three types. Others will say "There's room for me in the outside world. If you won't have me as a captain, I know I'll convince someone else," and they

disappear. Or, they become permanent copilots, and one or two of those people who have become permanent copilots have finished up by being excellent training people. Don't ask me why, but they have.

UNIDENTIFIED: We have an expression, those that can do and those that can't instruct.

CAPT. HOLDSTOCK: Well, I'll go one further, those that can't instruct, instruct instructors.

UNIDENTIFIED: Regarding the individual who becomes a career first officer — I've heard comment that there's a concern about the legal implications in our fail-safe crew concept. That is, if that individual who has been rejected in the command course now becomes a permanent or career first officer, and now you have an incapacitated captain and the airplane comes under the command of this rejected commander, as to what the legal implications are for the company?

CAPT. HOLDSTOCK: Yes, I see the problem. It's one that hasn't been suggested to us.

UNIDENTIFIED: This is the up-and-out or fall-back question and the implications to it.

CAPT. HOLDSTOCK: You wouldn't like to keep that problem on your side of the water, would you?

UNIDENTIFIED: How do you handle your flight engineer situation? Do you have professional flight engineers, career flight engineers, or pilot engineers?

CAPT. HOLDSTOCK: I'm a short-haul man and have been. My background was BEA, and in BEA we did not have flight engineers. The three-crew aircraft we had, like the Trident and the 1011, we flew with three pilots but not with one of them confined to the systems panel. We trained the copilots as copilots in the right-hand seat; we also trained them as systems panel operators, and they changed around the whole of the time. Now, on long haul, the old BOAC, they had professional flight engineers. And I say, they really are professional engineers and there's no upgrading; they're not pilots.

MR. SMITH, ALPA: Could you expand on your pre-command management study course or program on what you call project exercises?

CAPT. HOLDSTOCK: Yes. What we do at the beginning of the 2-week course, is divide them up into syndicates, and we face them with the project that they're going to have. It could be, if you like, command training. It could be something that is on the commercial side. But we give them a problem, and give them 2 weeks to sort it out and prepare a presentation for

the end of the 2 weeks. The last day is devoted purely to project presentations, and as a group they come up with their answers, their conclusions, their recommendations, and they can do what they like to make this presentation. If they want to use visual aids or films or anything we encourage them.

MR. SMITH: If I could just continue, it would appear that the system that you have placed this "command" thing before the pilot group, throughout their entire career. In other words, they think in terms of command on a very re-occurring basis. Can you indicate what the pilot reaction to this system is? Like, for example, the captain versus the copilot. Can you give us any feel for how the pilots in general react to the system where your copilots are being trained as managers or captains and so on all the way through, and they're interacting on the line with captains who have already gone through the command course?

CAPT. HOLDSTOCK: This we find is no problem at all. The average captain is only too glad to tell other people how good he is and to impart his knowledge and to help. I would think really about 50 percent of our captains take pride in sharing the operation and talking about it and saying what they would do under certain circumstances, helping the young man make decisions. There are some, of course, who just come in, take the money and go home. We all know about those. But the copilots are not flying in a crew way; they're constantly flying with different people so they get amongst the good ones which is the important thing.

MR. SMITH: Do you stress a certain captain requirement to be a training captain?

CAPT. HOLDSTOCK: No, but what we do say is that this young man flying in the other seat could well save your life. The more he knows about the operation the better.

CAPT. JOHANNESSEN, Scandinavian Airlines: Do you recruit new flight engineers for your long-haul operations?

CAPT. HOLDSTOCK: We haven't had any in the last year, but we were still recruiting last year, early 1978.

CAPT. JOHANNESSEN: So you are not specific to three-pilot operation?

CAPT. HOLDSTOCK: Sorry, I didn't hear that question.

CAPT. JOHANNESSEN: How many training captains do you have and are they simulator captains?

CAPT. HOLDSTOCK: We have three types of training captains. When a man does become a training captain the only place we use him is on the line, first of all in doing the job that he knows. Then if he is successful we



start using him in the simulator as well as on the line, and if that is successful, then he graduates to all aspects of training. That is, any aircraft conversion training that's necessary plus the simulator plus the line work. At the moment we have something like 150 training captains.

MR. COHEN, FAA: Do I get the idea that a considerable amount of the three steps of your training is on one's own initiative. This is not a duty status, pay status thing? Is a considerable amount of this training voluntary?

CAPT. HOLDSTOCK: Some of it's voluntary. Really, the only voluntary training is where a man is deficient. The actual planning of the three stages is done by us, and in that sense it is mandatory. But you also have to remember that we are not, at the moment on a full bid-line system. We don't have any worries about who does what, where, or when. What's going to happen when we do go on a bid-line system I'm not quite sure.

MR. TURLINGTON, Pan Am: I'm curious about that look at the personal qualities by that board of four or five that comes after about 8 years, could you elaborate on that?

CAPT. HOLDSTOCK: Well, all the time our line captains are providing reports on copilots. Nothing secret about this, they're all countersigned by the copilot, but if a couple fly together for 4 or 5 days the captain usually puts in a report. But somehow the flight managers, they get to know their staff, they get to know the problems, they get to know the ones who are taking the various bars apart in various parts of Europe. Maybe they do over here, I don't know. But you know the ones who are having problems at home. I'm not talking now about odd instances where one has a wife who's ill or family problems. I'm talking about long-term problems, people who are constantly in trouble. And really, history tells us that those people don't make good commanders. Because on the day that they're having most trouble, that's the day they make a silly decision.

## UPGRADE AND INTERPERSONAL SKILLS TRAINING AT AMERICAN AIRLINES

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(W. W. Estridge)

Three years ago, the American Airlines Captain Upgrade program constituted a detailed study of rules, policies and procedures. Special emphasis was placed on such subjects as Weather, Communication, Administration, etc., as published in a document entitled, Flight Manual Part I. This program was labeled, "Duties and Responsibilities" or "D & R." Naturally, in addition to the "D & R" training, each new Captain also completed a flight training program and the required rating rides in the left seat of the equipment he would be assigned to fly.

Originally, the "D & R" program was conducted by an instructor in a classroom/workshop format. However, many complaints about the program seemed to highlight the lack of standardization in the presentations. As a result, the program was produced on color video tape, using a panel format with the members being three of American's key Check Airman supervisors. The total video program required eleven hours of running time which was presented in forty minute sessions, each followed with a question and answer period.

This reduced the complaints concerning the "Duties and Responsibilities" program, but not to the point the training staff was satisfied. Therefore, it was decided that a survey was needed to determine the critical needs, or objectives, of the Captain's Upgrade program. Acting on that decision, a training development specialist visited several of the domicile bases and interviewed base management pilots and Captains, who had upgraded within the past year. The conclusions resulting from those interviews were:

1. Upgrading Captains averaged from ten to fifteen years with the company as cockpit crewmembers and had been exposed to the entire contents of Flight Manual Part I many times during their career. They believed a detailed review of the operational rules and policies could be accomplished by the individual through self-study.
2. Captains are advised they are an important representative of management, therefore it is absolutely necessary they become aware of the various company functions and programs that are in support of their day-to-day operation as pilot-in-command.
3. To assist new Captains in effectively directing the activities of other crewmembers, training was needed in Interpersonal Skills.
4. Proper importance should be afforded to the significant milestone in a pilot's career of being promoted to Captain.

To meet those identified objectives, a completely new Captain's Upgrade program was developed. The requirement to provide information on "various company functions and programs" was met by conducting the following presentations, all followed by question and answer periods.

Captain Ehmann and his immediate staff, during their presentations, mainly emphasize the importance of each Captain's new responsibility. They also outline major principles that Captains should consider in the decision making process as the Pilot-In-Command. The other speakers describe their major responsibilities and problem areas, and describe how they might be contacted and provide assistance to the Captains during future years.

1. Captain D. E. Ehmann, Vice President – Flight, and Staff
2. Air Traffic Control Director
3. Flying Operations Technical Director
4. Dispatch – Director
5. Crew Schedule – Director
6. Director – Flying Training
7. Director – Operational Engineering
8. Manager F/E Standards
9. Manager – Flight Service Training
10. AA General Manager DFW Airport
11. Manager – Aircraft Maintenance DFW Airport

In addition to those company functions, providing information on two supporting activities outside of the company seemed essential:

1. A visit to the Fort Worth Air Route Traffic Control Center where individual briefings are provided.
2. A presentation made by the FAA Principal Operations Inspector. This presentation covers compliance with FAR's, FAA's role in American Airlines' operations, etc.

In two one-half day sessions scheduled on the third and fourth days of the overall three and one-half day program, the recommended Interpersonal Skills training is conducted. During presentations on the first two days, several of the speakers, starting with Captain D. E. "Bud" Ehmann, Vice President – Flight, the importance of open two-way communications in the cockpit is emphasized. Also, the need for effective two-way communications with other supporting personnel is stressed: Cabin crewmembers, gate agents, maintenance, dispatch, etc.

The core of the Interpersonal Skills training is a five part 35mm color slide and audio program. This program was developed by American Airlines to train customer contact personnel – ticket agents, reservation agents, etc., and is titled TACT (Transactional Analysis in Customer Treatment). However, during the Captain Upgrade program the introduction and the discussions that follow the presentation of each part of the TACT program is directed to the cockpit work world. In terms of Transactional Analysis concepts the program discusses the make up of the personality, identified as three ego states. These ego states are identified colloquially as the PARENT, the ADULT, and the CHILD (P-A-C).

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From that basis individual transactions between two people are analyzed. Following the discussions students are then given an opportunity to analyze several transactions presented in slide tape format. During the remainder of the program students learn additional concepts which help them to understand many of the common transactions occurring daily on the job.

To provide additional importance to the promotion to Captain, besides congratulations stated during the Flight Academy presentations, an attractive brochure is presented to each new Captain. On the cover, Captain's wings and the individual's name is embossed in silver. The first page is a letter of congratulations from Captain Ehmann and the remaining pages constitute a notebook outline of the entire program with adequate space for note taking during each presentation. This brochure is presented to the new Captain before leaving for the Flight Academy Training program.

A highlight of the program at the Flight Academy is a dinner for the class hosted by Captain Ehmann. This provides an added opportunity for emphasizing the availability and interest of Flight Management in the new Captain's point of view.

The fifth day is spent at American Airlines Maintenance and Engineering facility in Tulsa, Oklahoma. There, they receive a briefing by Mr. R. J. (Rocky) Masiello, Vice President M & E, and his staff, followed by a detailed tour of all M & E shops.

These briefings and tours provide the new Captains with an understanding of the complexities and thoroughness of the Company's maintenance and engineering responsibilities.

At this time the basic program is complete and each new Captain commences his Operating Experience phase. Upon completion he continues a normal schedule as **Pilot-In-Command**. Soon thereafter an important part of this new Captain Upgrade program is conducted – a two to three month line check. This provides an opportunity for an experienced Check Airman to answer any questions the new Captain may have and to put a final polish on his techniques and methods of being a Captain for American Airlines.

The concluding step of the Captain Upgrade program is a one day visit to the General Office in New York City. Approximately six months after the Flight Academy program, each new Captain is scheduled with seven to ten other new graduates to spend a day with Mr. Don Lloyd-Jones, Senior Vice President-Operations, and his staff. In view of recent line operating requirements, all new Captains have not had the opportunity to visit the General Office on schedule. However, it is believed this is an appropriate conclusion to our effective program and hopefully future upgrading Captains will have this day of important training.

Since the beginning of this Upgrade program, student critiques have consistently and with unusual enthusiasm praised the merits of this new approach. Therefore, plans are being considered for including segments of this program in the First Officer and New Hire programs.

(Mansfield)

When we were faced with the request on the part of the crewmembers and base managers that interpersonal skills training be included in the captain upgrade program, I felt we had to concern ourselves with two considerations in selecting what the training would be.

The first one was basically an assumption. That assumption is that most of the candidates in the captain upgrade program had not had any specific training in interpersonal skills, at least within the last 10 to 15 years.

The second one was a fact, and that's the elements of time constraints and resources. I think we are all faced with that in a profit-making organization. After participating this far in this particular symposium, I would certainly suggest that we have all our captains sit in on this kind of a discussion. That would be quite ideal, although not quite realistic.

Faced with that assumption and that particular fact, I finally chose a program that had been developed within my company, one that I had been using for some time in the check-airman training program. This program is a two-part program, taking 2-1/2 days, and it is built around a slide-tape program of which I'll show you part. Actually, it was put together to train customer contact people; it's one that's been in existence in American Airlines for some time. This program was developed to train the ticket agents, the reservations agents, those kinds of people that have a very short but very important contact with our customers, and that would include our flight attendants — the people that probably have the most effect on whether our customers come back the second time.

I think all of us, regardless of our company, certainly wish to strive for that kind of feeling in our people and in their transactions with customers.

As I stated, I've been using this program in the check-airman training, and in view of the need to find something that would address the subject of interpersonal skills in a rather short, concise way, this seemed appropriate.

The program is built around a method developed rather recently, called transactional analysis.

Now, how to tell you about this? I pondered on it a little. I could go through a long verbal description, but I thought probably the best way is to show you a couple of segments.

I'm actually going to show you the first segment exactly as it's presented to the captains. I precede the showing of that section with an introduction. I won't go through all of it, but one of the things I bring to their attention is that they've had 10 to 15 years of experience sitting in the other two seats, realizing full well the effect that the captain has on the tone, on the atmosphere, and on the working conditions that take place within the cockpit.

Secondly, I highlight the fact that in that uniform with those four stripes he also has considerable effect on the young people that come through the cabin door trying to conduct business in the cabin who are coordinating with the front end, with the maintenance man on the end of the pushback line, the dispatch clerk, the scheduler, and many other people within the company that are there to support the operation of getting our passengers safely from A to B.

With that, I then say let's use a vehicle called "transactional analysis" to talk about your work world, and that is exactly what we do.

So what I'd like to do is actually demonstrate a slide-tape portion of the program. I'm going to revert to a master slide changer and let the program now speak for itself.

Synopses of four of the tape programs used by American Airlines are given here:

#### *Synopsis No. 1*

The TACT Program opens with a Prologue which, through images and music, presents a day in the life of Everyman. After the student has inferred the dehumanizing aspects of life in a technological society, the narration commences with a reference to the bestselling book, I'M OK — YOU'RE OK, by Dr. Thomas A. Harris, which provides the behavioral theory (Transactional Analysis) around which the TACT Program revolves (Transactional Analysis in Customer Treatment).

The first teaching point is that the human brain functions like a high-fidelity tape recorder which stores our earliest experiences and feelings. These recordings are permanent; then cannot be erased. These past events and our original feelings about them replay today in response to *today's* stimuli, and the effects of these visits to our past are generally far greater than their duration which may be only a fraction of a second.

The next teaching point is that continual observation has supported the assumption that three ego states exist in all people. These ego states are identified colloquially as the *parent*, the *adult*, and the *child* (PAC). These three ego states comprise the personality, and each has a vital value for the human being. The *parent* and the *child* are recordings in the brain of *actual* experiences of external and internal events. The *adult* is a recording of data acquired and computed through exploration and testing.

### *Synopsis No. 2*

In this portion of the course, the student observes the formation of the *parent*, *adult*, and *child* ego states in one little boy. The student also learns how the painful, civilizing process which this entails leads to the almost universal life position I'M NOT OK — YOU'RE OK.

The first teaching point is that the *parent* contains the taught concept of life; the mother and father become recordings inside the little person who observed them.

The next teaching point is that the *child* contains the felt concept of life, the responses of the small person to what he sees and hears. These events and feelings (primarily NOT OK feelings) also are recorded.

A third teaching point is that the *adult* contains the thought concept of life, the recording of data acquired from about 10 months on through exploration and testing. The *adult* is a data-processing computer that grinds out decisions after computing the information from three sources: the *parent*, the *child*, and the data which the *adult* has gathered and is gathering.

The decision I'M NOT OK — YOU'RE OK is, perhaps, one of the first functions of the infant's attempt to make sense out of life. Once his life position is decided, he has something to work with, some basis for predictability.

### *Synopsis No. 3*

Having developed a language, we come to the central technique: using that language to analyze a transaction. The transaction consists of a stimulus by one person and a response by another, which response in turn becomes a new stimulus to which the first person responds. The purpose of the analysis is to discover which part of each person — *parent*, *adult*, and *child* — is originating each stimulus and response.

The student is first provided with physical and verbal clues for each ego state. This brings us to the first rule of communication in Transactional Analysis: When stimulus and response on the P-A-C transactional diagram make parallel lines ... the transaction can go on indefinitely. The second rule of communication is that: When stimulus and response cross on the P-A-C transactional diagram, communication stops. Examples of "parallel" and "crossed" transactions are provided.

The student is then given an opportunity to analyze several transactions. (Instructions for this drill are provided both in the taped narration and in a note to the script following Slide C.60.)

Following the taped exercises, a brief discussion is scheduled during which the discussion leader makes several comments concerning P-A-C

terminology, and requests the student to provide written examples of parallel and crossed transactions (one each) for discussion at the next session of the TACT program.

#### *Synopsis No. 4*

In this portion of the TACT program, the student learns additional P-A-C concepts which help him to understand many of the common transactions occurring daily on the job and elsewhere. These concepts are *stroking*, *trading stamps*, and *games*.

*Stroking* is literally essential for our early survival as infants. Today, *stroking*, in the form of recognition, is just as essential for our psychological well-being. Hence a *stroke* may be used as the fundamental unit of social action. An exchange of *strokes* constitutes a *transaction*, which is the unit of social intercourse.

*Trading stamps* symbolize the negative (dirty stamp) feelings and the positive (gold stamp) feelings that people save up to cash in for guilt-free prizes. Stamp redemption is one technique used by people to deal with their uncomfortable, NOT OK feelings.

Another technique used to deal with NOT OK feelings is *games*. *Games* are special, ulterior transactions programmed by the *child*. Such transactions differ from simple parallel or crossed transactions in that they operate on two levels, an ostensible or social level, and an ulterior or psychological level. Games are always resolved on the psychological level.

The student is then given examples of how *stroking*, *stamp collecting*, and *games* affect him on the job, and is shown how putting the *adult* in charge of a transaction can often stop a game from progressing to its payoff.

That's exactly how the program is designed in the first section, representing about one-fifth of the total slide presentation. At the conclusion of this particular section that we just listened to, we then have a discussion trying to relate to their work world some of the concepts introduced.

For instance, my first question usually refers to the prologue or the introduction, and I ask them what was the intent of that particular introduction. It takes a little while to get some answers started, but it's a pretty alert group, and it doesn't take them long to define that those were there to portray the experiences that take place in people's everyday life and some of the feelings associated with those kinds of experiences, both good and bad.

They do a good job describing the frustrations, the aloneness, the various other happenings that take place that generate, maybe unhappy, but some of them happy feelings that go along with the work day.

Following that I usually ask them what takes place in their workday that brings about those same kinds of feelings of frustration, etc. By this time

they can warm up rapidly, and I won't repeat all the responses I get, but some examples are "The captain I flew with last month," or "The day at the gate over which I had no control," and so on.

We then go into the actual concept of transactional analysis and discuss some parts of the program, the *adult*, *parent*, and *child* that's already been presented, and go into a little further development before the second part is presented.

In the second part the slide presentation addresses more of the how's and why's in the development of the three ego states, and what some of the clues are that you and I can observe. I realize I'm addressing this to people who may not know about transactional analysis, but we do go into detail because most of the captain candidates have not heard of this method, nor have they had any direct interpersonal skills training. After the second section is shown we again have a discussion period and it gets livelier as you go deeper.

The third part is the meat of the whole thing, so I'd like to show you about 2 or 3 minutes of that third part to give you an idea of how this program flows. [Slides were shown.]

As I stated, that's just a little segment of the third part of this particular program. And, again, following the conclusion of this we get into discussion in which there are some practice transactions.

The transactions, presently, are in the ticket agent's work life. We are designing some to be in the cockpit work life, but even as presently shown, the crewmen can relate very well to a ticket agent and transfer the event to the happenings that take place around them.

The fourth part of the program addresses other concepts of transactional analysis involving reinforcement, both positive and negative, and also some of the more complex transactions that Dr. Berne, the originator, has titled Trading Stamps, Games, etc.

I conclude the program with some practice transactions and a 30-minute film that summarizes the idea of transactional analysis, and does an excellent job of showing the role-playing of games that people get involved in on the job.

As to the success of the program, as Capt. Estridge said, we have presented this as part of the captain-upgrade program to about 700 candidates. Certainly the written and spoken critiques have been in large part favorable. I think the most important benefit is that it possibly makes each captain, or most of them anyway, a little more aware of how they might operate in transacting or dealing with other people, especially those people who are so crucial to the safe operation of an airplane, the cockpit crew first and certainly all the other supporting people.

Based on what I have observed as a result of including this in the upgrade program, I would like to see some extension of the approach. Possibly



this basic explanation and then some role playing, such as we do for our check-airmen. Then we hope that we can soon get into LOFT training where the effectiveness of transaction is discussed during the critique.

#### DISCUSSION

DR. LAUBER: I'm sure that these gentlemen will be happy to answer questions.

DR. TANNER, NASA: Do you have any thought of doing this on a recurrent basis?

MR. MANSFIELD: No, it hasn't been discussed. The only thing that might address what you are asking, is that we have thought of backing it up in time, as it were, because one of the first comments at the conclusion of the interpersonal skills training was, "Why did I have to wait to become a captain to get this kind of training?" So the thought was to insert that kind of training both in the first-officer upgrade and the new-hire program, at least for a period of 4-5 years, until we've covered everybody on the low end. Regarding the entire program in addition to the interpersonal skills, we have been challenged on how we can present this to captains who have already been upgraded. That challenge hasn't been met as yet.

CAPT. ESTRIDGE: A question that's often asked in the class by candidates is "Why didn't you give that to old Joe, he sure could have used it." And there's a good point to that. I'm firmly convinced — I'm absolutely convinced — that a hostile cockpit atmosphere, or even one that's uneasy, in which a free exchange of ideas and thoughts and responses are inhibited, is a dangerous cockpit. It's an accident looking for a place to happen. And there is a method to this madness, because this pays off, it works, and I hope we can develop it even a lot better than we have.

CAPT. FRINK, Pan Am: Have you any evidence to indicate that old Joes don't exist any more since this 7 years of application of this interpersonal skills program on the 700 new men that have gone through it?

CAPT. ESTRIDGE: I wish I could answer you in the affirmative and say old Joes don't exist, but they do. Of course, this has been just 3 years and we've done 700; that's only a third of the captain population.

CAPT. FRINK: But among this new group, do you still have some of the old Joe types even though they've seen this?

CAPT. ESTRIDGE: I guess we don't have positive feedback that all of them are performing 100 percent.

MR. MANSFIELD: A subjective response to that, which I've heard expressed by some of our base managers, especially those at the smaller bases and those bases where the new captains are going, is that they feel that it's effective, that it is helping. But that's a subjective judgment, and that's the best feedback I can provide.

CAPT. CARROLL, United Airlines: Thinking logistically of the numbers you say you have plowed through this program in 3 years, what's the frequency of the time you hold a command course, what are the numbers that are in the course? The reason I ask is that getting them all activated at the same time and in position to take this course at the same time, to go to Tulsa at the same time, and make the visit to New York at the same time becomes quite a problem. I'm concerned about it from the standpoint of some of the programs that we run, that is, of the availability of the principals, as an example, to be on scene to do this kind of thing. It's kind of a complicated question, but how often, and how many, and what do you do for the principals being there?

CAPT. ESTRIDGE: Well, it's triggered by the number of captain upgrades that we need for the airline. They are programmed into the flight academy on the basis of bids opening up, and it's just a matter of numbers. Logistically, they get there because we need them to fly in the left seat. It's averaged about 20 a month for the past 3 years in upgrade. As far as taking the program to the rest of the airline or taking these people to all of these functions that we described, such as the maintenance and engineering visit, we have been able to successfully do that except for the last class last week, which we weren't able to get into the engineering center. But the one part of the program we do have difficulty in scheduling is the general office visit downstream a month or two. That's sort of difficult to work because of the schedules of the individuals involved. It is a real problem, it takes a lot of effort, and it could be quite expensive.

MR. MANSFIELD: The general office visit has not been fully successful. We're hoping that with the general office move, we could schedule that kind of a visit as they come in, maybe each 6 months on their semi-annual recurrent session.

CAPT. TRAUB, United Airlines: Did you say that you had a 2-3 month line familiarization program?

CAPT. ESTRIDGE: No, the line familiarizations are the 25 hours done immediately after the upgrade checkout course. But then we have a follow-up of 2 to 3 months in that area line check of the new captains, in which a check-airman goes with him on several segments to take a look and discuss a lot of the good things that you'd want to reinforce at that time.

DR. TANNER, NASA: You mentioned that in the course of the TA training there are times when there's role playing by the candidate?

MR. MANSFIELD: No, it's just a discussion. What I said was, the first addition I'd like to make is role playing. For instance, in our check-airman training program we require certainly the same training as in the captain upgrade.

Secondly, within the check-airman's first year we try to schedule him for a 3 or 4-day workshop, conducted by the management training section.

In this workshop certain roles have been tailored for the flight department. It's done with the use of video playback and critique. That I would like to see also in the captain upgrade program.

MR. RANDALL, NASA: I can see a lot of advantages to what you're doing; I think it's very commendable. I think one of the main things you get out of it is happy employees who have probably a little better company orientation than they had previously, but do you see any evidence that they're better able to manage resources in the cockpit?

CAPT. ESTRIDGE: Yes, I think that's a direct fallout that we are able to observe. And the base flight managers, the check pilots, and the people who have observed them subjectively have reported that cockpit communications and interactions between crewmen are better than they were. It's rather interesting that there were a few specific individuals about whom they made observations to the effect that they have definitely made an improvement; there are a couple I would like to see improve even more.

MR. MANSFIELD: The other recommendation that I would like to see implemented is that we adopt the LOFT concept soon. There the decision-making process or crew coordination can not only be observed, but it also can be used to practice what we have taught prior to the LOFT training. In that way we can reinforce the training by providing experiences in something of a real-time setting. I think that addition is much needed.

## CAPTAINS' TRAINING AT SWISSAIR

Capt. N. Grob\*

In the following short lecture I should like firstly, to comment on some of the limitations as regards pilots, within which our Airline has to operate, and secondly, to examine the objectives, crucial points and problems of the individual phases of the captain's basic training. What I have to say completes and emphasizes the essential points mentioned in the Working Paper submitted by Capt. Grünwald, our Flight Training Manager (see appendix B).

We all have the same target: we want to train copilots to become captains, captains to whom we can entrust, with a clear conscience, passengers and material of immense value. Each airline, however, has to a greater or lesser extent, *different prerequisites*. Already in the selection, for example, the requirements vary considerably. Not only the intellectual but also the flying capabilities are very different. One company may only recruit Air Force pilots; others prefer ab initio applicants. On the one hand a matriculation may be demanded; on the other a relatively lower standard of education is sufficient. Also varying considerably are the systems of promotion, the demands and pressures from the unions. And certainly the various flight training departments are also subject to varying economic pressures exerted on them by their managements.

With this, I must say that I don't expect to receive a gold medal for Swissair's methods, but rather to offer a solution, based on experience, that functions well essentially as far as our marginal requirements are concerned.

These can be described as follows. We recruit yearly about 40 pilots, of whom one third are from the Air Force and two thirds ab initio applicants. The average age is about 25 years. At present, after basic training, they fly about 12 years as copilot. As regards assignment to aircraft type, the management has a free hand where copilots are concerned. Usually for the first 5 to 6 years, copilots fly the short-range DC-9, after which for about 6 years they change to one of the long-range aircraft types — DC-8, DC-10, or -747 (fig. 1). Then follows a retraining period on the DC-9, a 2-month assignment as DC-9 copilot, and finally comes the long awaited initial upgrading to captain. The captain's career is in 3 steps: captain of a DC-9, captain of a DC-8, and captain of a DC-10 or -747.

Wherein lies the exact *problem in the captain's training*? In my opinion, the main aim is to further the ability of the pilot to recognize clearly situations that require him to make decisions and to make those decisions in good time, with the best means available. This we can define as *management*. Prerequisites are *knowledge* and *flying ability*.

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\* Division Manager, Cockpit Crews, Swissair.

For a long time we only concentrated on these two lines. In actual fact, it started originally only with flying ability — localized in the extension of the spine! Nowadays, Swissair bases its captain's training on three points:

1. *Theoretical knowledge* has taken on immense proportions in the fields of aerodynamics, performance, aircraft systems, regulations, and so on.

2. *Flying skill or ability* is still demanded to a high degree; it is not yet replaced by progressive automation. For the next few years, we shall still be living in this demanding interim phase. A pilot must be capable, on the one hand, of being a back-up system for normal operations and primary system for abnormal operations; on the other hand, he must act as programmer and supervisor of the automatic systems. Both areas, manual flying as well as automatic flying, must still be demanded in their entirety.

3. *Management*, that is the ability (1) to recognize situations and problems in good time, (2) to analyze, and (3) to find the best possible solution.

A high failure rate in the early 1970's forced us to introduce *two innovations* (fig. 2):

1. For one morning, approximately 1 year before the captain's course begins, all aspirants from the same age group are briefed as to the objectives, course structure and organization, and the problems and possibilities of preparation by the flight training manager, the DC-9 chief pilot, and myself.

The mental preparation and motivation toward a higher personal commitment are essential. A cold engine doesn't take kindly to a quick change from idle into top gear!

2. Whereas earlier the transition from long-range to short-range aircraft was combined with the captain's course, we have now made a definite separation. The pilot is consequently not so overtaxed. He completes the transition course as copilot, under less stress, and for 2 months has the opportunity to familiarize himself with the new equipment, the new route structure, and the new rhythm of short-range operations. The well known so-called "slow starters" now have a better chance.

In addition, we have the opportunity, in such cases where weaknesses are observed in the transition course, to extend the period as copilot by a few weeks, or even months, thereby also reducing the risk of failures. We still come across the occasional case each year, however.

And now comes the big hurdle.

*The Captain's Course* (CC). On the average, we train 24 new captains each year, of whom 3 to 4, or about 15 percent, fail to pass this part of the

training. For humanitarian and economical reasons, this figure is still too high and we are not satisfied with the result. Studies of each individual case make it essential that our selection, teaching methods, and aids are continually examined and improved. These unsuccessful pilots continue for at least one year as DC-9 copilots before getting a second chance. Half pass at the second attempt; for the others, the alternative is to remain as long-range copilot.

After several negative results, we have abandoned the procedure of giving a third chance, because only more damage is done. Little hope and a minimum of self-confidence are destroyed completely — the process borders on torture!

The *reasons for failure* are mostly an accumulation of poor flying aptitudes, mental inflexibility, and meager leadership qualities. In some cases, performance was definitely shadowed by private problems. We have to accept the fact that a pilot's progress cannot be forecast exactly during the selection, and that in the course of time as copilot, outside influences are at work over which we have no control. The long copilot period is in itself a problem and could quite well provide a topic for such a workshop.

The *objective* of the captain's course is clearly recognizable. The aspirant must understand the normal and abnormal flight procedures and be able to apply them in the simulator and in the aircraft. Compared to the demands made of the copilot, we add (1) engine failure in all phases, and (2) approaches and landings with abnormal configurations (0-flaps, slats, etc.).

The captain's course comprises the following (table 1):

1. One day (6 hours) theory flight procedures, which comes under the heading of knowledge
2. Five sessions (9 hours at the controls) simulator and flying skills
3. Three sessions (4 to 5 hours) flight training and flying skills
4. Three sessions (10 hours) simulator and management

In the *flight training*, we concentrate for the most part on VMC circuit work, which is still required for a few poorly equipped airports. As the overall majority of our destinations offer navigational luxury, the training opportunities for low circuits are small. In this respect, Air Force pilots have more experience compared with ab initio pilots.

Now that the individual bricks are provided, it is up to the would-be captain, as a last step, to assemble them and make a building. He must deal with various realistic trouble situations independently, right up to the landing.

The focal point is management. Here the prospective captain must not be the soloist but rather the conductor, making the optimal use of his orchestra to build up a harmony, using his knowledge and skill, his copilot (we have a two-man concept) and the assistance of ATC, dispatcher, etc.

Thereupon the chief pilot takes over. In a 5-day theory course, the so-called *Captain's Theory Course I* (fig. 2), we want to introduce our future manager into the domain of the large-scale enterprise of Swissair, at the same time going into the details of the captain's *rightful position*.

Captains are in a sense isolated, as a result of the nature of their work. Ground personnel, being stationed in one place, generally feel themselves more integrated into the company as a whole. Together with 400 captains, there are about 15,000 employees pulling on the same string. All want to carry a large number of satisfied passengers safely over our route network. There is an enormous profit to be gained from a good cooperation between all departments, but this depends entirely on understanding the problems and opportunities of the others — above all, mutual respect. The captain, in his work, comes into either direct or indirect contact with practically all departments connected with the airline business.

We strive for a close coordination and cooperation by getting to know, above all, the direct contact officers, such as dispatch, crew coordinator, ATC, station manager, and so on — but not forgetting those who remain rather more in the background. The managers of the various departments appear personally as speakers. Although under pressure of work, they accept this duty willingly.

These efforts bring real rewards and the results of a harmonious integration of flight personnel can be easily recognized as a sound motivation and healthy working atmosphere as a whole.

And now we throw the aspirants into the pool, with the swimming teacher standing watch. For about 150 hours, we train the would-be captains *in practice*. This phase we call *upgrading* (fig. 2). During the first 70 hours, the aspirant sits in the left seat with the route instructor taking the place of the copilot in the right-hand seat, the regular copilot occupying the observer seat. At the end of the 70 hours, the route instructor changes places with the copilot, allowing the captain and copilot to work together as a normal cockpit team. During the first phase, some aspirants occasionally have difficulties playing the role of boss, in the presence of the experienced route instructor.

The upgrading is made up of three phases (fig. 3):

1. In the *Introduction Phase*, mistakes are by all means accepted, as long as safety is not affected.
2. In the *Second Phase*, the qualities of leadership, crew supervision, initiative, powers of decision, and cooperation with other departments come more to the front.

3. In the *Final Phase*, we want to make sure that the prospective captain is now in the position, as pilot as well as manager, to master his job and prove his capabilities regularly.

In the upgrading, we seldom have failures. Each aspirant flies with approximately eight *route instructors*. Each day the mistakes are discussed with the aspirant, personal experiences imparted and, by means of a syllabus, knowledge of the flight operations manual, aircraft systems, performance and flight procedures are explained and checked. Each route instructor issues a qualification.

As a result, the chief pilot can assess the progress of his pupils and can take immediate action and the necessary measures, for each case individually, should any difficulties arise.

Our system demands much adaptability on the part of our would-be captains: adaptation to different viewpoints, personalities, and temperaments. Differences, however, have the big advantage in that they provoke discussion and the analysis of a problem. Not only that, but the route instructors, and finally the management of flight operations, are forced to continually reflect on the basic points.

Out of a total complement of 200 DC-9 captains, we have 50 route instructors who are in direct contact with the chief pilot. Every 2 months each route instructor calls a 1-day meeting, at which general information is exchanged and problem cases and questions discussed. We try continually, using examples, to come to a unanimous assessment of the aspirant concerned.

These route instructor meetings give us, in every respect, a clear insight into the working atmosphere, the worries and needs of our crews; we can obtain valuable information from them.

The captain's appointment is celebrated with a dinner, at which a representative of the top management, usually the President himself, is present. The wives are also invited to this celebration. Shortly after the appointment, all the new captains are invited once more to a secluded center in the Swiss Alps. Using examples of some of the problems in line operations — with cabin personnel, passengers, station and hotel personnel, etc. — we work out management principles for the captain, in group discussions.

We place this course at the end of the training (fig. 2), and after the appointment as captain, because with the participation of people who are no longer under duress, and who can introduce problem situations which they themselves have experienced, we can achieve an essentially greater success. This final 3-day course is conducted by the DC-9 chief pilot.

To conclude, allow me to make a few statements, which I hope will act as stimulation for the working group activities that start tomorrow.



It is *no problem* to train our copilots to become enthusiastic, well-motivated, and qualitatively excellent captains. Subsequently, however, forces are at work over which we have no power of control. Insufficient challenge in daily routine; the changing role of the pilot; the sinking image of the profession in the eyes of society; the effects of top salaries for a minimum of creativity and having a say in matters; the changing social and family structures and the resultant increasing personal problems are just a few of the animating keywords.

The main problem lies in *maintaining the standard* of our young first-rate captains until their retirement.

#### DISCUSSION

DR. LAUBER: Are there questions of Capt. Grob?

CAPT. JOHANNESSEN, Scandinavian Airlines: Did you say every month, a few days with the route instructor?

CAPT. GROB: No, every two months a 1-day meeting.

CAPT. FRINK, Pan Am: Did I understand that the president of your company personally greets each new captain?

CAPT. GROB: Right.

CAPT. FRINK: That's wonderful.

CAPT. GROB: We take them all together, about 12. We have the celebration twice a year, and then the president will be present for that celebration.

JOAN BARRIAGE, FAA: Would you comment on what type of training you have for the training captains with respect to resource management? Your captains are imparting to your new captains a concept of how they manage in the cockpit — I was wondering what principles or what background might be common to all of your training captains in regard to this particular aspect of training?

CAPT. GROB: Our training captains are trained in a course. That course takes about 5 to 6 days and there all the principles are discussed. And also these route instructor meetings are for that purpose — to standardize procedures and to find the "unité de doctrine." Does that answer your question?

JOAN BARRIAGE: I understand then that it is through this joint meeting of these individuals that, shall we say, a common approach evolves in dealing then with the whole range of anticipated problems in the cockpit?

CAPT. GROB: Yes.

CAPT. FRISTOE, United Airlines: In connection with the flying skills, you stated you had five sessions in the simulator and three sessions of in-flight training. Would you briefly describe what each one of these days involves? What is the length of training involved, and so on?

CAPT. GROB: Yes. You mean this here?

CAPT. FRISTOE: Yes. It says you have five sessions over a period of five days; that would be one session a day, is that correct?

CAPT. GROB: That's right, every day a session.

CAPT. FRISTOE: What is the length of that day and what does the session basically involve?

CAPT. GROB: A session takes about 3 hours in the simulator and then comes the briefing time. And we go through all the flight procedures, all normal and abnormal procedures. So we build the brick here, we form the bricks. That's the reason for these sessions. In the flight training we can't go through all the flight procedures, we just select a few of them. I'd say mainly the VMC part, which can't be simulated completely in the simulator, and also the landings with abnormal configurations, are done during the flight training. And these 3 days and three sessions here, (post flight simulator) we have different problems, situations which the new captain has to deal with. That's where we teach him to assess the situation, analyse the situation, and to manage his resources. We had just two cases in the last 2 months where we could see that there was quite a problem and quite a bit of progress to be made, and we think that we will extend these 3 sessions here. Here the captain can learn something really new — something that they have to know for their future job.

MR. COEN, FAA: Capt. Grob, is that what we're calling LOFT, that last three sessions?

CAPT. GROB: Yes, right, that's the same.

MR. MANSFIELD, American Airlines: That being the case, with the new captain, there will be qualified line crewmembers in the other two seats, in the case of the three-member airplane?

CAPT. GROB: Yes.

MR. MANSFIELD: Are they undergoing some kind of training or just there to support?

CAPT. GROB: Just there to support.

CAPT. GILSTRAP, United Airlines: You mentioned the reasons for failure. Lack of pilot aptitude, I think was one, and the third one was a lack of leadership qualities. What was the second one in between those two?

CAPT. GROB: Yes, it is the lack of flexibility.

CAPT. GILSTRAP: Could you expand on any of these three, in any way, as to what you see there in the way of failures?

CAPT. GROB: Well, we thought a lot about how we could reduce this number of failures, of course. I'm not sure if we should invest more time. We have quite a big program, I think, compared with the programs you have here in the United States. We will give training as long as we can see an improvement. However, very often the improvement stops, and then it doesn't make any sense to go on further. So our way is to say, "then we stop here, and we start again in 1 year."

DR. LAUBER: Capt. Grob, thank you very much.

TABLE 1.- CAPTAINS COURSE

- THEORY – FLIGHT PROCEDURES – 1 DAY – KNOWLEDGE
- SIMULATOR – 5 SESSIONS – 5 DAYS – FLYING ABILITY
- FLIGHT TRAINING – 3 SESSIONS – 3 DAYS – FLYING ABILITY
- SIMULATOR – 3 SESSIONS – 3 DAYS – MANAGEMENT

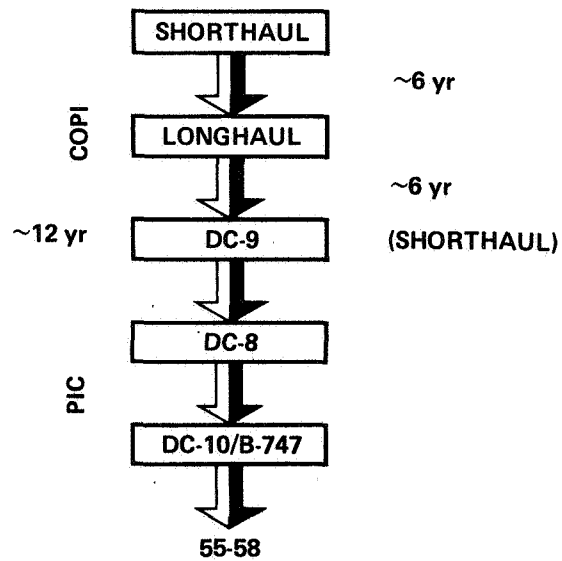


Figure 1.- Pilot career progression.

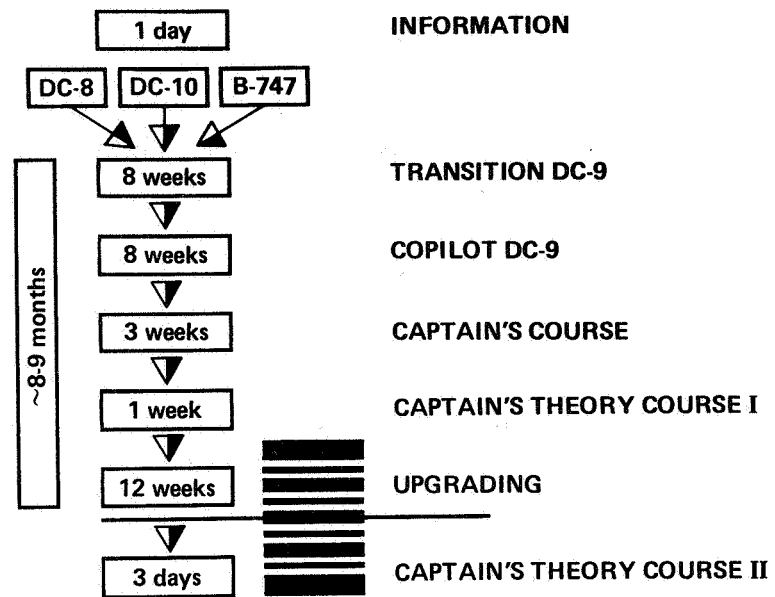


Figure 2.- Course program.

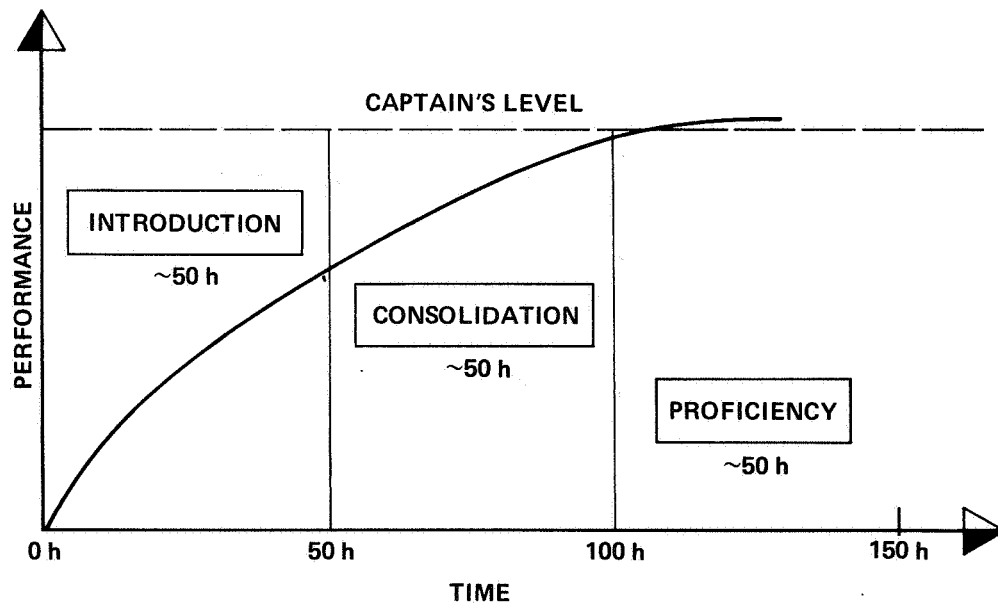


Figure 3.- Initial upgrading.

## LINE-ORIENTED FLIGHT TRAINING

Captain Berton E. Beach  
Manager-Intermediate Jet Training  
Eastern Air Lines, Inc.  
Miami, Florida

I'd like to talk about some ideas on Line-Oriented Flight Training (LOFT):

- Why we at Eastern chose that program as a training tool;
- How we've developed our program;
- What it has done for us so far at Eastern Air Lines, and;
- What uses we plan for it in the future.

The environment in which we operate continues to become more demanding of management skills on the part of the pilot conducting the flight. This is directly related to the complexity of an operation intended to attain absolute safety while conducting all weather flight. We recognize the need to shift from training in manipulative skills to something closer to management skills.

Line-Oriented Flight Training (LOFT) is not a new idea. We used a similar format at Eastern in the late 1950's on our DC-8 and Boeing 720 series aircraft. At that time, the simulators available had no motion, nor visual capabilities. As a result, we were unable, until recently, to develop a training environment that would simulate the real world with acceptable fidelity. We needed to illustrate the value of standard operating procedures as they affect the line pilot in everyday operation. The advent of simulators with motion, plus the visual system ability to reproduce a realistic airport scene, provided us with the tools we needed to construct a worthwhile line-oriented flight training program.

Our first effort to implement LOFT was a scenario we developed in 1975, wherein the crew took a three-leg, four-hour flight that satisfied all requirements of Appendix F, except for steep turns and approaches to stall. By the end of the four-hour period, the crew had seen a major fault in every system on the aircraft. They conducted at least two ILS approaches and two non-precision instrument approaches per pilot. Most, if not all, of the emergency procedures had been reviewed.

To accommodate all this activity, the legs between the city pairs used in the scenario were shortened electronically. Shortly after this time, Eastern applied for, but was not granted, permission to operate under an exemption from Appendix F. Appendix F lists the requirements for the demonstration of competency as outlined by the Federal Aviation Administrator. In fairness to the Administrator, I must point out that this regulation is intended to accommodate all operators under Part 121, including those carriers who may not have the most modern training devices.

Since ours was a special case, we felt that strict compliance with the regulation would not provide the flexibility needed to shift emphasis from training in "manipulative skills" to training in management skills. We were unable to obtain the exemption and LOFT was put aside for a time.

Our current format was developed after guidelines for exemption were published, and we found that we were not required to conform to Appendix F at all - except that we must maintain our landing certification to Category II or Category IIIa minimums. This was no real deterrent since our visual systems are capable of visibility reductions, to whatever degree is required. If individual performance indicated a need for remedial training in normal VFR approach and landings, this could be completed as an add-on to the LOFT session. Right now we have two programs in operation, both approved by the Federal Aviation Agency (FAA). One is for the Boeing 727 aircraft, the other for the Douglas DC-9. LOFT programs for the Lockheed L-1011 and the A300 are being developed now. We expect to have these programs approved by the end of 1979.

Our present program consists of six scenarios per aircraft type. Each scenario contains three legs. The scenarios are designed to fit within the four-hour time frame ordinarily used for a training period.

When we develop our programs, we emphasize strict realism. All the legs are flown in real time. The problems presented for the crews to solve are those which can, and in some cases, have happened in real aircraft. The visual systems can construct the airport environment with considerable fidelity. The picture the pilot sees on approach to a runway in our simulator is amazingly close to what he would see in the real world. These visual breakthroughs add immeasurably to the flight crew's acceptance of LOFT, and therefore, enhance our program's value materially.

When we began to create scenarios, we needed to consider some key items:

1. What route segments and airports should we use which would give the best indication of the Captain's management skill? The approach briefing, individual task assignments, crew coordination and the command presence were some of the items we considered. For example, Pittsburgh, Pennsylvania, gives us a chance to work on Category II. It also affords us the opportunity to use an inner marker for decision height rather than a radio altimeter.

The VOR approach to Runways 5 or 36 in Charlotte, North Carolina, compels the flight crew to make an approach to what is commonly known as a "black hole" type airport - which is to say, there are no perimeter lights to rely on for attitude judgment. The only things you see when you break out are the runway lights and those lights adjacent to the terminal. So, we chose Charlotte to illustrate that particular problem at night.

Operations in and out of Atlanta, Georgia, gave us a chance to operate in a complex air traffic control environment, and another try at Category II approaches as well.

We chose Miami, Florida, because of the variety of approaches available in generally VFR weather. Previous experience in upgrade training from Second Officer (Flight Engineer) to First Officer (Co-Pilot) has indicated a need for training in approach and landing based on visual perception rather than electronic guidance.

2. What aircraft systems and procedures should we examine and where should we put them in the scenario to ensure the highest degree of realism? For instance, current emphasis is being placed on the use of maximum braking in the event of a rejected takeoff. This is the result of industry experience which indicates that:
  - A. The rejected takeoff is more likely to be the result of some malfunction, such as a blown tire, or a fire warning indication, rather than a failure of the most critical power plant; and,
  - B. Admonitions to the flight crews to go "easy on the brakes" - "consider costs" - "don't try to make that first turn-off," have resulted in the use of less-than-maximum braking when needed.

In the scenario, we can consider including the rejected take off, to physically demonstrate maximum brake pedal deflection, and the effectiveness of ground spoilers and reverse thrust in reducing roll-out distance, and by using an airport layout in the visual scene, such as Washington National, the results of non-standard operating procedures on a rejected takeoff can be dramatically displayed.

3. Finally, how should we tailor these scenarios to fit the four-hour time frame?

First, we decided what approaches we would "shoot" into what airports. Then we took city pairs and linked them together to form the legs of the scenarios. We decided, on each leg of each "flight," what problems we would present for the crews to solve and also, how many problems, and where they should occur. After we roughed out our plans, we went to our dispatch department, and drew from the computer actual flight plans that are stored there, selecting those city pairs we had chosen. Once we had those plans in hand, we began to fit the segments together to form the four-hour training period needed to satisfy our requirements.

As soon as all six scenarios were composed and all of the legs were laid out, we test-flew them in the simulator to be certain that they fit within the four-hour time frame. We allowed adequate time between legs for short breaks for the crew. When all of the scenarios were put together, we invited three different groups to fly the scenarios, and we solicited comments from each group.

First, our simulator flight instructors were scheduled to fly the scenarios. In each case, they were asked to consider:

- Whether the flight plan was realistic and could be related to a typical EAL flight segment.



- Was the routine excessively demanding? and,
- Could the expected response by the crew be indicative of a lack of management skills?

Next, the Training Committee from ALPA reviewed the scenarios and flew one. Since all members of the committee are regular line pilots, we felt that their input as potential users would be significant.

We then invited a group of Air Carrier Inspectors from the FAA to try a scenario or two and give their opinions. We felt that FAA participation at the early stage of program development was important. Since they would be the approving authority, we could use their input to help identify any possible problems which might delay program approval. Once we had collected all of the ideas, comments, and suggestions, we put a final polish on the total package and passed it to the FAA for its official approval.

The training period begins with the full crew attending for the examination of the flight departure papers. At Eastern Air Lines, all of those flight departure papers are stored; that is, dispatch releases, flight plans, fuel requirements, weather sequences, and forecasts are all in the computer and are recalled as each crew requires them prior to departure. Since we strive for considerable realism in the LOFT program, we also have the flight departure papers for the program stored in the computer, accessible to us in training. They are recalled by the instructor prior to briefing his crew, before the training sequence.

As in normal operations, the crew examines the papers for minimum equipment items, fuel requirements, notices to airmen, and so forth. They also check the appropriate weather sequences and forecasts, determine fuel requirements, and perform any other preparations that a Captain may require.

When the Captain decides that sufficient time has been spent on briefing, the crew proceeds to the simulator. While in the simulator, the Instructor/Check Airman links normal communications among start crew, ground control, tower, departure control, and so forth. He does not, under any circumstance, interfere with normal operation or functioning of the crew.

Once under way, the crew must solve all problems according to their own best judgment. We took great care to avoid overloading the scenario. Had we cluttered it with unrealistic situations, we might have induced mismanagement. But, any of the crew's mistakes or errors in judgment, or ignorance of procedures, will remain until corrected, or until the "aircraft" is on the ground. The training requirement is for four hours, and all the legs need not be completed.

A word about scripting is appropriate at this time. All sequences are tightly scripted, and deviations and additions are not permitted, except that items may be deleted if there is not enough time in the four-hour period left to perform them. As a timing aid to the instructor who is conducting the scenario, we designed the last leg with an adjustable time frame. The script is so written that the instructor has the option of selecting that point at which the problem will be presented which best utilizes the training time remaining.

When the simulator period ends, the Instructor/Check Airman leads the crew's debriefing session.

In the year and a half since Eastern Air Lines began the LOFT program, we have come to see it as the training vehicle of the future. We believe that LOFT can provide more realistic initial training because, from the first day of training, we can emphasize the kinds of skills needed to operate a particular aircraft in today's complex environment. We believe that LOFT develops considerable judgment skills and provides excellent experience in structuring priorities. It also illustrates the consequences of poor resource management, ignorance of proper procedures, and lack of command presence.

Training conducted in simulation, very closely matching the environment in which the crew normally operates, gives a crew the best opportunity to see normal and abnormal situations and their solutions. For example: in the simulator, a Category II approach to a runway closely approximates what the pilot will see in the real world. But in a trainer aircraft, as soon as you "pop the hood," the pilot finds himself in an entirely visual environment. For this reason, we feel that LOFT provides considerably more realism.

In addition to its value as a training vehicle, a line oriented training program is an excellent evaluation exercise. The simulator's ability to accurately reproduce the line pilot's normal working environment, plus the instructor's briefing prior to the start of the period, emphasizes to the crew that they are expected to perform in the simulator exactly as they would perform in the real world. This permits us to see a more accurate picture of how the crew functions in such areas as decision-making, cockpit discipline, the Captain's command presence, crew coordination, and other resource management skills. The crew is also briefed that the LOFT program is not constructed as a pass or fail check ride; it is, rather, an evaluation of their skills to uncover in what areas, if any, they may need additional training. We feel that it is important to remove any threat of embarrassment or punitive action. By so doing, we diminish the tendency of the crew to respond in the way that they think that the instructor wishes them to respond, and apply instead their own best solution. We believe that this environment produces a very clear picture of the capabilities of the crew being evaluated.

We have found LOFT to be excellent for remedial training. We have taken crews off the line who have had a problem of one kind or another, put them in a LOFT training format to duplicate the problem or circumstances they experienced, and let them pinpoint the moment when things go wrong. We can show them what they did, find out why they did it, and demonstrate the better way to do it next time.

As a result of our success with this approach in remedial training, we are now experimenting with the construction of modules to be stored in the computer. Each one will be fabricated to illustrate a particular problem or abnormality that, if mishandled, could have serious consequences.

When we get a crew requiring remedial work, for whatever reason, we hope to retrieve these modules from the computer, examine them, and extract those which, when linked, will result in a LOFT scenario for that particular crew to exercise in. Eventually, we hope to have enough modules to cover the majority of difficulties we see on the line. In this fashion, we will tailor a training program, almost exactly, to fit the kind of training required.

We also intend to use LOFT to evaluate our current operational procedures for both normal and abnormal situations, and to help us determine needs for, and the effectiveness of, new procedures. For instance, at Eastern Air Lines, we have no written procedure to cover crew incapacitation, both subtle and dramatic. By observing the crews as they handle these situations, we will decide whether or not we should have in writing some procedures for crew incapacitation, and if so, what they should be.

We intend to further use LOFT to spot any trends indicating weak spots in our training program.

When all of our simulators are approved for the landing maneuver, LOFT will make it possible to complete all phases of training in the simulator. We want training programs that will assure competency in the area of manipulative and management skills prior to assignment to scheduled operations. The line operating experience will serve to validate the effectiveness of the training program.

To sum up: Line-Oriented Flight Training, as it has been developed at Eastern Air Lines, represents the best training vehicle we have seen thus far. We believe it matches all our training needs more than anything yet devised.

We shall, of course, use LOFT programs in training, and for the annual and semi-annual proficiency checks. Soon we will build it into initial training. We see it as a marvelous device for remedial training as well, and for reviewing the effectiveness of operational procedures. As a tool for developing new procedures, we have found it to be unequalled. We are confident that LOFT will lead us to zero aircraft time.

## DISCUSSION

MR. RANDALL, NASA: I agree with you, the CGI systems are really classy, but I've never seen a generation of terminal weather with those things. Is it done electronically or optically?

CAPT. BEACH: No, it's electronic.

MR. RANDALL: Could you describe how it looks?

CAPT. BEACH: The best description I can give you as to how it looks is — I'll go back to the example I used to begin with. In Category II, for instance, the only thing that you do not see in the visual system, if you're looking at fog at the airport, is the halo around the lights — we have done everything but that. The discrimination of the runway texture, the numbers, the slight blurring of the centerline, all of that, touchdown zone lights, their intensity. If you're not careful you think you're in a real airplane, that's how good it is. The only thing we don't have in the visual system now is the occulting of buildings. As you taxi up to the terminal, for instance, at Washington National Airport in Washington, D.C., you can see through the buildings. It is only a slight infidelity, but it is not too dandy and we're working on it.

MR. RANDALL: Do you have the phenomenon of broken clouds — now you see it, now you don't?

CAPT. BEACH: Yes, that mode is called scud. I'm not sure what the random occulting is, but there is a random, patchy fog that we can use. As a matter of fact, we use it for a missed-approach maneuver, now you see it, now you don't, you've got to go.

UNIDENTIFIED: How do you handle an unsatisfactory or less-than-capable crewmember?

CAPT. BEACH: What is done depends entirely on what the check captain feels is required. Since there is no pass or fail, we take the instructor's recommendation as to what kind of training is required to bring the man up to our standards, how much and in what direction. We rely completely upon the instructor to give us that input. If Capt. Jones needs a 4-hour training period with emphasis on nonprecision approaches, that's what he gets. Then another evaluation.

MR. MANSFIELD, American Airlines: I understand what you're going to do in the next step, but up to this point in time do you use LOFT at all in the standard transition program, and if so, how?

CAPT. BEACH: On July 1 we are beginning to use LOFT concepts to reduce aircraft time. We're doing what really amounts to a dress rehearsal for the type rating ride. It will be done in our AST simulator, and I have

constructed a small mini-scenario to be used by the training captain as a dress rehearsal. That's the beginning. Ideally what I want to do, and I think we will when we have the development-type simulator, is use line-oriented flight training in initial training. The first simulator period or two will be devoted to systems and procedures, after which it begins to be a line trip. That's next.

CAPT. SESSA, Allegheny Airlines: After, say, a pilot receives 4 hours of emphasis on nonprecision approaches, how is the reevaluation conducted? Is it under a LOFT basis, or on a normal proficiency check?

CAPT. BEACH: On the normal proficiency check, because we require for a LOFT program a line crew. Which is to say, if the line crew is not present, we can't do LOFT. For one thing, the exemption, I think, prohibits us from putting check people in to be used as additional crew members. So because the crew he went through the LOFT program with is gone, plus the fact that we want to focus on his individual problem, we take him aside and plug him into the ordinary program.

MR. COEN, FAA: Lest we scare some of these other people off, the rule was changed about 9 months ago to allow for LOFT training, under Subpart N and 121. So now you have the three options of 409 training, Appendix E and other proficiency checks for the LOFT training, and it spells out the regulations.

CAPT. BEACH: I'm not entirely sure that I have seen that particular modification across my desk, but I'm glad to hear it.

MR. COEN: Anybody who wants to can go into LOFT; we don't want to scare you off.

CAPT. HOLDSTOCK, British Airways: We have gone down this road, and, like you, I do appreciate the value. However, for the period the flight is actually going on there is no training. We call it training, but we're not, we're checking, we're evaluating. The training comes at the end with the debriefing. However, there are times when a mistake has taken place during the flight, and the one thing you need to do for the individual is to right it, then and there. You don't want to send him home with the thought that he did something stupid or was incapable of flying the procedure — you want to put it right. Do you have any facility in this training?

CAPT. BEACH: We have done perhaps the other side of the same coin you're talking about. We specifically do not interrupt the flow of the flight as it proceeds. For example, the DC-9 aircraft electrical fire and smoke is one of the more frightening things about that airplane. If you find a crew that simply cannot handle it, we sit back and let the thing crash. The idea being we want the man to dig as deep a hole as he can dig. But once he has crashed, if that's what turns out to be the case, once the aircraft is back on the ground again, then by debriefing immediately thereafter we can begin to show him what he did wrong. But we don't

interfere with things as they are happening. We used to do that on what we called the 4-hour training period in lieu of a proficiency check. Launch the aircraft, present a problem, put the simulation on freeze, and let's talk about what you've seen — why did this happen or why did that happen. We crammed a wealth of information into that 4-hour training period, and you could see it leak out of the man as he walked away from the simulator.

We felt that you never learn better than when you embarrass yourself, if it comes to that. Those kinds of things that make a dramatic impression on you or those kinds of events where you could have killed yourself. So we felt rather than, and we specifically talked about that subject, rather than put it right at that time, we'll use the debriefing for that. If we feel that we have made the man overly humble, then we'll put him back in the machine again, and let him do it right, just to prove to himself that he can.

CAPT. FRINK, Pan Am: Can you tell me to what extent you are required to do additional specific remedial or brush-up-type training following the LOFT exercise? Also, how do you face the fact that in the normal course of a man's line flying, he does not come upon an engine cut on takeoff, he does not come upon a two-engine approach or three-engine missed approach. Yet throughout the years we have been using our periodic checks and our training in lieu of checks to give him practice in maneuvers that we feel they need. To give him a smattering of these, but not all of them, in a LOFT program has caused us to look very, very carefully at the concept of the LOFT because of the economic effect it would have. On the one hand, it would force us to double our training in order to accomplish the practice piece of this thing, yet on the other hand it would obviously take advantage of the crew concept aspect and the management aspect of LOFT itself. It would be very helpful to us if you could tell us exactly how much additional training it will require if we were to go to the LOFT concept for our training in lieu of check.

CAPT. BEACH: We haven't found a specific amount of time required. Maybe I can address your question by answering the last half of it first. Part of what you're talking about is those kinds of things, as I mentioned earlier, when we had the 4-hour training period, where he saw one each of everything that could possibly go wrong. Engine failure at V-1 in the case of the 727, an engine-failed approach, an engine-failed missed approach, double-engine failure, single-engine landings, electrical fire and smoke, abnormalities — all of that in 4 hours. As you just said, it doesn't happen all the time. But maybe he ought to see it once a year, at least, to refresh his memory on why things happen like that. That's what we used to do. But we felt, all of us who talked about it in concert, that that kind of thing lasts just about the length of time it takes him to walk out the door if you put that much into a program. We felt that we were teaching better management of the flight by selecting those kinds of things which, if improperly managed, could be catastrophic. For instance, one of the scenarios is an engine explosion that throws pieces through the center engine; as a result, you are on one engine about a 100 miles from Pittsburgh.

There it is, 100 miles away, you can see it, what do you do? Or you're looking at single engine drift down. We felt that the length of time that we exposed the people to that problem was far more beneficial than running them through three anti-icing exercises perhaps. But that anti-icing exercise is part of the scenario. So we covered the kinds of things that could get you in the deepest trouble, engine failure at VR, that kind of thing. We felt that we should cover really those things that would be beneficial to the crew rather than gyro failure or compass failure, which don't really provide a great base to build a training problem on. With our approach, although there's no pass or fail, we have had to take some people out of the program and retrain them or upgrade their training. There has been no specific amount of retraining that we have had to do — it depends on the individual. We have had people come through who can almost walk on water, and we have some who don't wash. Between those two is the ordinary pick and shovel aviator like myself who manages to stumble through it every time. So we felt that the program really hadn't caused us any extra training at all except for those few who really need it, and they would be the ones who would probably fail the PIC check or the semiannual check anyway. So there has been no training generated in excess of what we ordinarily do. I hope that answers your question.

MR. SMITH, ALPA: Has this had any effect on your instructors in terms of what they're required to know and to be able to transmit in terms of information? How do you feel this has affected standardization of procedures under emergency situations?

CAPT. BEACH: The effect on instructors has been considerable because when we first put the program together, it was incumbent upon us to be sure that the instructor conducting the program, which is really an evaluation, knows what he's doing.

It is, as probably you have gathered, quite subjective in scope. Whether the man is good, bad, or indifferent depends entirely on how the instructor feels. So we have, I won't say rigid, but rather comprehensive briefings among the instructors who are LOFT qualified and myself, about what the program is about. In our handout, the script we give to the instructors to use is a foreword that gives my ideas of what line-oriented flight training is and what the instructor's responsibilities are, and we discuss those when he comes in to talk to me before he's LOFT-qualified. It hinges very much on the instructor, and he's very much aware of the fact that that's his position, and we train him for that.

MR. SMITH: But in the standardization of the emergency procedures, has there been any problem in terms of the instructors' techniques to solve a problem?

CAPT. BEACH: No, there is no individual opinion in the line-oriented flight training as we constructed it. The emergencies are handled according to the standard procedures as spelled out in the airplane flight manual. That doesn't mean to say the captain can't use whatever solution

he feels best, but in debriefing he should be prepared to defend it. If you deviate from standard procedure, we expect you to say why. One benefit of the LOFT program we feel may be that if we find your procedure is better than the one we have written, we may change the one we have written. We haven't yet, though.

CAPT. FRINK: The training committee requested of the FAA, when they were considering this regulatory change, that they change the time distribution for LOFT to 3 hours for the scenarios and allow us 1 hour remaining to do specific maneuver practice that may be a seasonal thing. We might want wet runways, icy runways, we might want crosswinds, we might not want wind shear, something of this nature. But we felt a very great need to be able to have some time to concentrate once a year on specific needs that the operations has indicated are there. In your opinion, having used the LOFT to the extent that you have, would a 3-hour period be adequate to do the job that you're trying to do?

CAPT. BEACH: A 3-hour period again would depend on what kinds of things you want to see. Our operational requirements, and particularly the airplanes I'm involved with, are unlike yours. The situation that you are probably looking at, where maybe you get one landing a day, doesn't apply to us. So you would perhaps need that extra period to focus on the kinds of things you feel the crew may not ordinarily get to see. Because of the way we're operating and the kinds of airplanes and route structure we have, we elected to go the full 4 hours for line-oriented flight training and have three legs to develop the kinds of things we wanted to see. Can you do it in two? Yes, I think you can. You would have to sit down with the people who are going to construct the program and decide your priorities and then construct 3 hours based on what you feel is really important, which is what we really did for 4 hours.

MR. COEN: I would like to suggest that maybe we ought to have a training committee meeting. The 409 training presently in the book that a lot of the carriers have is nothing but a race through all of the maneuvers of Appendix E. Now, when you get into LOFT, it's Appendix E training in a logical sequence, in a realistic sense. And the grading or the pass-fail situation is no different for LOFT training than it is for 409 training, using all of Appendix E instead of line check. So there is really no great change in the additional training that would be required to bring a man up to a standard if he in fact was not. I don't know how many carriers are using it, but there are many. So there is no real great change here.

The other thing is that the LOFT training program, at the recommendation of the training committee, requires a minimum of 3 hours and 20 minutes and the other 40 minutes are there for such things as wind shear and what have you.

CAPT. BEACH: Every airline has its own flavor, I believe, based on the kinds of things that you feel you need for operational requirements. Ours may taste differently from yours. But I think if you adopt a



line-oriented flight training program that suits your needs it probably won't be different completely from my own, but will be every bit as good for the kind of training you need to do from your particular point of view.

DR. LAUBER: Thank you, Bert. I'd like to underscore a couple of things that Bert brought out and Capt. Holdstock brought up. One of the things that Tom Nunn did up at Northwest was to administer a questionnaire to people who had gone through his program to get some idea of what their ideas and impressions were about the program. Tom provided those data to us, and we analyzed them in an attempt to find out what people who had been through the program thought they learned about it. There are a couple of selected comments that we got back that I think really speak for themselves. These are direct quotations.

"Judgment in flying can be described as the ability to place relative importance on many variables while in different situations. LOFT allows the individual to exercise this judgment."

Another comment, "LOFT offers the chance to take a situation to its conclusion regardless of whether the procedure selected was good or bad. It forces them to carry through with a series of actions and forces them to think about it."

Another one, "It was a real eye-opener to see a crew lose its coordination. It brought out two things to me. One, there's a heavy load on the second officer during emergencies and two, the necessity for deliberation before taking action. You must think about the consequences of every action."

I think these are some indication of the insight that people get into their own behavior when they go through this. Two final ones.

One, "This program should make a few maverick loners realize how much we need coordination within the cockpit."

And the final one: this individual learned "How easy it was to compound ignorance with damned foolishness."

## FLIGHT MANAGER AND CHECK-AIRMAN TRAINING

Capt. J. E. Carroll\*

The industry, and specifically United Airlines, went through a period when things were going just about the way we wanted. It was a stable period from approximately 1970 to 1977. Things were going well operationally, but our pilots called it the period of stagnation. We had very little movement, very few promotions, very little attrition through normal retirement or people having to retire because of illness. We did realize one benefit, however, because with this stagnation we were building up a very high level of experience in our cockpits. As a result of this lack of movement people were in the same airplane, the same seat for a long period of time. And obviously, when you do the same thing over and over again you should become more proficient and there should be fewer incidents and accidents.

However, in spite of things going so well we found we were beginning to get a little uneasy. Things were really going very well, but we began to worry just a little bit because they were going so well. We reasoned that if it's going this well, the only way it can go is down. Every airline, as J. D. Smith, our resident expert says, has a safety footprint, and what it tells us is that in a certain period of time you can anticipate that you're going to have an accident. It varies between airlines, but you can look at the record and say in "x" number of months or years you're going to have a major accident.

On United Airlines we had a safety footprint of 4 years between major accidents. At this time we had gone 4 years and hadn't had a major accident, so with each succeeding month we wondered just what we were doing so well, or what was about to happen.

Other things were giving concern. We were becoming, as far as the crews were concerned, rather complacent — perhaps because so many things were being done for us. The automated flight planning, the extensive radar vectoring, INS systems; all of the conveniences and the advances of technology were really leading us into the position of taking for granted that things were going to be "okay." As an example, I think mention was made in one or more of the presentations in the last day or so of the Dulles incident when a crew took a vector and an altitude for granted.

All these things started to cause a vague concern, and then we found that the situation was about to be compounded. We passed the period of stagnation, and we started to expand. The attrition rate was beginning to increase and we started what Bill Traub referred to as the new-hire program. We anticipated, as we approached the new-hire program, an addition of 1,800 persons over a 5-year period, or roughly 360 persons a year. With this movement we found we were losing the advantage that we had of stability

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\*Vice President, Flight Standards and Training, United Airlines.

and experience, because with the pot being stirred we had new people in all of our seats in all of our airplanes.

We could conceivably, and I'm quite sure it will continue that way for some time, find within a cockpit a captain brand new to the airplane, a first officer flying his first trip after having moved up from second officer, and a new-hire second officer in the third seat. And the new second officer could in this case be a female. Depending on the attitude of the crew, that could exacerbate the situation a little more.

So we all of a sudden went from a position of stability and experience to one of mobility and low experience.

Toward the end of this period of growth, we also found a lot of incidents beginning to occur. The winter of 1976-77 on United Airlines was the worst winter we had had for a long, long time. There was ground damage to equipment, off-the-side-of-the-runway excursions, with no big damage to the airplane, but at much too great a frequency, blowing out windows in the terminal, going off the end of runways — we would go 3 or 4 feet off the end of the runway with no damage to the airplane, but more than a little embarrassment to the crew.

We were apprised by our Western Division vice president who attended a meeting in Hong Kong that Japan Air Lines said they had had exactly the same experience about that time, with an increasing number of incidents. We were not unique, and there was an overall concern in the industry.

We then conducted what we call a road show, taking all of this to the field to tell people about it and what we thought they could do about it. And we'd like to believe, since we spent three quarters of a million dollars doing that, that the road show was very beneficial because our performance the next winter was a big improvement.

We had one accident at that particular time, the one at Salt Lake City, and it was in the vein of what we've been talking about here — poor resource management and taking for granted what you were told.

But we at least thought that the road show had helped us in the area of minimizing, if not eliminating, our incidents.

And then the winter of 1978-79 turned right around, and we had a problem all over again, with one more accident that involved resource management, we believe. I realize the final report isn't out, but the preliminary report, which Bob Helmreich quoted although he didn't identify the accident, indicated that that was perhaps a contributing factor to the accident.

Throughout this period uneasiness was growing in the industry, and the ATA Training Committee came up with the expressed need for what they called a more meaningful line check. Due to a feeling at that time that perhaps we

were not being as attentive to our line-check supervision as we should, that because of the stagnation — the same crews, the same people working with the same check-airman — we were becoming comfortable with each other, and weren't addressing as attentively as we might, the need for correction.

We put all of these things together with the recognition that with the sudden turnaround and the expansion we were having, we were also assigning a lot of new supervisory people, new flight managers as we call them. They were having to work with a lot of new crewmembers in a new environment for those crewmembers, while they themselves were new to the job.

Now, what we recognized at that particular time also was that our approach to career planning had been based primarily on what Bill Traub covered by saying that when we hired someone we hired a captain. We looked at them in the past and said, "When we hire you it's in anticipation that you're going to be a captain, so we're trying to hire good people." Our career planning and succession planning, as far as management was concerned, only carried it one step further. If you hire a good captain, naturally you're going to have a good manager. That's a rather false philosophy, but nevertheless I think that's what we premised it on. And we really didn't carry it much further than that.

I think we also recognized that what we had done in the past as a way of selecting our managers was more political than it was objective. It was a buddy system to a degree. It was a case of who knew whom in what particular area, and they then became the manager, again premised on the fact that if they were good captains they would be good managers.

With the recognition of all of these problems we decided that with the numbers of people that we had on our airline (we have 9 bases, 6,000 pilots, a few more than 2,000 captains) — that to try to address directly to the crewmembers the curing of a lot of these things was probably just too much to bite off at one time.

But we could take it down to a smaller group of people — our flight management. And if we did what we should have done a long time ago for them, trained them better, then they would be in a position to pass on what they could to the flight crews.

So the subject of what I'll be covering today is twofold. One program was the specialized education and training of our flight management people. And the thrust was to aid our managers in helping our professional pilots be more professional. We weren't going on a witch hunt, we weren't out to get people, we weren't out to try and crack the whip, we were just trying to smooth out our operations by helping professionals be more professional. That was the thrust behind our management training program.

The second thing that we recognized, for a variety of reasons I'll cover later, was the rather urgent need of our crew members for some training in command or resource management. We initially termed it, and we are adjusting our thinking now, as command training for pilots.

Management recognized this need, the flight crewmembers themselves recognized it. It was being asked for to a degree that was disturbing, because obviously it point out to management that we hadn't fulfilled a need. First, however, I'll review the program we evolved for the training of our managers.

To understand where this fits, let me give you a very brief description of how United Airlines operates. We have, as I said, 9 bases. We divide them into 3 divisions, with a division vice president. Each one of those division vice presidents then has three bases reporting to him, headed up by a director of flight operations who has flight managers working for him. In a couple of our bigger bases we have an intermediate level called flight operations manager who have some of the flight managers reporting to them.

As early as 1973 we recognized that from the second level of management on up we had 25 persons, all but one of whom were going to retire in 9 years. That's a pretty good turnover.

We also recognized that as we started to expand we would have even more people pumping in at the bottom with a need to be trained. So, hopefully, whatever training we could give would help them, as they progressed in management, to help others who would eventually work for them.

Initially, and going back to the period of time when I was selected as a manager we used to have essentially a simple way of picking managers. He had to be and this, of course, is self-fulfilling, a better than average pilot. He had to have some skills in interpersonal relationships which would have been evidenced through ALPA activity and in some cases, also applicable to myself, in continuing military activity, and have a reputation of being a good commander and one that people could work with.

With that as a list of criteria to use, I reported to the flight office and my manager said, "Good morning, it's nice to have you with us." I said, "Fine, what would you like me to do?" He said, "Your desk is back there, go to work."

And there was my indoctrination, there was my training, there was my selection, and I was told I now had 70 crewmembers assigned to me and I should supervise them.

I said, "What specifically would you like me to do?" He said, "Well, most of your work is going to be going out and giving line checks. You have taken them — go out and give them."

That was our program. They paid people a lot of money to do that sort of thing. If they did that in any other industry, I think they'd fall all over themselves with laughter that you paid that kind of money and gave that kind of training to somebody in that position.

But we now recognized, very forcefully, that we needed a flight management training program. We put it together in five phases. Phase one, as we call it, was devoted to the basic operational concerns of a flight manager in dealing with his people, plus some industrial relations work and some philosophy and psychology that would address itself to the supervision of people.

We decided we would basically want to put together a course for management candidates but we had the recognition that there would be problems if we threw these neophytes into the field with all this highfalutin training, philosophy and theory we had given them, and they then got into a domicile with some of the old hands, the managers who had been around awhile who would say to them, "What are you doing?" "Why are you pursuing this particular area in this way?" And they'd say, "That's what they taught me." They'd be told, "Oh, ignore that, we don't do it that way."

So what we did was cycle our incumbent managers through first. But ultimately it will be a course for management candidates.

With known attrition, in a given year we will train the number of candidates that we anticipate we will have to put into the system in the following year or 6 months. We have put some candidates and some incumbent managers through these classes and the mix has been good because the exchange is good. The group shares experience with the incumbent managers, and they get the enthusiasm of the candidates.

Briefly, what we cover in the course is first, an introduction by the senior vice president of operations to attest to the importance of the program. We do some training in the job of managing given by some professional teachers and instructors that we have in our headquarters training group. We also cover what we basically call our "den concept."

We call our flight managers "den mothers." We assign 70-some people, up as high as 90 or 100 depending on the domicile, to one manager and he's responsible for all their activities. We treat what we call the "whole man concept," not only operationally, but personally. The flight managers are concerned with their personal problems as well as their education in other areas.

During the training we have a "hangar flying" session on one of the evenings in which people get a little more relaxed, (the attitude adjustment hour), and exchange opinions. We also go into some personnel policy so that they can learn to handle the personnel situations.

We review the process of evaluation which at first is a theory-type approach. We cover three operational areas that we call the operational approach to checking, which is given by our director of flight standards and procedures, or one of his flight managers. There we emphasize the need for objectivity in checking on proficiency checks and rating rides, which our managers will handle at some time. We point out that when you do take an

operational approach to a check, you ask questions on orals and approach the subject from the cockpit out rather than the system in; that is, "What can you do about it?" "What's your ability to handle a particular situation?" We encourage them to ask the questions in that way rather than esoterically, and to avoid getting deeply into a system over which they have no control.

We cover — and I have handled this myself — we cover enroute checks, and then move on to that more meaningful line check. The reason I handled this one initially with the incumbent managers, quite candidly, is to emphasize how seriously the company felt about what we were after, that we really meant what we were saying. The senior vice president felt that this was best done by having an officer of the company convey the information.

We wanted a little more professional approach to enroute checking. "Call them as you see them." "Record what you see." "Bring to people's attention the necessity for change." Not just to write things up, just to put something in the record. As most of us who are in this business recognize, the worst thing in the world we can have is something in our record that somebody can go back and look at.

So we bring to their attention that this approach is what we want to avoid. But given the recognition that these sorts of things will take place, we point out that unless we record them when we do see them we sometimes don't get people's attention.

We all indulge in an ego trip too many times I think. I can only speak for United Airlines people, but it's probably true of everyone. When you supervise pilots, everyone thinks he's the world's greatest pilot. You know, "You can't be, I am."

But when you take that approach as far as supervision of people is concerned, the ego spreads to the point where you say, "I notice this, I recognize this. But I'm so good that I'm going to be able to bring to this individual the recognition of what he has to do to change, and he will change because I'm giving it to him, and he'll be better for it."

If you indulge in this ego trip, almost every time you do, the first ride is for free, because you always say to yourself, "The poor guy never had the opportunity to be given what I can bring to him, nobody else ever told him this I know, and now that I have told him, it will never happen again."

I'm going to digress for a moment on this ego factor. Lee Bolman might know this story, I don't know. I like to tell it because I think its very apropos of the ego that we all indulge in.

This has to do with John Kenneth Galbraith. When I went to the Advanced Management Program at Harvard, I heard this from one of the Harvard professors. John Kenneth Galbraith is supposed to be the biggest egomaniac

in the world, and I guess his students were aware of this to a very high degree, and they got a little sick of it after awhile. One of them, trying to bring to his attention that he was very egotistical, chose Christmas to send him a birthday card. But he was not at all taken aback. Coming back to class after the holidays he apprised the group of students that he had received a birthday card, but obviously somebody made a mistake — they should have sent it to his son.

Now, sadly enough a lot of management people indulge in the same type of ego trip. "I can handle anything as long as I have the opportunity, and they will be better for it." Then he forgets that the individual may change to another airplane, to another supervisor, and start the process all over again. Or, as one of our enterprising flight officers found, all he had to do was transfer from domicile to domicile to get out from under the problem.

At any rate, we do cover all of this; we also cover overall evaluations. At the end of the year we write what we call a "green sheet" — it's a personnel evaluation.

And at that point we emphasize again the need, in handling these 70 or more people assigned to us, for calling them as we see them, for having an objective appraisal at that particular time, because the only thing that remains with the man through his career is that annual appraisal.

We also train in industrial relations, which Rod Gilstrap has handled many times, and so has Bob Crump. And that's a very interesting day and a half session. We cover contract interpretation, discipline and grievance, and a new one, the employee assistance program, which is the approach to problems of people who are involved in alcohol dependency.

We get into management counseling skills, with role playing, so they can see how they handle themselves in situations or how they should handle themselves.

We review accident and incident investigation, so that it's done correctly and we learn from it, not just go through the paper work. John Perkinson is involved in our safety department and can attest to the fact that too many times we have put together an accident or incident investigation, and it's just been a case of getting the paper work out of the way. We haven't really learned from it, or disseminated what we did learn to the rest of the crews.

To wrap it up, another session is led by the senior vice president to get the reactions of the people; the reactions so far have been very, very fine. What they say is, "We have needed this for a long time; no one ever told us this before."

We include a little precourse study and a little homework while they're there during the week. It's in our Training Center in Chicago, so it's away from home, and they can address themselves more intensely to the subject.



The second phase of our management training is check-airman training. We usually give that just prior to the assignment of the man as a manager. He spends 5 to 7 days in Denver learning how to be a check-airman giving proficiency checks and rating rides.

If you have never thought about it, it's a very tough thing the first time you appraise a flight crew. The only thing most of us could ever bring to an appraisal of a flight crew is our own standards, the way *we* fly.

Consider that most of our people who are assigned as managers are well above average pilots so that they can have credibility in the operational supervision of other people. When you do approach the task you have a very high set of standards, but you really are only looking for a passing performance of an average pilot.

No pilot wants to be called average. It's the worst thing in the world you could put down, "He did a good, average job." That goes crossways in your throat. But you have to get into the atmosphere and recognize what it is that is a good solid performance, and it is a learning experience. You also have to learn how to communicate with the people in a positive sense, so that it's constructive and you'll be able then to transmit reinforcement to the individual so he can benefit by it.

The reactions to that phase of training are always very positive. They're always a little shaky, because it's a little tough the first time people go through it. But it's a very beneficial thing.

We also give them right seat time — offset approaches so that when they're out shot-gunning people, they're in a position to recognize what they should be looking for and how to correct for it.

The third phase of our training is what we call our Executive Offices Seminar. This is similar to what a lot of you have discussed in the past day or so, in which we cover all of the other departments in the company.

Who is behind that voice on the phone, who can you call about a situation. Also the total recognition that — again, going back to the ego position — most of the flight operations people have. "You are not the only ones in the world who run this airline, it takes a lot of people to bring that product to you. And when they do bring it to you, you have to do a good job so you can bring the passengers back again."

All of those things and all of the departments in the company are brought to their attention in the week of training at our headquarters in Chicago. It is done either just before their assignment as a manager or within the first 6 months of their assignment.

Phase four of the training for managers, which we are working on right now, has to do with enhancement modules. This covers material in the course that perhaps they would not have been in the position to absorb initially,

and that they wouldn't have been assigned responsibility for in their initial assignment as a manager. Such things as hijacking situations, the identification and selection of future management candidates, motivation and productivity — a lot of things preparing some of our people for second-level positions. We cover industry and agency media involvement, and business principles, since they start getting involved in budgets, etc. Also, some hazardous materials training.

The final phase of our training, and one that we have gone into very little so far, is going to be devoted primarily to the people who show real potential for advancement to other positions and who are going to be given outside training. Such things as the advanced management program at Harvard or Stanford — a course run by Chicago University to which some people have been sent and, of course, Michigan. We weren't too enthralled with the one at Michigan but in case anybody's here from Michigan, it's only because it didn't serve our purpose. But we are taking advantage of outside training. So much for the flight management aspect of training.

Now to the need for command training. As you have probably recognized if you have worked at it, and if you have a program at the present time, a lot of the things that you people had in your command courses we are giving in a different way. Our EXO seminar covers the rest of the company. Some of you people have that included in your command training, but we are referring to the specific subject of command, human resource management.

We at United have been talking about it for a year and a half. Corporate approaches to things being what they are, priorities being what they are, it takes time to get people's attention. We talked about it in February of 1978 but it wasn't until February of 1979 that we had our first meeting of the task force put together by the senior vice president of flight operations to address this particular problem.

We found, finally, that not only was management aware of the need for this command training, but also that the last two accidents we had had highlighted the need. Some ingredients in both of them suggested that the management of resources within the cockpit perhaps could have precluded the accident. The second accident really got our attention, so we started to work on it.

Then the strike intervened, and we really weren't able to do very much until the strike was over. We finally had the third meeting of our task force here, Monday, of this week, and we intend to meet again tomorrow morning for an hour or more and then again tomorrow afternoon at the conclusion of the conference to condense what we have been able to pick up from you and what we perhaps might want to use in our approach to command training.

We have asked a lot of questions. We took a sampling of our people and we had personal letters from some people indicating the need for this training. We put all this together and went out with a questionnaire, and the answers we got back were rather easy to follow.

Some of the general conclusions were that people believe the ability to command or to lead can be enhanced. They believe that a command or leadership learning experience should include philosophy, psychology, and interpersonal relationships skills. Also some of the basic management and human resources management skills, and decision making and problem analysis skills.

Specifically and in descending order of priority the responses state

1. That it was necessary to have an understanding of people.
2. There had to be a willingness on the part of the commander to use the rest of his crew, and of the crew to participate, cooperate, and communicate.
3. Interpersonal relationships skills are obviously very necessary.
4. There had to be a recognition of the necessity to accept responsibility. The knowledge of job procedures, the operational aspects were very low on the list.

Let's consider where we are right now and what we're going to be doing. It is a big problem to make 6,000 people aware of the environment and atmosphere necessary for good command. I recently picked up an expression, "When you're going to have to eat an elephant, the best way is one little bite at a time." We have an elephant here, with 6,000 people plus the cabin crew people to increase their awareness of the problems.

We anticipate that probably the first people we are going to train are, again, our managers. When they are aware of what it is that is necessary, they can look for it, better assess it, and then more constructively communicate the need for adjustment on the part of others. We will take it in steps. Perhaps we will do it next with our new captains, and then take it on from there.

We think one of the things that's going to enhance our ability to do this sort of thing is the fact that we have the CDC PLATO system, which American Airlines is also involved in using. We have gotten approval from our Board of Directors to buy our own computer and put in our own in-house program. If you're not familiar with the PLATO system, it's a computer-managed and computer-assisted program with which we can do individualized training. We are going to extend its use to our domiciles where we'll install terminals. We anticipate starting that the first of next year. Once we have the terminals on the scene in the domiciles, then we will have the ability to bring in groups of people without having to bring them to one central location, and we'll be able to do it much quicker and get better exposure.

Obviously, what we teach is going to have to be different for each group of people. But, nevertheless, we anticipate that will enhance our ability to do it.

Right now we are first reviewing the question of what we'll include in this course. As I said, it will be theory, psychology, the practice of command on United Airlines. Then the methods that we perhaps can use to give this kind of training, including role playing since that strikes us as being one of the best ways to proceed. We might even have films to show at the domiciles.

But we do believe without question that it has to be done with all of the people who are involved in the operation of the airplane, the cockpit *and* the cabin crew, so that they will all recognize that command is a very lonely position, and that when it comes times to make a decision, it may not always be popular with everyone. But if we can educate all of the crew members to the recognition of what it means to be a commander, and what it takes on the part of the rest of the crew to help that commander, the position will not be quite so lonely. When it comes times to make a decision, support will be more readily available — more cooperation will be evident.

In closing, one of the things that I have recognized in listening to what a lot of you have given us as the benefit of your knowledge and experience, is that there are distinctions to be made between airlines. What can and can't be done depends on the economic constraints that a lot of us are confronted with, and also the size of our airlines.

I've always been one who has great admiration for the Swiss. Anything they do they approach with great finesse, great skill, great attention to detail. Anything they manufacture they do on a limited basis so they can control the quality of the product. In their case, Nick Grob indicates that he handles 24 captains a year, and he uses, I believe, 50 route-qualifying captains. If I equate that with my operation I'd be putting through 15 times as many captains a year, and I would need 15 times as many route-qualifying captains. Also, I do it in 6 weeks, and he takes 9 months. I'm afraid my quality control is not quite as good as his. I also have different economic constraints in being a private organization. But we are all after the same end result — we're looking for the best product we can possibly turn out.

We hope that the two programs that I have outlined here today will be as good as the best, and in not too long a period of time.

## DISCUSSION

CAPT. BEACH, Eastern Airlines: Talking about recruiting managers, and the idea of someone who knows someone who would be a good one, we have probably all done that since year 1. Since you find that less than acceptable, how do you recruit? Where do your managers come from?

CAPT. CARROLL: We have in our group here today at least one man who has not been at the job too long, and he may correct me when I say this. What we do now, in recognition of how bad our system has been in the past, is

screen the people in each den. Each group of pilots assigned to a manager is screened by that manager for the potential that he sees in the individual for being a manager. The next step is to discuss them with his director. If there is no objection by the director to the use of that individual as a potential manager, then an interview is conducted to find out what his interest is. If he is interested, then we will process him through a management evaluation by our people in Chicago, psychological testing, etc. Not too dissimilar to what we're talking about with the new hire approach, except this is new management. If this all pans out — we get good feedback from the psychologist and the candidate is still interested — we then put him through this management training program. It could be that currently the best candidate for a vacancy is from Miami and the vacancy is in Seattle. This would mean tearing up the individual and his family, paying for the move on the part of the company to get him out to Seattle and then perhaps when he gets into the job discover that it wasn't his cup of tea. He didn't like being a manager.

So, to avoid this, we are still in the position of using primarily people from within a domicile as much as we always have, but now we do it on the basis of a much more selective, much more detailed approach. Not that, "I've known Joe all my life and we play golf together and we go to cocktail parties together and we're good friends and, therefore, I'd like him to work for me." That's how most of it was done in the past, including second, third, and fourth level promotions, but not anymore.

Since 1976 we have had a senior vice president who takes an entirely different approach to succession planning. The ears of people who are on that succession plan should burn because we go through a discussion several times a year on those individuals. We discuss whether they stay where they are in the plan, or whether they are moved off.

I'm very proud of the fact that we have a very fine system right now. It's been in operation for 3 years. About 5 years from now it will be what it should be. We've got it projected, on a tentative basis, 5 years into the future to account for all of the recognized attrition that's going to take place.

That's also how we program the training through various phases for a manager, based on the potential they've shown.

CAPT. BEACH: May I ask you one more question on that. When you come into the program as a bottom-level manager, have you a goal that you're looking at, or do they just float as their ability dictates?

CAPT. CARROLL: Personally they may have a goal. The company has no goal for them at that particular time, not until they prove themselves. Until they find out if they really want it, and we decide we want them to continue. It is no bad thing for an individual to go back on the line. I know your system is a rotation system. Economically there's not that much of an advantage in being a manager and there's no question the working

conditions are a lot worse from the standpoint of time off. But the company has a goal for them when they start to show potential. They'll probably recognize that they're showing that potential by the assignments they're given, by the training that they're given, by the challenges that are addressed to them. But that takes time. At least it's a formalized management program and there are products of that program in this room right now. Four of them that I can see, who have been part of that system since it started, and I think they're pretty fine people. We're doing a lot better than we were when we first started out.

JOAN GALLOS, ASSISTANT TO LEE BOLMAN: You mentioned a problem that was referred to yesterday, namely, the growing potential problem of cockpit cohesiveness with the introduction of women and also some of the minorities in the cockpit. I wonder what you're doing in the redesigning of your training program to surface and deal with some of those issues?

CAPT. CARROLL: I don't know that I can say we are addressing it specifically in the area of females and minorities, because I don't think we ever want to address it that way. I think what we want to do is address it as the cockpit. Of course, we have to have the recognition that there are ingredients that go into it, but we don't want a program that says, "For this particular manager, who may have women assigned to him, a different approach to things is needed."

So far, we have 21 women in our system and 48 or 49 minorities. I'll address myself specifically to the women. They have done an outstanding job. One of the women in our first class was the daughter of one of our DC-8 captains. At that particular time about 3,500 or 3,600 people had been processed through the system and had been tested, and she had scored the second highest of the 3,500 people.

I honestly believe they're doing a fine job. I don't know how many of you read the book "She'll Never Get Off The Ground" written by Rod Serling, but that addresses itself to the first woman airline pilot and all of the emotional involvements. The problem is there, but I don't think to the degree that it's been magnified. What we are doing to address the problem, without being specific about females and minorities, is to address the cohesiveness question in the cockpit in general. We think that as a result of our command training approach and the exposure of all the other people in the cockpit to the same information, all have an awareness of the arena in which we operate and the need for cohesiveness. We have examples of what can take place if we don't have the cohesiveness in the cockpit. So we don't specifically address that particular area, because we don't think we should. We think we should take it as one problem and not two.

MR. MURPHY, NASA: You mentioned that you either are or intend to train in decisionmaking and problem analysis. Is some of that being taught now in classes? Would you say a little more about that, what kind of success do you have?

CAPT. CARROLL: We will address it in the command course. I've been through a course on problem analysis and decision making. We will not address it as it pertains to the general question of problem analysis and decision making, but more specifically to the type of questions and problems that would arise within a cockpit.

We will present some theory on the subject, and then we'll go into role playing. To forecast the success of it, I think is something we are not going to be able to do right now. I think we'll be good at it. Not because it's us, but because of the people we're working with. All flight crew-members, those in the cockpit specifically, are a cut above the average, in many respects. They also have had a pretty high standard of living, so they move in pretty fine circles and pick up a lot from their travels and people with whom they associate. I think they're an easily trained group and they're hungry for this kind of information. I think we should be successful.

## LEFT SEAT COMMAND OR LEADERSHIP? FLIGHT

### LEADERSHIP TRAINING AND RESEARCH AT

#### NORTH CENTRAL AIRLINES

Capt. Gramer C. Foster\* and Michael C. Garvey<sup>+</sup>

It's refreshing to be with a working group that is talking about the how and what form resource management training should take rather than debating the issue of whether or not it should take place. Although we at North Central have recognized the need for flight leadership training for some time, we found it a really difficult subject around which to write a definitive program. Initially we thought we could do it ourselves, but it soon became apparent that the job was more difficult than we had originally thought.

First we were hampered by the absence of either good resource material or a good reliable data base. Soon we were seeking someone from the outside who could provide the insights and perspective we lacked. At about the same time, and this is going back about 2 years, our company had engaged Mr. Michael Garvey, management consultant, to provide training for all management people at North Central.

The program conducted for our management personnel had as its foundation the Blake and Mutton managerial grid along with its rather substantial data base. For those of you not familiar with the grid it allows you to measure your own style, and it provides you with a quantitative management language against which you can measure any number of management behaviors. Although the Blake and Mutton management grid had not been previously utilized for flight crews, we felt that the similarities between good corporate and good cockpit management made this instrument a reasonable choice. And an additional plus to this concept is that it provides our pilots with a management language that is common within our company. Mike Garvey agreed to help us put together a program to help captains improve their flight management skills.

Since we intended to spend quite a sum of money on the project, it was necessary to secure approval from our president, Bud Sweet. In writing the rationale for our project we not only spoke to the issue of air safety, but we also argued that a captain exercises at least some control over an enormous amount of operational money, and, therefore, should be afforded some management training in order to better manage these resources. This was probably the clincher along with the air safety argument, and our project was approved.

With financing ensured we started preparing our first seminar. Since Mike would be doing the bulk of the program, and since we did need to define some of the differences between business and cockpit management, we set up a

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program designed to familiarize Mike with as many aspects of a pilot's life as possible. In the process Mike rode endless hours of jump seat time and he interviewed many, many pilots, both captains and copilots. He also interviewed flight attendants, mechanics, station agents, dispatchers, tower and ACT people, and, I'm not sure, but I think even some FAA people.

When Mike felt confident that he had a good feel for the captain's role, we put the finishing touches on our first product, and invited a mix of 20 check pilots and ALPA representatives to attend. We chose these people for our first program because we wanted the very best and most constructive criticism we could get. It's worthy to note here that through this entire effort the ALPA group in our airline has been most helpful, even to the point of supplying some of the manpower necessary for our success.

Our first program was a 2-day affair, and, as we have at the end of each seminar, we asked the participants to fill out an anonymous critique form. Further, we asked that within 30 days they write an unsigned letter telling us what was right and what was wrong about the program.

Now, we all know how difficult it is to get a pilot to take pen in hand, but the response to the request was tremendous. Out of 20 participants we received 15 follow-up letters, many of them typewritten pages running three or four pages in length. They contained both praise and constructive criticism. All but one thought the course should be continued and even expanded. There was one criticism that did have kind of a common thread in many of the letters, and that was that we hadn't been prescriptive enough for specific situations.

In our subsequent seminars we expanded to a very full 3-day program, with the third day spent at the air route traffic control center, and then we went back into the classroom for a session that we have dubbed situation analysis.

To date we have conducted four seminars for a total of about 80 pilots. The response has been good to all four programs, but we still have requests for more prescriptive solutions. We hope in the future to satisfy these requests in a couple of ways. First, we are planning a home study course for upgrading captains. That will cover regulations, dispatch requirements, alternate weather requirements and the like. Additionally, we are designing an initial line assignment syllabus, which is designed to reinforce the home study program, and, also to expose the new captain to a more organized line check.

We want to follow this with our restructured command seminar. Notice that I have changed from flight leadership seminars to command seminar.

A poet of some renown once asked what's in a name, and I was amused and interested in Bob Helmreich's story about the Merchant Marine captains who resented being called shipboard managers. This struck a familiar chord because our early efforts bore the title Flight Leadership Seminar. There

was a vague feeling among the participants that this somehow undercut their command, so our more recent program was called Command Seminar. The pilots seemed to like this better. We don't pretend to have all the answers, indeed we don't have all the questions. But we are trying, and we are improving, and I think that's what counts.

I have given you a quick overview of our efforts. Now I'd like to turn it over to Mike Garvey for his usual fine job of explaining the details of both this program and some of the research programs which we have on the horizon.

(Mike Garvey)

You're going to get perilously few details in the approximately 10 or 15 minutes remaining to give them to you. I thought what I'd do is provide as much information as I could to you about what we cover with the captains, how we go about it, and give you my observations about the results.

Generally, you have gotten feedback from Gramer that we do get very good evaluations, but I'd like to give you my observations about what seems to go smoothly and where the sticking points remain.

First, I'm going to give you an overview of the management grid concept. Those of you who have been exposed to it before can bear with me, and those of you who haven't may want to take some notes. Then I'd like to discuss how we apply that concept in our work with captains. And that will also tie back into some of the data-gathering results of interviewing the work groups who work with the captains: first officers, flight attendants, and so on.

And then I'd like to go back through the rest of the outline we have laid out here (table 1) and touch on how we approached the areas of communications.

Later on in the second day we switch over to some departmental representative presentations and discussions.

I'd like to now start with the grid (fig. 1). Blake and Mutton were social psychologists with the University of Texas who studied the management literature about the best ways to manage versus the not so good ways to manage. They tried to organize that information into some kind of a system that would make it more sensible and more easily usable by the management audience. They reduced the study of management to two overall dimensions.

One dimension was the concern for production or output, that a manager might have. They decided this concern was not something that would be either all present or all absent. It can be represented on some kind of a scale, and they applied the numbers of 1 through 9 to represent that scale. Nine, in this case, would represent a manager's maximum concern, a very high concern, for output. One, would represent the absolute minimum concern that

a manager could have for getting the job done. By the way, let's consider output and production concerns in a very broad way. It could be amount of information, quality of information, quality of decisions, solutions to problems, or it could be manufacturing care.

The other dimension they focused on was the dimension of concern for people. This was not people in the sense of passengers, for example; this was people in the sense of employees; or those resources that are available to us to accomplish whatever output it is that we need to obtain.

Once again they put this on a scale from low to high, 1 to 9, such that, when they completed this grid, they wound up with  $9 \times 9$  or 81 different ways in which a manager can combine his or her concern for output and for people. Each one of these different ways represents a different style or different approach to dealing with people to accomplish results.

Rather than focusing on 81 styles, they focused on the five major styles. The first one was called 9-1, which represents a very output-oriented style, with minimum concern for people. An opposite sort of style is 1-9, minimum concern for output, associated with a maximum concern for people. The style somewhere in the middle is called 5-5 which represents a moderate concern for output counterbalanced by an equally moderate concern for people. So he maintains some kind of a balance with people who are his resources for getting things accomplished.

There is also a style called 1-1 which is kind of a do-nothing style of management. Blake and Mutton describe this as an impoverished style of management with only minimum concern for output and people. There's more of that than you might imagine.

We usually start out in a class situation with the captains laughing and joking about how ridiculous that is. After looking at some of the behaviors of 1-1 they say, "Oh yes. There are some people who give you a cold vacant stare," which may mean, "My God, it's me."

The last style that they focus on is a style called 9-9, maximum concern for output and at the same time maximum concern for people involved in helping to get that output. These different styles represent different categories of behaviors.

You could label this style of behavior (9-1) as autocratic. You could label this style (1-9) a real nice guy, country club approach. Treat people nice and production will take care of itself.

This style (5-5) on the other hand, is represented by an awful lot of compromise. There is nothing wrong with compromise per se, but in this style we're talking about a disproportionate amount of compromise. Acceptable, perhaps, only mediocre results; just something to waffle through the situation.

And, of course, here (1-1), as I've already indicated, an appropriate label might be "Impoverished Management."

Of course, here (9-9) the label that we'd apply probably is team manager. Not always in team meetings, but trying to manage the resources for the most output and the best quality output possible, yet keep the resources motivated and part of the total team effort.

Now, in using this concept with the captains we go through a bit more detailed explanation than I just gave you. They also have a number of pre-reading articles and other pieces, as much as we could find in the literature. Then we quickly shift from the management grid concept per se and into its application to captains.

We begin with the style 9-1 and I ask the captains to help me build a profile of the kinds of behaviors they would expect from a 9-1 captain. They have no trouble at all in doing this.

And after we build a behavior profile of 9-1, we switch to 1-9, and once again I ask the captains to describe the kinds of behaviors they would expect. Once again, no real difficulty in building up dozens and dozens of descriptions of the kinds of behaviors that these styles of captains would use in interacting with members of the crew.

We then do a very interesting thing, I think. We switch from the behaviors themselves to trying to explore what might be the consequences, the reactions on the part of different work groups, first officers, flight attendants, controllers, and so on. Once we can reasonably agree on what the normal reactions might be, we focus on what might be some of the potential consequences of these reactions along four different dimensions.

One of these is the motivation of other persons affected by this style of management. The next is economic considerations, that is, total Republic Airlines success. The third is passenger service, the quality of passenger service. And, of course, the fourth is flight safety.

I'd like to show you the format that we use with the captains (fig. 2). Based on our prior discussion of the grid, we ask them to identify the typical behaviors of each style of captain. Then, focusing on different work groups at different points in time, for example, the first officer, we focus on what might be the typical first officer's reaction to these kinds of captains' behaviors. Once the typical reactions are developed, we explore some of the potential consequences associated with these reactions. The captains did a very good job as a total group. As you might believe, there were differences between the group members, but they did a very good job in laying out the behaviors, reactions, and potential consequences.

Here are some examples of typical behaviors of a 9-1 captain toward a first officer: Authoritarian, dictatorial — commands without first officer

input, perhaps even at all — no delegation of authority — may do all takeoffs and landings himself or herself — minimal communication, and the communication that is used is very one-way — over-reacts in a very punitive way to mistakes that might be made — very picky about the kinds of decisions and choices that the first officer would make when he's flying the leg.

The typical reactions that you might expect from first officers, also, as these captains related it: first officer would normally become defensive, clam up — become intimidated — avoid confronting the captain or clarifying information with the captain — would have fear of failure, high tension, and so on.

Some of the potential consequences are obvious: more mistakes — more violations — safety would be compromised — passenger service would tend to go down — may be a little stronger ego commitment to a wrong decision than a captain should have. For example: flying through rough weather without turning around because he had made that decision initially.

One of the things that is kind of interesting is that many first officers spend a lot of time trying to get out of certain captain's block of time. There is a lot of fatigue for a first officer working with this kind of a captain, and a much higher experience of stress.

Now, let's contrast those kinds of behaviors and potential consequences to the kinds of responses we got when we looked at other styles of management. The captains, after the first one or two workshops, took the five major styles of the grid and shortened up the process for us. They said, "We're very concerned about the 9-1 style, very concerned about the 9-9 style, but we already have a phrase in our industry that fits some combination of 1-9, 1-1, and 5-5, and for us it's complacency, the complacent captain."

So from that point forward we began to lump those three styles together and it saved us some time in the workshops.

The kinds of behaviors they would expect from a complacent captain: in subtle ways to allow the first officer to begin to run the flight — allow him to initiate the routine procedures — exhibit a lot of behaviors to gain approval — accepts "spit-outs" from the system; pretty much "Whatever the system says, that's it" — allows the system itself to support and carry them rather than manage the system — very hesitant to get into a disagreement with anyone — kind of allows the flight to run itself with minimum captain involvement.

Typical reactions of a first officer: probably a tendency for the first officer to try to take over the flight — certainly would hold the captain in less esteem — might also be sloppy themselves, have no real reason to maintain competency and professionalism — probably less pre-planning — there might be a lot of confusion around the area of communications and authority relationships, questions of who's really in charge and so on.

Let me just quickly run through some of the behaviors the captains would expect of a 9-9 captain: the 9-9 captain in behaving toward a first officer would more often seek input on operational problems and feedback on his own problem solving and decisions — would listen more to the first officer — would teach and coach the first officer — would learn from mistakes — would help the first officer learn from mistakes — would be constructively critical — would absolutely demand quality performance — would be very assertive, etc.

Reactions of the first officer to these kinds of behaviors, as you might guess: very motivated — for the most part, very supportive of the captain's decisions — probably provide better quality work — better flight planning — more attention to detail — more alert — feel more challenged — quicker to intervene with the captain to clarify misunderstood data, etc.

Very positive potential consequences in terms of flight safety, motivation, passenger service, and so on.

So we use these kinds of descriptions of behaviors, reactions, and potential consequences to get across to the captains the effects of different approaches to managing the leadership situation and to dealing with problems in the cockpit and between the cockpit and the cabin crew. It usually goes very well.

We then make a rather abrupt shift from applications of management style to communications. We teach communications to the captains by using a learning simulation. This is not to be confused with what you usually call a simulation within your industry. It is a communications exercise which takes about an hour for the captains to go through. Then we spend about an hour analyzing what took place during that exercise in terms of good and poor communications practices.

We try to make this a personal learning experience for the captains. We cover a lot of learning areas, one-way and two-way communications, the effect of taking a public stance on a decision, and the difficulty of changing your mind and moving on to another position.

We continue with communications the next morning from the standpoint of the intergroup aspect of communications, cooperation, and relationships. We have an additional simulation we put the captains through, which focuses on the kinds of relationship difficulties that arise when members of different employee and occupational groups must interact for some joint purpose. As a result of the learning from this simulation, we analyze ways to improve effectiveness between captains and first officers, captains and flight attendants, captains and maintenance, and even captains and air-traffic controllers.

That afternoon we spend 2-3 hours touching briefly on motivation. One concept we present is called the self-fulfilling prophecy, or the Pygmalion effect.

We discuss with the captains how their expectations of the other people with whom they interact can, over a period of time, begin to build certain behavioral responses from the other person. These behaviors take on the form of fulfilling the captain's expectations — therefore, a self-fulfilling prophecy.

In other words, if I as a captain regard my first officer as a very competent, probably successful, very alert person, I treat him that way, I show those expectations. Some of the ways in which I behave in doing this I'm not even aware of; it's nonverbal communication. But I communicate those high expectations to the first officer, and I consequently, over time, begin to get that kind of behavior back in return.

Contrast that with regarding my first officer as very, very junior in all respects, probably not too competent, probably prone to failure and making mistakes. I communicate that, and, as you might expect, that's the kind of performance I receive from that first officer. Before this portion of the workshop ends we spend a considerable amount of time trying to put all that we have done up to that point in some kind of perspective. We go back to the grid concept and reinforce the 9-9 style. However, we try to get away from the mystique of saying that you have to change your whole style, that if you're a 9-1 captain you have to move completely to 9-9. That's quite a leap, and probably involves more change than most of us are capable of accomplishing.

So we try to get away from that. We try to get the captain to think of this grid framework and the related data as a perspective to use to improve his judgments and predictions about what kind of behavior is appropriate in a certain situation with first officers, flight attendants, and others. We try to get the captain to think in terms of adjusting behaviors, rather than getting too focused in on changing overall style.

Probably there are very few 9-9 managers in the world, and similarly very few 9-9 captains, although I think we have been blessed in having some in our classes.

Now I'd like to turn this back to Gramer to quickly discuss the remainder of the program. Then, before we break into questions and answers, we'll quickly describe the research project coming up.

(Capt. Foster)

There is one thing I'd like to just touch on briefly. An interesting output of the Blake and Mutton research with regard to the managerial grid is that something like 65% or 70% of all of the managers in the major corporations in America fit the 5-5 style. It's interesting for us to try to see where the flight crews fit. Wherever they fit, we show them that they don't

have to stay in that style, that although that may be their basic management style, they can slip out of it if they recognize the situation, and manage in a better way.

After Mike does styles in perspective, a representative from Flight Control, perhaps the Director of Flight Control, comes in and speaks with the captains about various dispatch problems and dispatch requirements. That gets to be a kind of two-way program in which there's a good deal of give and take.

We also include Maintenance Control and the Flight Attendant group.

What we've tried to do is include the people with whom the captain interacts the most, discounting the first officer, of course. So that the captain gets a better feel for some of the problems that they have, and where they're coming from, and there is a good flow of ideas and interchange of ideas.

The third day is spent at the Minneapolis Air Route Traffic Control Center, that is, 4 hours of it are.

The traffic control people have worked out a real slick program for us; we are very happy with it. It actually starts at 7:30 A.M. and finishes at 12:00 P.M., and during this time we introduce them to basic air traffic control procedures.

You know how a pilot typically feels he could control traffic better than anyone else. Well, we manage to get the pilot into the ATC simulator, which has become quite popular, and we shoot a lot of problems to him. It gives the pilot a little perspective on the air traffic controller's problems. They will typically put North Central and another carrier neck and neck and, of course, the pilot in the controller position has no difficulty saying United do a 360 and North Central continue on.

But they find out that doesn't always work. Then the pilots move on to control positions on a one-to-one basis with traffic controllers. They plug into a sector and actually sit there and observe the controller work traffic, and discuss the problems attendant with working the traffic. It's been a very popular part of our seminar.

We return in the afternoon to the classroom once again and here again we try to address some of the previous criticism that we haven't spoken to, prescriptive means of solving problems. For this we have a session that is called situation analysis.

This is a program that Sherm Cornell and I have been doing, in which we outline a given problem, and then, taking these 20 captains who have had this exposure to some new ideas and concepts, we let them present their ideas on how they would solve the problem. We get some quite interesting interactions there.



Then at the end we have the written evaluation, which is done in the anonymous form, followed by the letter. I think that pretty well covers it.

At this time we might throw it open for questions.

#### DISCUSSION

CAPT. PERKINSON, United Airlines: How long have you been using this technique at North Central?

CAPT. FOSTER: We started about 2 years ago. We've done a total of 4 seminars. We, like most people in the industry, are impeded by pilot shortages and the availability of people for the programs. So we have only been able to do 4 to date, or a total of 80 people. We do have authorization to continue. We plan to pick up with an improved format, and plan to make it an ongoing thing.

CAPT. TRAUB, United Airlines: You mentioned in the situation analysis session you present a problem. Could you give us an example of the type of problem?

CAPT. FOSTER: We might present a captain with a recalcitrant first officer, a first officer who isn't performing up to standards, something like that. Then we go around the room and let each one indicate how he thinks he might handle the situation. We might do that, we might have an ill passenger, any number of things.

DR. HELMREICH: I was just curious to hear a little bit about where you're going with the research and evaluations?

MR. GARVEY: I'll try to give you a couple of quick thoughts on that. Let me tell you about our motivation first. One of our constant concerns about our workshop is with the issue of data. We don't feel right now like we have an adequate data base of information to provide to these captains about their specific behaviors and, therefore, it makes it difficult to talk about understanding and changing those behaviors. We do it as best we can given a model like this, and it goes very well for what it is.

We would love to be able to provide the captains coming into our workshop with a profile of how he or she thinks, approaches situations, and behaves. Then we could give them better help in adjusting their behaviors.

The other concern we have about our workshop is that we are unable to do any kind of valid pre-post testing on just how much effect our workshop has. Does it help? Does it hurt? Does it do anything at all?

If we had an instrument that would fulfill the initial data need, and then could be readministered 3, 6, or 8 months later to give both the captain and us some feedback as to how that program affected that person, it would be very helpful to all concerned.

That led us to the research project. We have begun to formulate a research effort with a consulting organization in Plymouth, Michigan by the name of Human Synergistics. They have over 10 yrs of history in using their instrument with the general management population. They have developed norms on over 100,000 managers throughout the country. These profiles and norms are not based on psychological illness; instead they are based on psychological health. Specifically, these instruments measure the thinking patterns of these managers and how these patterns cause different behaviors. We'd like to use these instruments on a group of pilots and see if we couldn't develop norms that would be predictive of more effective and less effective captains. Of course, we also have to develop criteria for defining captain effectiveness.

We don't yet know if the instruments will work on the pilot group, as they have with the general management population. But we're hoping to answer that question with the research results. The current proposal is to work with a sample of 25 captains and 25 first officers from North Central, and an additional 25 captains and 25 first officers from Southern Airways.

If we wind up with a good set of profiles, the initial use of these data would be for the development of captains in our workshops. The individual data would go straight to the pilot and not to the company, thereby protecting the pilot's anonymity. Later it could be used as a selection tool as well.

CAPT. CRUMP, United Airlines: Were you going to make any attempt to select those captains and first officers for any quality or were you just going to take an overall....

MR. GARVEY: The initial attempt was planned to be random. The difficulty will be in coming to an agreement on the characteristics of an effective captain, the same issue we discussed a couple of times yesterday.

CAPT. CRUMP: I just wanted to comment that somewhere downstream you're going to have to evaluate what type of a performer he is on the airline in order to validate your testing.

MR. GARVEY: Oh, sure, that will have to happen as a companion issue.

MR. MANSFIELD: You say the continuing effort will still be a random choice?

MR. GARVEY: No, the continued effort would not. This is just initial research to see whether these instruments will be predictive of a

pilot's behavior or not, as they have been with managers. We may need a completely different instrument. We may just need to develop evaluation criteria. We don't know.

MR. MANSFIELD, American Airlines: Maybe I didn't state the question clearly. How will you choose the candidates that are going to participate in the future in this program?

MR. GARVEY: That's voluntary. At this point, we are encouraging captains to come in to the workshop. Pseudo volunteering? Gramer, I think you'd better field that.

CAPT. FOSTER: The workshop has been full pay and credit; we haven't asked anybody to do it on a freebie basis. We are paying them flight pay loss, full expenses, hotel bills, the whole bit. We try to make it a prestigious thing, and we do pretty well assign the people to it. We've had a little grumbling by some of the participants, wondering why they were selected, and thinking that perhaps we had them in mind for some reason or other. And sometimes we did. But usually they went away saying, "Although I had some reservations and wondered why you selected me, I'm very happy that I came, and I got a lot out of it." We have had some really good feedback.

MR. FELL, FAA: Are there any plans for Republic to expand this into a recurrent type course or update type?

CAPT. FOSTER: No, not currently. Although it's obvious that a program of this kind is an ideal foundation, and that there should be something built upon it in an ongoing way, I think that something in the way of a full-mission simulation might be an ideal method of doing it in an ongoing way.

CAPT. TURLINGTON, Pan American: Are you at present just inviting captains to this program?

CAPT. FOSTER: For the most part, yes. We have taken some very senior first officers who have not yet flown as captain, but who are about to fly captain, and had them in the program. If there are no other questions, I'd like to express our appreciation for your attention; thanks again.

TABLE 1.- COMMON LEADERSHIP WORKSHOP OUTLINE

	DAY 1	DAY 2	DAY 3
MORNING	<ul style="list-style-type: none"> <li>• INTRODUCTION</li> <li>• MANAGEMENT STYLES</li> </ul>	<ul style="list-style-type: none"> <li>• COMMUNICATIONS</li> <li>• MANAGEMENT STYLES IN PERSPECTIVE</li> </ul>	<ul style="list-style-type: none"> <li>• MINNEAPOLIS AIR ROUTE TRAFFIC CONTROL CENTER VISIT</li> </ul>
	LUNCH	LUNCH	LUNCH
AFTERNOON	<ul style="list-style-type: none"> <li>• CAPTAIN'S BEHAVIOR</li> <li>• CREW REACTIONS</li> <li>• POTENTIAL CONSEQUENCES</li> </ul>	<ul style="list-style-type: none"> <li>• MOTIVATION</li> <li>• DEPARTMENTAL PRESENTATIONS                             <ul style="list-style-type: none"> <li>– MAINTENANCE CONTROL</li> <li>– FLIGHT ATTENDANTS</li> <li>– FLIGHT CONTROL</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• SITUATION ANALYSIS</li> <li>• EVALUATION</li> <li>• ADJOURN</li> </ul>
EVENING	DINNER <ul style="list-style-type: none"> <li>• COMMUNICATIONS</li> </ul>	<ul style="list-style-type: none"> <li>• COCKTAILS AND DINNER</li> </ul>	



### SESSION 3

#### THE WHAT, WHEN, AND HOW OF RESOURCE MANAGEMENT TRAINING — NASA/INDUSTRY WORKING GROUP MEETINGS

CAPT. A. A. FRINK, CHAIRMAN  
Pan American World Airways

#### INTRODUCTION

#### GROUP REPORTS (in order of presentation)

##### Recurrent Training and Line Operation

Group 5, Capt. Ron Sessa, Allegheny Airlines, Chairman

##### Selection and Initial Training

Group 1, Capt. R. E. Crump, United Airlines, Chairman

##### Recurrent Training and Line Operation

Group 2, R. C. Houston, United Airlines, Chairman

##### Transition and Upgrade Training

Group 3, Capt. L. F. J. Holdstock, British Airways, Chairman

##### Selection and Initial Training

Group 4, Capt. Berton Beach, Eastern Airlines, Chairman

##### Transition and Upgrade Training

Group 6, Lawson White, IATA, Chairman

#### PANEL DISCUSSION



THE WHAT, WHEN, AND HOW OF RESOURCE MANAGEMENT  
TRAINING — NASA/INDUSTRY WORKING GROUP MEETINGS

INTRODUCTION

DR. LAUBER: At this time I would like to turn the proceedings of this workshop over to Capt. Al Frink, Vice President of Flight Standards for Pan Am, to give you some words of advice.

CAPT. FRINK:\* I don't presume to give you words of advice really, I think everybody here knows what they're doing, and we've seen ample evidence of that for the last day and a half.

John indicated that he had done something right with some of the speakers that we have heard here, and I'd like to say this is one of the most outstanding groups of speakers at a meeting such as this that it has ever been my pleasure to listen to. They've been to the point and interesting in their presentations, and I fully agree with John that we owe them a debt of gratitude.

I want to quote from the recommendations made by the National Transportation Safety Board about the accident that occurred in Portland some time ago.

The complexity of current air carrier flight operations imposes considerable demands on flight crewmembers, particularly under high workload conditions. Moreover, accident investigation experience, as mentioned above, indicates that captains have failed, sometimes at critical points in the flight, to take advantage of important resources that are available to them.

These resources have included not only available equipment and supporting services, but also the assistance of the coordinated crew. First and second officers have not in some cases adequately monitored flight progress, positively communicated their observations, or actively assisted the captain in the management of the flight. Therefore, the Safety Board believes that present efforts to foster improved flight deck management should be expanded to include all air carrier operators.

Accordingly, the National Transportation Safety Board recommends that the Federal Aviation Administration issue an operations bulletin to all air carrier operations inspectors

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\* Pan American World Airways.



directing them to urge their assigned operators to insure that their flight crews are indoctrinated in the principles of flight deck resource management, with particular emphasis on the merits of participative management for captains and assertiveness training for other cockpit crewmembers.

Gentlemen, flight deck resource management is a recognized need. I think we all know that need. Everything that we've heard for the past day and a half has indicated this. As Gramer mentioned just a few seconds ago, it's very rewarding to see that we're not discussing this as a possibility but as a fact, and how to achieve it. Accidents that we have studied, the efficiency that we need, the complacency that we have observed over the years, all have very definitely indicated a need for this kind of training and for attention to this subject.

One of the things that I think we have to guard against is that we all think we're doing pretty well. Some of us, as we've seen here in the last day and a half, have individual programs that we think are facing some of the issues that we're talking about.

Some of us have been fortunate enough to go for years without an accident, so we think we're doing pretty well. Some of us have been chosen as managers without the benefit of some of those great programs that Ed Carroll referred to a while ago. But I think, Ed, in this room there are a lot of people who, despite that rather random selection, are still with it, and I think doing a pretty good job. But we do recognize that there is a real need for some of the procedures that Ed outlined.

I think that we all have to put aside for the moment our pride, our ego as to what we have all done, and to accept as a primary premise that we can improve. Each and every airline here and each person here can improve, and we should go into our seminars with that thought uppermost in our minds.

We have heard some specific ideas, we have heard some generalities, we have heard theories very well expressed. Bob Helmreich talked about group and goal orientation, and Lee Bolman very clearly outlined the principles that we are involved with here today. We have heard some wonderful presentations about specific methods that are being used, and it's now our job, your job, to determine how and when — we already know why — to apply these ideas.

So we should, in these groups that we are about to participate in, be very free in coming up with any new ideas, very free with thoughts of when to use them.

We should not be restricted to particular methods of training that happen to be familiar patterns that we are using now. Let's open up our minds. Maybe there are different patterns of training, different times they should be done. Maybe it's a continuing process. Let's open up our minds to new thoughts.

How much of it is training really? How much of it is the development of the habit patterns of the individual, and how do we go about dealing with that? How much of it is procedural? Do we accomplish some of this in our manuals? Do we accomplish some of this through our communications within our airlines, as separate from training? And how much of it do we accomplish in the selection process and the weeding-out process itself?

So these are the questions that we should freely face. I'm going to suggest that when we all break up and go into our small working groups, the first thing we should all do is to have an open mind, to listen to the other fellow's thoughts, and to possibly expand and comment on that.

I know that each person here has done a lot of thinking about this. Each person represents an airline or a group that has done some things that you're probably proud of. Good. Express that, explain it, but don't home in on that so much that the progress of your group is held back. This is a challenge to the chairmen. The chairmen are going to have to see to it that no one person with an axe to grind — and I guess that's everyone in this room — no one of us dominates the groups to the elimination or the dilution of the effect of the others in the group.

Try to think of all the means of attaining the goals that we're shooting for. And above all, we are challenged with coming up with recommendations. The recommendation section of this working group should be specific. The group should attempt originally to organize their method of approach to these problems with the specific goal in mind of coming up with recommendations.

Be general at first, discuss concepts at first, and then come down to recommendations. We are going to have to come up with a report from each of the working groups tomorrow morning, and in those reports we should have specific recommendations. (A handout, "Instructions for Working Groups," is shown in appendix C.)

I think we have a very big job cut out for ourselves in these working groups. The speakers have set a very, very fine example for this seminar, and I hope that the working groups will carry on that well. The chairmen have a big challenge ahead, so let's go to it.

## RECURRENT TRAINING AND LINE OPERATION

Capt. Ron Sessa\*

Chairman, Group 5

CAPT. FRINK (Introductory comments): Today is report card day for all of us. We're going to find out just exactly how well we did yesterday in our discussions. It was very interesting to me to move among the groups from three to four o'clock yesterday afternoon and see the horribly worried faces on all of the chairmen in those rooms, and then to visit with them this morning and see them all smiling and happy. So something happened between four o'clock yesterday afternoon and early this morning to make them feel comfortable. It had to be that you all contributed enough to give them a report to be proud of.

Normally I would like to have gone through our working groups in the order of the progress of the individual to his career, but because Ron Sessa has to leave, we're going to break the routine and start off with Ron's report. We are further going to break the routine to have some discussion on his committee's report before he leaves, so that he'll be able to answer any questions that any of you have. Ron was the chairman of Working Group 5, Recurrent Training and Line Operations.

CAPT. SESSA: Thanks, Al. The approach of our committee was to establish specific recommendations toward implementation of resource management training to the flight-deck crewmembers in recurrent ground school, simulator, and line operations. Our objective was to establish introductory methods that would educate crew members to the importance of resource management and that would motivate them to develop and to utilize those skills in their day-to-day operations. We felt that ground school introduction to resource management, prior to practice in the simulator and on the line, was the best method for introduction of this type of training at the recurrent ground school level.

Our specific recommendations for the introduction of resource management training in recurrent ground school, simulator, and line operations was, first, to establish a program for proper training of instructors. This training could be accomplished either inhouse, outside, or inside with outside assistance, depending on the individual airline's available resources.

In addition to comprehensive resource management training per se for the instructors, we felt that the training should also stress situation analysis, the importance of technical competence in applying resource management techniques, and that comprehensive training in observation skills should be included.

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\*Allegheny Airlines.

Secondly, we felt that an audiovisual program should be developed for presentation at recurrent ground school, with course content focusing on the following areas: (1) leadership and authority; (2) crew coordination and communications; (3) awareness, and the effect of fatigue, stress, boredom and work load on the level of awareness; and (4) planning, with emphasis on flexibility and the ability to change plans according to the situation.

We would then recommend development of LOFT scenarios or other simulator situations that would stimulate crew interaction and require the application of learned resource management techniques. The result of this exercise would be subject to evaluation, critique and additional training when necessary. Some possible enhancements that were suggested to this phase of the training included video taping of pertinent portions of the session or at least audio taping in order to improve recall of results for debriefing and critiques.

The third step at this level for the pilot would occur on the first line check following the completion of his ground school and simulator session. This would allow sufficient time for exposure to the principles before actual online evaluation was performed. We felt — I think most of us did — that this would increase the pilot's interest in the program if started out gradually without a connotation of testing immediately.

An additional recommendation is for the development of a LOFT planning committee to offer recommendations to industry regarding LOFT scenarios. The intent would be to utilize the experience of carriers already using LOFT, particularly with respect to management training or resource management training.

We had some research recommendations. In any new system, there will be questions about the best way to proceed to insure a good product with a high dollar return. We in industry can pose questions about methods and techniques, but are not really in a good position to do extensive research studies to answer these questions. We would seek assistance from appropriate agencies outside our companies to address these issues.

Areas in which it appears we should seek support include the following: determining the content of LOFT-type training programs that will develop the appropriate behaviors for evaluation and training; developing techniques for training and expert instructors who can perceive and evaluate resource management behavior; preparing guidelines for the planning and development of LOFT-type training scenarios; dealing with the questions of fidelity of the scenario and content of the training situation; and establishing scenario structure, length of training session, extent of time impression, how a simulation can be promoted, and the effects of reality in training as pertains to real flight.

Some other questions were also raised. How does one teach resource management training once resource management is recognized as deficient? And the whole question of criteria, evaluation, feedback of results for program evaluation and modification — how can inappropriate behavior be

modified using behavior modification techniques that are acceptable and efficient? We felt that a lot of these questions and studies should be conducted by an outside agency.

In summary, our objective was to introduce resource management training utilizing the basics, with the intent to enhance the program to a higher level in subsequent years. At the recurrent level, every pilot would at least have been exposed to the basics in one year. We didn't feel, as a committee, that we had sufficient time to identify what that additional training or ongoing training beyond 1 year should include, or make any recommendations along those lines. But it should be married to the other training programs that would be instituted by an airline in the resource management training. That's the end of my report. Are there any questions?

CAPT. CARROLL, United Airlines: Speaking of the review during recurrent training of the principles involved in resource management, I have two questions. How deep did you feel that you wanted to go at that particular time? And as a result of that depth, how long would you be keeping the individual there just for this particular portion of recurrent training?

CAPT. SESSA: We felt that at the ground school level there would be no evaluation, that it would be a presentation, an audiovisual package, lasting 1 or 2 hours. And that that would include those things that I mentioned — authority, leadership, crew coordination and communications, awareness, and planning. It should not be made any more comprehensive than that. But initial exposure to this type training should be restricted to basics. We would have it presented by a trained instructor. He would be there to turn a machine on and off, answer questions, and be kind of a salesman, if you will, to get the ball rolling, get a positive response to this type training, and have it accepted by the pilots.

CAPT. CARROLL: You use the word initially. I'm thinking of this in the context of recurrent training, meaning that every year we would be doing this for the individual. Do I hear you saying that we would be doing essentially the same type review, perhaps revised slightly, each year?

CAPT. SESSA: Revised each year. In other words, what we would envision is that the next year the program would be enhanced, brought to a higher level because everyone would already have been exposed to it. At the level we were asked to make our recommendations, we felt that it was important, if this were put into practice and we started tomorrow, that in a year we'd have every pilot exposed at a certain level, everybody would have the basics. And that then you could expand upon that in year-to-year recurrent training, and also in specialized programs for upgrade and transition.

CAPT. TRAUB, United Airlines: Would the LOFT scenario then follow this audiovisual?

CAPT. SESSA: Yes. We envision the LOFT scenario following the audiovisual, where now the pilot could utilize some of the skills he had learned in the audiovisual presentation along with some briefing and so on, and then a critique afterwards. The suggestion, I think where carriers were able to do it, is to video tape. Video taping is good because you see the whole situation. I think we all agree that it would be an ideal situation to video tape it, and to sort of allow the pilot to observe himself.

And we felt, to go on with your question, that he should not be evaluated in his own world, that is, the cockpit on-line operation, until he had adequate exposure to the principles, some training in it, and prior evaluation on a simulated basis for the most part.

CAPT. CARROLL: This video taping that you refer to, Ron, would it be of each individual session? Or would it be of a session to be used as a training vehicle for others? In either case, in the video taping, how did you envision we would avoid the distraction of the video taping, or the personal embarrassment in using that particular session for others, to see if there were obvious indications of lack of resource management?

CAPT. SESSA: Well, we hadn't envisioned using it beyond that session for only the participant to observe. We really didn't get into some of those other issues. We didn't really address those other issues except for the fact that it would not be seen by anyone except the participant.

CAPT. CARROLL: So that's just done at that particular session?

CAPT. SESSA: Right.

CAPT. FRINK: Did you consider at all the possibility of a mock session, that is, video tape a mock session where mistakes may be made, but obviously made, because of a lack of organization as a tool?

CAPT. SESSA: Not specifically. We talked about some staging during LOFT scenarios by one or more of the crewmembers, but we didn't talk about creating a mock situation per se.

## SELECTION AND INITIAL TRAINING

Capt. R. E. Crump\*

Chairman, Group 1

CAPT. FRINK (Introductory comments): At this point we'll start with Working Group 1 and go right on through the rest of the groups. Working Group 1 was headed by Bob Crump, of United Airlines, with John Lauber as his assistant.

CAPT. CRUMP: Thank you very much. This has been the most thought-provoking, stimulating, informative, hard working workshop that I have ever attended. Resource management skills, behavior and proficiencies are critical to the safe, efficient operation of a carrier's aircraft. We have all read the accident reports that graphically illustrate this point. Working Group 1, which I represent, was asked to look at resource management in relation to the earliest events in an airline pilot's career, his or her selection for the position of aircrewmember, and the initial training that follows that selection. Let me discuss the selection process first.

Development of resource management skills, behavior and proficiency begins the first time a student pilot enters the cockpit, whether the person is aware of it or not. The process continues as training becomes more intense and technical, and by the time the individual applies for a position as an airline pilot, he or she has gained a certain level of proficiency that is the result of a number of factors, among them basic personality, nonflying education background, and pilot training. Different applicants obviously have different levels of proficiency in resource management at this point. In addition, the applicants have different potential as far as further development of these critical skills is concerned.

At this point, with the benefit of what we have learned at this workshop, it is apparent that it is important that both the level of resource management skill at the time of application and the potential for improving these skills to a level that will allow a person to become a safe, efficient aircrewmember, be measured and evaluated in making candidate selection.

How are we doing in this area? I can't speak for everyone, but from my experience in helping to develop the United Airlines Pilot Selection Program and from what I've heard here, I believe we are not doing well at all. This matter is not being adequately addressed and I think this has serious safety implications. There is a measure of evaluation of present skills that is lumped into our other criteria for selection, but it isn't specific. In the area of measuring potential, even less is being done.

In order to be able to evaluate skill level and potential, it is necessary to establish a standard against which to measure the applicants. Our committee feels strongly that no such standard exists today. Although we initially tried to deal with this in our deliberation, it quickly became

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\* United Airlines.

obvious that the task was beyond us, in fact, overwhelming. A great deal of research needs to be done. Who can do this? The individual airlines possibly. Perhaps individual airlines in time could develop the resources, but it would be time consuming and very expensive.

We believe what is needed is an industry approach to these twin problems. It is our recommendation that the industry and NASA jointly develop a research program to provide the tools to measure both resource management skills and potential. We are suggesting that this study concern itself with establishing a list of attributes and characteristics which best equip an airline pilot to perform at a high level of skill in resource management; a profile of the successful pilot, the high achiever in this area. We further believe that we should begin by looking at these characteristics in a broad spectrum of our present airline pilot population, from the long-haul Boeing 747 pilot to the short-haul DC-9 pilot. We believe the profile should allow us to screen in good candidates, not screen out poor ones.

Let me list some of the other concerns we feel should be addressed; the list is not intended to be exhaustive. First, the role of the pilot has changed significantly in the last 10 years and will continue to change in the future as we introduce such aircraft as the Boeing 767. What implications does this have when it comes to effective pilot resource management? Do we have to look for different attributes in pilots in the future? It seems this may be possible. It needs to be studied.

Second, as more females are entering the airline pilot ranks, we feel that this may in some way affect cockpit resource management. We feel that this should be a subject of a phase of the recommended study.

Third, education is an important resource that the pilot applicant brings to his job. We recommend that the study look at what type of educational background best suits a person for a pilot career, and more specifically, what type education enhances the native ability pilot trainees have in the area of resource management. Our group felt that a 4-year college education with perhaps equal emphasis on business, science, and the humanities might be best, but we would like more guidance in this area. From this study, it is hoped, would come a profile of the pilot who would be skilled in resource management. It would be up to the individual airline to refine this profile to suit their own needs. The study, to be successful, would have to be longitudinal, would have to continue over a long period in order to validate the study; this is an important part of our recommendation. The ALPA would have to play a vital role in establishing the study. Without the wholehearted participation of this organization, the study could not be successful.

Another aspect of pilot selection and resource management concerns the supply of qualified pilots. The pool of experienced applicants will dry up. The study we are recommending could give colleges with aviation programs guidance in the selection of high quality students for their programs.



Resource management training and evaluation could become a part of the program. This would provide the airlines with higher quality applicants.

Let me now address the second portion of our report, new-hire training. It follows that if we believe it vital to test for resource management skills and potential in our applicant population and select with this in mind, we strongly advocate management skills training during new-hire school. For the purpose of this discussion, Working Group 1 defined initial new-hire training as consisting of the following phases:

First, basic ground school, which covers FAR, company policy and operating procedures, and other items of general interest.

Two, technical training equipment specifics and checkout as either flight engineer or copilot, depending on aircraft type.

Three, supervised line experience or the shotgun phase.

Four, the remainder of the probationary year. I think it's important to note that we feel that new-hire training extends into the probationary year.

The group thus examined the requirements for training and, equally important, the evaluation of resource management skills in each of these four phases.

Here are our recommendations: Working Group 1 believes the current new-hire training programs do not address resource management in sufficient depth. Further, we believe that current approaches to evaluating new-hire performance do not adequately address resource management skills. Accordingly, we recommend that the new-hire initial training program incorporate resource management training in the basic ground school phase. We further recommend that more effective use of the opportunities for evaluating and training resource management be made by check-airmen during the probationary phase.

We have three specific training objectives: first, definition of crew members' roles and responsibility. We recommend that new-hire trainees should be thoroughly indoctrinated in the basic multi-pilot operation. This must include clear definition of each crew member's role and responsibility. The importance of monitoring, cross-checking, and effective communication should be stressed. This definition of crew roles should extend beyond the cockpit to include a definition of how crew member roles are integrated with those of the airline management. We recommend that these roles be defined in such a way that the new hire clearly sees that he or she must continually work on improving resource management skills in order to successfully move into positions of increasing responsibility.

Two, identification of resources available. The new-hire initial training program should clearly make the point that flight-deck resource management is not just the responsibility of the captain, but that all crew

members have resources to manage. To successfully accomplish this, the resources available to the new-hire flight engineer or copilot must be clearly identified. These resources include the following:

1. Manuals — the flight engineer usually has access to manuals that are not available to other crewmembers.

2. Charts — an obvious resource for pilots, but also important for flight engineers because they make cross-checking and monitoring more effective.

3. Log book — the flight engineer may often be in the best position to identify or diagnose the problem because of his or her knowledge of the mechanical history of the aircraft.

4. Systems panels — a resource that is not often considered, but it is of some importance. Some systems, pressurization, for example, can be operated in a manual or automatic mode, thus modifying workloads.

5. Other crew members are a resource — the new hire should be trained to recognize situations involving high workload or situations in which close monitoring or supervision is required. In these situations, the new hire should be trained to ask for assistance. For example, asking the captain or first officer to verify that the proper fuel cutoff lever has been selected prior to shutting down an engine.

6. Other human resources — these include the cabin crew and, via company radio, maintenance, dispatch, and other sources of assistance. His or her experience as an airman is a resource even if relatively small. This is particularly valuable for helping the monitoring and cross-checking process.

7. Related to this is the credibility of the flight engineer or first officer. Professional airmen should strive to establish credibility with their fellow crewmembers because this makes for more effective crew coordination. "I can rely on Joe to do a good job," translates into, "I don't have to spend too much time monitoring Joe's work."

8. Another valuable resource available to the flight engineer is his unique vantage point in the cockpit. The flight engineer is frequently in the best position to observe, monitor, and cross-check the other crewmembers.

Now, I want to talk about interpersonal and communications skills. We recommend that new hires be given specific training in interpersonal skills and effective communications. Monitoring and cross-checking can be effective only if the results of the process are effectively communicated to the appropriate recipient. Furthermore, this training should include methods and ways of adjusting to the domineering captain that the new hire will inevitably fly with sometime in his or her career.

Now, for specific training approaches. Many of the objectives identified above can be effectively and economically met through the application of audiovisual programs. It would be desirable if a library of such programs could be produced and made available on an industry-wide basis. Other possibilities include role playing and other group techniques. Furthermore, the check-airman and the flight manager should play an important training and evaluation role during the supervised line experience and probationary phases by closely observing the resource management performance of the new-hire trainee and providing feedback, advice, and guidance to help refine his skills.

Generally, reading material — for example, flight operations newsletters and various awareness-generating programs — should also be made available. Simulation, especially LOFT, will also play an important role in the training. That brings my report to a close.

## RECURRENT TRAINING AND LINE OPERATION

R. C. Houston\*

Chairman, Group 2

CAPT. FRINK (Introductory comments): Working group 2 was headed by Bob Houston, who is also involved with recurrent training and line operations; Duncan Dieterly, of NASA, was his cohort.

DR. HOUSTON: We have some recommendations and conclusions very similar to those of Ron Sessa's group. We had a lively and spirited discussion, and covered a lot of topics that I'm not going to be able to review here.

The group felt that the papers that we presented were very helpful, provided a good basis for group discussion, and that the concepts presented by Lee Bolman, Bob Helmreich, and Mike Garvey had a definite application to airline operations. In our group, we had really no serious differences of opinion. We did recognize the necessary differences in airline approaches because of different requirements of route structure and volume of training, and for that reason we didn't try to get specific as to exactly how some training should be conducted.

We did have full agreement on the need for resource management training and the urgency for it. As the first step we tried to define resource management. The general definition that we came up with was "The optimum and efficient allocation of resources available to the crew, including personnel, facilities, equipment, and manuals."

We decided that the need for resource management skill certainly is not limited to the captain, but it's most evident as the captain's responsibility, and particularly when a crew member upgrades to captain. We did agree that company management has a certain responsibility to make sure that the resources available to the crew are appropriate and proper and not unnecessarily redundant; this would include manuals and paperwork and approach charts. Certainly we want the crew members to use their printed resources, but it's essential that the resources be properly designed so that they can be effectively used.

We talked about the critical components of resource management, and we will try to cover a few of them. Some overlap with the information that John Lauber presented earlier in this symposium. One of the broad headings of resource management was the captain's authority and control. Under that we subscribe to Lee Bolman's theory of advocacy and inquiry in which the captain should test and seek and diagnose the information sources available. He should check conflicting information from the advocacy or group orientation point of view. He should be considerate of the needs and points of view of the first officer and the flight engineer. In terms of the management grid, certainly he should be people oriented as well as goal oriented.

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\*American Airlines.

The captain again, in exercising his authority, should ensure clear delegation of roles during normal and emergency procedures. In some of the accidents that we discussed, a contributing factor was that there was not a clear delegation of what each crew member was supposed to be doing, particularly with reference to flying the airplane. That delegation should not only be clear, but positive, and the captain should be able to depend on the other crew members to be able to accomplish the duties that he has assigned them.

A second area that we considered as one of the critical components was the captain's responsibility to set priorities. In some situations, the priorities are obvious; however, they are not so clear in others, for example, in situations where there are conflicting requirements, as in the case of multiple-factor emergency. The captain then must establish the sequence of events; he must minimize distractions; evaluate other possible information; eliminate the noise or the interference of lights that come on in the cockpit that are not urgent; and then tie together the variety of procedures.

Another major heading is that of interpersonal relations, which Ron Sessa has already covered. One of the things that was pointed out was that communication between crew members cannot wait until the crew is in the cockpit, but it has to start in Operations, with the very basic step of having the crew members introduce themselves to each other. It can't just start when the flight starts, but rather as soon as possible in the whole flight sequence.

Another major heading is decision making. We discussed the role of procedures versus the captain's innovative capability, his ability to use other additional resources. We didn't really arrive at a conclusion. We agreed that there had to be specific, well-outlined procedures, but there also had to be room for the captain to exercise his proper judgment when circumstances required. I think we agreed that just establishing new procedures or additional procedures wasn't necessarily the solution to the decisionmaking process.

Another factor (another component) is situation analysis. In this connection, we talked about some of Lee's [Bolman] concepts of the theory of the situation, and whether it's a correct analysis of the situation.

As pertains to training to meet the requirements of resource management, we much agree with the previous committee report. We think that the training should start early in a person's career and, we hope, if we're successful in training our captains to be the ideal model of resource management, that the junior crew members will learn from that model. Now, that's an ideal situation, but it would be nice if that could be brought about. If we're going to train for resource management, first we have to define a little more specifically the management skills to be trained, and that was one of our objectives. We need to give examples and come out with specific definitions, if we're going to develop good training programs.

We do need to spend some time in the recurrent training process in a classroom or with audiovisual tape or computer-based instruction program to get across the concepts that we think are important for resource management. We would agree with the need to sell the concept. There was one suggestion of playing back some of the audio tapes of crew conversations prior to some recent accidents, as a means of convincing the crewmembers that the resource management prior to those accidents was not what it could have been. Playing back those conversations, with some graphic illustrations of where the airplane was and what was happening, could be an effective method (even without further comments) of convincing the crewmembers that they really did need to pay attention to this area.

And then, of course, we felt that we need to train the managers first, that is, start from the top down so that they would have a full understanding of what was meant by resource management and what the other crew members are being trained for. We suggested that role-playing could play a significant part here in teaching the concepts that we want to get across. It was also suggested that the crewmembers themselves could create some scenarios. At American they have found that to be very effective.

Having done all this teaching we might find that the crew member has, to use Lee's term, an espoused theory of operation. But we need to find out whether he can actually put that theory into operation; whether it can be a theory of practice. We concluded that a well-designed LOFT situation was the place where we could determine whether the crewmember was able to put the concept into practice.

This again would require that the check-airmen and instructors be thoroughly trained so that they would be able to observe the crew's performance. We did talk about the possibility of recording or video taping either some role-play sessions or actual sessions, but we didn't get into the details of exactly how this would be done.

LOFT training is certainly a feasible concept that's supported by all of the papers that were handed out to us prior to our meeting. It would enable us to put the crewmembers in realistic emergency situations and let them see for themselves how they can respond and handle those situations. The thing that needs to be addressed, of course, is the observation of their ability to manage their resources, to work with the other crew members, to use information that's available to them both in the aircraft itself, the instrumentation, the operating manuals, procedures, and so on. This requires the development of trained observers, who can debrief the crews afterward and make suggestions as to how their management of their resources could be improved.

Similar opportunities occur in line checks for which we need properly trained check-airmen who are aware of the need for good resource management. Well-trained observers could counsel and guide the crewmembers in improving their ability in resource management.

One suggestion for a research project would be the development of a self-test to evaluate an individual's resource management capability.

Now, this would be his espoused theory, in Lee Bolman's terms. And then, related to that, of course, would be to establish LOFT-type-scenario measurements with reference to resource management. In other words, we'd have a measure of the man's espoused theory, put him in a LOFT situation, and do some research to develop ways of measuring more effectively his resource management in the LOFT situation. I thought that was a good combination.

There's one other question that may be a little controversial. The suggestion was made by one member that after the crewmembers have gone through LOFT training they rate each other in the management of their resources. As I say, that got mixed reception from the committee, but that's always a possibility depending on the airline situation.

It was also suggested that there be some research on the effect of automation and self-confidence on the level of resource management and on the pilot's self-image and job satisfaction. Will the automation, particularly in future aircraft, reduce the individual's capability in resource management and reduce his ability to innovate and use additional resources?

Another recommendation was to encourage validation of a managerial concept in the cockpit setting, the program that's under way at North Central now. The concept proposed by Bob Helmreich and Lee Bolman can be further validated in a cockpit setting.

Another is, do some further research on this gap between the espoused theory and the theory in use in a cockpit setting. That, I think, attracted the attention and interest of all of us.

We need to do a better job of defining and perhaps rank-ordering for training emphasis the critical components of resource management, and to give examples and identify behaviors. And then we need to develop measures of capability in resource management.

One final recommendation — research into the effect of fatigue on resource management facility. Is it conceivable that resource management skill is more susceptible to fatigue, either as a result of a long flight or what went on prior to a flight or the number of segments? Do we tend to become less effective in our intercrew communications and interpersonal skills after many segments of a long flight or under fatigue conditions, more so than we drop off in actual skill in flying the airplane technically, for example, in making the approach?

In summary, I learned a lot in our workshop. Now I'm anxious to get back and see what we can do to apply some of these concepts at American Airlines. We have a little work to do to develop some of the details and some of the economic implications.

## TRANSITION AND UPGRADE TRAINING

Capt. L. F. J. Holdstock\*

Chairman, Group 3

CAPT. FRINK (Introductory comments): It's obvious that a lot of good information is coming out. We have a lot left to do though, and it's a sad thing that many airlines are not represented here. So we are going to ask NASA to get something ready as a result of this so that the other airlines will benefit from this work that you people have done. It's very valuable work and the whole industry is going to benefit.

Working Group 3 was also concerned with transition and upgrade training. The chairman was Len Holdstock; his assistant, from NASA, was Ren Curry.

CAPT. HOLDSTOCK: Our group tried, first of all, to agree in their own minds on what was meant by transition and upgrade training. And after 4 hours of discussion and some very erudite explanations, you will be pleased to know we are still in the dark.

We then decided to confine our thoughts to those attributes in which resource management could play a part. That seemed to be the object of the exercise, and we immediately found that with transition and upgrade training we were looking both backward and forward. We were dependent on material coming from behind us as we were preparing people for a future. We then decided that we had to make some assumptions.

The first of these assumptions was that flight crews have to be trained to appropriate standards. We want here to stress the importance of flying standards and technical standards, and that the training has to meet both company and regulatory requirements.

The second assumption we made is that the roles allocated to each crew-member are understood and respected by the other crewmembers, so that the influence of resource management is known to all.

Thirdly, we realized that there could be a number of factors changing in the world of aviation. In the last few days, we have heard of energy problems. There may well be not problems but changes in equipment and outside influences, air traffic control, all of which may change the roles of the crew. For the purposes of this exercise, we assumed that in the foreseeable future, there would be no changes.

And lastly, we assumed that any recommendations we made or any thoughts we had would not necessarily be applicable to all groups and all airlines.

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\*British Airways.



We then went on to try and answer the question posed in the paper by NASA, "What are the specific management resource skills, behavior and proficiencies to be developed?" One point made straight away, largely in reference to transition training, is that there will be different levels of resource management available at any particular time. To enlarge on that, immediately after training there is a basic level of competency. Following that there will be change, there will be increased competency, and as that competency changes, so will the resources available change.

Now, the ultimate objective, of course, is to insure that the crew, under the control of the captain, will eventually operate as a totally coordinated unit with the maximum level of efficiency. We then went on to list those skills that we think are necessary, but I must emphasize that we are not listing them in any order of importance or priority. We merely list them as the group discussed them.

We have put them under three recommended headings, first of all dealing with social and communication skills. Although we haven't listed them in any priority, we did classify them either above or below a line. The ones above the line, we thought, should be specially emphasized in upgrade and transition training; those below the line should be taught as generally desirable attributes.

<p>Thus, as shown in table 1, the interdepartmental relations are listed above the line. Interdepartmental relations refers to the relations between the crew and the cabin crew or flight attendants, the ground crews, maintenance — anyone who is contributing to the safe operation.</p> <p>TABLE 1.- SOCIAL AND COMMUNICATION SKILLS</p> <p>INTERDEPARTMENTAL RELATIONS</p> <p>-----</p> <p>CONSIDERATION</p> <p>FAIRNESS</p> <p>INSIDE COCKPIT</p> <p>OUTSIDE COCKPIT</p>	<p>And below the line we then put consideration of everyone else. Consideration for the rest of your crew, both inside and outside the aircraft. When considering them, we thought that there must be a degree of fairness, fairness in judgment. One has</p>
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to bear in mind that a fast judgment or a judgment based on incomplete information could well impair the future effectiveness of an individual. And this, of course, is both inside and outside the aircraft. I know we tend, when we're flying, to wrap ourselves up in this cocoon of metal, but there are a lot of people involved, and they all have a part to play.

TABLE 2.- PLANNING, PROBLEM-SOLVING,  
DECISIONMAKING

CONSIDERATION OF ALL ALTERNATIVES  
SETTING TASK PRIORITIES  
-----  
COMMUNICATION OF PLANS  
ANTICIPATION OF SITUATION

Under the heading of Planning, Problem-Solving, Decisionmaking (table 2) we listed 4 points. The first one above the line is the necessity to consider all alternatives. We need training in the ability to consider all alternatives, to know the situation, to respond to the situation. Secondly, we have to be able to set the task priorities. It's a function of time, and of ability within the crew.

Below the line, good communications of future actions and anticipated actions are needed. It's not good enough if you, as one crewmember, are aware of an impending problem. You may know that you are quite happy to meet it and do the right thing at the right time, but it's also necessary for everyone else to know that you're going to do it.

And lastly, below the line, is the anticipation of other influences on the situation. These include environmental influences, possibly company influences, influences of passengers, influences of cabin crew on the flight deck, and influences of control. All in all, a general awareness and anticipation.

A third heading is that of Leadership and Management (table 3). Above the line, we think it's necessary to develop an appreciation of new

TABLE 3.- LEADERSHIP AND MANAGEMENT

APPRECIATION OF NEW RESPONSIBILITIES  
AWARENESS OF CREW'S TASKS  
ABILITY TO DELEGATE  
WILLINGNESS TO TEACH/SHARE  
ABILITY TO INSTILL CONFIDENCE  
-----  
PROFESSIONALISM  
SELF-CONFIDENCE  
COMMAND PRESENCE - STYLE - INTEGRITY  
COMMUNICATION OF INTENT

responsibilities, changed responsibilities. It's necessary for the leader to be totally aware of everyone else's tasks, to have a complete picture. Equally, it's necessary for other crewmembers to know what he or she can expect of everyone else.

We think it's necessary for the leader to be able to delegate — not to offload those small, unnecessary tasks — but to delegate with the thought that there is some teaching to be done. The crew will learn by use of the resources; and if they're delegated early in the man's career and increasingly delegated, the picture will be constantly improved.

Below the line, and it should be acknowledged that there was some difficulty in defining the word, we put professionalism. We went on to say that self-confidence was necessary. We thought it necessary that a leader should have command presence. Again, a difficult word to define, but I think we all know what is meant. The man should have style, he should have

integrity. Lastly, there should be a distribution of activities to use all available resources in the best possible way.

Now, all of the points mentioned do apply to both transition and upgrade training. At the same time we appreciate that all these points are learned throughout the airman's career and any periodic reinforcement must be to the individual's benefit, whether it be by way of courses, information, or word of mouth. It doesn't matter how it comes, as long as it's constantly spread.

We didn't spend too much time deciding how one was to do this. There are a number of tools available. There are classroom tools, the case study approach, the role playing that has already been mentioned, exchange of situations and duties in simulators or not necessarily in simulators, but just simulated conditions. Obviously, use of the simulator, LOFT training, aircraft training, and there are a number of other possibilities.

We thought that there should be more prebriefing and debriefing by the ordinary line crews. We all know that it's easy to walk aboard an aircraft, and at the conclusion of the flight say, "Thank you very much, goodbye." But very often something happens during a flight that is worth discussing and that should be discussed right then and there.

Management courses are of value and in this respect I think that one should not necessarily confine such courses to the commanders, to the captains, but that the sooner one involves copilots the better.

In summary, the feeling of our group was that the expertise of pilots and crews is necessarily an ongoing matter, and they should be encouraged to accept the fact that they are in a profession calling for constant learning and constant improvement.

## SELECTION AND INITIAL TRAINING

Capt. Berton Beach<sup>\*</sup>

Chairman, Group 4

CAPT. FRINK (Introductory comments): The topic of Group 4 was selection and initial training. The chairman of Group 4 was Bert Beach, of Eastern, and he was assisted by Maurie White.

CAPT. BEACH: By way of introduction, we felt that to enable the clear separation of the issues of resource management from those of otherwise well-qualified airmen, we should treat the skills and training required for resource management as incremental; that is, as not necessarily being evident in the physical operation of the airplane. This statement of the approach is perhaps not the clearest we could develop, but at least it had the virtue of helping to focus the task that we considered in this discussion.

One of the fundamental conclusions that we reached unanimously was that resource management should be sought and fostered at every stage of evolution in the captain's career, including selection of the candidate airman, from the first day he's on the property. The inference of this decision is that given the present pattern of flight-deck promotions, the candidate should have skills and qualities that will enable him to function effectively as a subordinate during the long wait for captaincy, and that, upon obtaining command rank, he should exhibit a new balance of these skills as required by that job.

These considerations lead to a definition of the skills required for resource management that might not have otherwise been introduced in the selection process. They also impose a responsibility for the airline management to help maintain early motivations through the long period of subordinate status.

It should be noted further that the delineation of skills and qualities that should be looked for in the selection process doesn't necessarily mean that we already have the criteria and the test procedures needed to identify them. Possibly knowledge exists regarding availability of such information, criteria, or test procedures, but they weren't immediately at hand in our working group, and the consensus was that either those procedures exist currently or could be developed.

The provision of resource management training during the initial training period was discussed, and it was agreed that such training must be provided in order to enable the junior airman to function effectively in support of the captain. It would have the added benefit of ensuring that his indoctrination to captaincy was carried out as an ongoing, progressive, evolutionary process, one that is more easily digested than the kind of crash courses we seem to be providing today.

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<sup>\*</sup>Eastern Airlines.

To ensure that the candidate either already has resource management skills or can be trained in these skills, certain qualities over and above the obvious ones needed for good airmanship should be looked for and evaluated in the selection process. And we felt some of these things should be as follows.

1. He should have effective interpersonal communication skill.
2. He should be a team player. That is to say, he needs to be tolerant of deferred gratification.
3. He should be a good follower as well as a good leader.
4. He should operate cooperatively within the system, that is to say, the aviation system, and he should have a strong personal interest in that system.
5. He should have a stable personality.
6. He should be flexible, that is to say, he needs to be adaptable to changing conditions.
7. He needs to have the proper motivation to become an airline captain.

We got a little hung up on what motivation means, but we'll address that later.

The criteria and test procedures for evaluating the above skills may already be available in an adaptable form from the psychological literature now extant. If not, programs ought to be conducted to develop them. The final selection for the candidate should be done by Flying Operations as the ultimate arbiter of the man's suitability as a potential aircraft commander.

Training for resource management should be started as early in the airman's career as possible, in initial training, obviously. It should be carried on continuously through his progress toward being an airline captain. Training for resource management, even at the subordinate level, should include improved methods of providing expanded orientation training. This would enable the new hire to be aware of the resources available to him, and to begin to think early in his career as he would if he were a captain, and could thereby provide the captain with informed support.

Because of the cosmopolitan makeup of our group we tended, in discussing methods we thought would be applicable to training, to be very general, realizing that each carrier may have specific requirements. We felt that formal training on interpersonal skills and management skills was an absolute requirement, formal training being classroom training, slide tape presentations, audiovisual, TV, film — whatever fits the carrier's needs.

Training in the complete crew concept should be given early. Complete crew concept being not necessarily limited to, but including "What is your role in the crew?" "What is your role in support of the other person's role?" "What do they do?" The complete crew concept, we felt, meant just that — what do you do, what is available to you, and how do you use it.

We felt that early in the training program, perhaps in initial training, full-mission simulation or LOFT training, if you prefer, should be initiated, beginning with normal situations, and proceeding on to the more difficult abnormal situations. We also felt that the publications that flight crews use as guidelines for operations should reflect resource management considerations. Perhaps that might be a project that NASA could undertake since we weren't certain how we could rewrite training manuals and aircraft operating manuals to reflect the kinds of things we feel were important in that area.

Procedures should be developed to evaluate the effectiveness of this kind of training. They could include such things as feedback from the line captain as to how effectively we're training the initial crewman, and written reports, that is, line pilot's reports, on how well the man is performing in his job. There was a need for effective supervision by check-airmen from the carrier to watch the initial trainee and to report back any deficiencies they saw in the things we supposedly trained him to do. We also felt that LOFT, used as an evaluator during recurrent training, would give us a handle on how well we had done our job in initial training.

We also would ask the student for feedback immediately upon completion of the training — what he thought of it, what he felt he had missed, an overall judgment of our ability to train him well. Additional feedback should be obtained after he has completed the probation. It was thought that we might find a little more candor after he was already assured of the job than when he was at our mercy during our training program.

We also felt, as I see the other groups did, that we need open communications between the trainers and the managers on the one hand, and the representatives of the pilots, in our case, the Air Line Pilots Association, on the other hand, to provide us with additional feedback.

In summary, we felt that resource management skills and potential should be identified and considered in the selection process. Certain qualities of the individual contributing to resource management skill have been delineated, but the criteria and procedures for evaluation may need to be developed. Training and resource management should be provided continuously throughout the airman's career starting in initial training.

A variety of possible methods for evaluating the effectiveness of resource management training can be utilized, including possible activity by company management, feedback from the pilots' selected representatives, etc.

Some developments might require projects outside our scope, that is, projects perhaps for NASA. We spent about the first hour we were together trying to decide what an airline captain is, since that's the decision the training ultimately takes. We had some difference of opinion about: Is he a leader? Is he the commander? Is there a difference? Defining what a captain is might be a problem, and since we couldn't solve it to our unanimous satisfaction, we felt it might be a good project for NASA to undertake to develop a definition. Once we know that definition for sure, then we might be better able to address the training methods to make him one.

We also thought that to initiate some training in resource management, it might be possible to take an air carrier's initial training program and run two groups through it. One would be put through the carrier's existing initial training program, and the other through a program developed perhaps entirely by NASA or the carrier's program modified by NASA to include the interpersonal skills emphasis, the resource management emphasis. At the end of it we would try to evaluate which produced the better aviator.

That, in summary, is what we spent the last day and a half doing.

## TRANSITION AND UPGRADE TRAINING

Lawson White\*

Chairman, Group 6

CAPT. FRINK (Introductory comments): Our last report is from Working Group 6, which was chaired by Lawson White, of IATA; he was assisted by George Cooper. Their topic was transition and upgrade training.

MR. WHITE: We too found it a problem to define what we meant by transition and upgrade training. To our group, transition training is that training given to a flight crewmember in order for him or her to be qualified to operate in the same capacity in a new aircraft type. And upgrade training we considered as the training given to a flight crewmember in order for her or him to operate in a higher capacity in the same aircraft type, that is, from first officer to captain or even from second officer to first officer.

I propose to read you a summary of our discussions. For transition training, the working group concluded that the resources to be managed would vary according to the aircraft type, the crewing philosophy, the type of operations, etc. Nevertheless, the principles of resource management would remain the same, that is, using all the available resources to the best advantage.

It was agreed that resource management training, if it is included in a transition course, should consist solely of instruction on what resources were available to the crewmembers. The reason we reached this decision was because we didn't know what had gone on in initial training, and we didn't know what had gone on in recurrent training, and so we had to make some assumptions that the other groups would take care of that. We thought it important that the crewmembers already had some training, and we just had to identify for them in this transition what was different on the new aircraft type.

We also agreed that the knowledge and skill in resource management would be different for the captain and the other crewmembers. The reason for this is because the captain must have the legal authority for the safety of his aircraft, and he is, therefore, responsible for the total operation, including proper resource management. The role for the other crewmembers, and this includes cabin crewmembers, would be that they are part of the captain's resources and hence have roles that are different and supportive. Resource management training should, therefore, reflect these different roles for the different crewmembers.

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\* IATA.



It was agreed also that resource management training should, therefore, start with the initial hiring, and continue through each crewmember's career to reflect the requirements of the roles that I have just outlined, namely, supportive and managerial. There was also no doubt that each and every captain should be capable of proper resource management. To do this he was required, first of all, to show proper credibility to the other crewmembers. This infers competence, imparting skill and knowledge as a prerequisite for a good resource manager and, of course, continued maintenance of this proficiency.

We next turned our attention to identifying the skills required of a good resource manager and we first of all outlined these (fig. 1) as social and communication skills, leadership and management skills, planning, problem-solving and decisionmaking skills. We expanded the requirements to some extent, although incompletely, as follows:

Under social and communication skills (fig. 2) we felt that the manager, if you will, should have training in interpersonal relationships and in the mechanics of communication and communication errors. In figure 3, management skills, you note, I dropped leadership from the title and I'll return to that. He should have training in delegation of authority; establishing priorities; achieving proper crew coordination and crew cooperation; allocating duties; distributing workload; recognizing stress; supervising assigned tasks; monitoring tasks; and, particularly, in accepting his responsibilities.

With regard to planning skills (fig. 4) he needed training for the situation awareness and staying ahead of the aircraft. What we mean by that seems self-evident.

In problem-solving skills (fig. 5) training should be provided in problem recognition and solution strategies.

With respect to decisionmaking skills, we felt the training should be in the knowledge necessary to make the decision, training for the self-confidence to make a decision, and the courage to stand by or change that decision as necessary.

Now, with respect to leadership, this skill gave the working group the most difficulty. After a long exchange of views in which each member of the working group gave his idea of what we meant by leadership, we came to the conclusion that the necessary skill in this field would be provided if he had the skills in the other fields I've just mentioned. In other words, if we covered properly decisionmaking, problem-solving, and the other skills, he would have the necessary leadership skill.

We then turned our attention to exactly what upgrade training meant. First, when should this upgrade training be given? We concluded that by the time the new captain takes his first trip as captain, he should have had that training. That may seem a sort of motherhood and sins statement, but

the situation is so complicated that we felt that we had to leave it to each individual airline as to when they gave that training.

With respect to the method of conducting this training, including who did it, again we felt that this needed to be determined by the airline concerned, because each airline has different resources available. The various training techniques are well known, but they may be suitable to one group and not another. And we felt it was necessary for the airline itself to decide its method and who should do it.

We haven't really identified any specific research task needed. It was our group's feeling that with the airlines' activity in this regard and with NASA monitoring it, there may be some areas for research that are self-revealing. But one point was made — that perhaps we should consider the possibility of a time and motion study of cockpit tasks, and that this may help us in proper resource management.

With regard to the second officer to first officer upgrade course, we did not think there was any difference in specific training. We felt that with the training he received from initial hire until he became second officer, plus his recurrent training, he would not require any additional training when he became a first officer other than in the resources available to him.

A final comment — another prerequisite of all of this is that the check-airmen, the people who are doing the checking, obviously have to be trained as well in the roles that the second officer, first officer, and captain are going to play. It necessarily follows, of course, that all of this has got to be authorized from the top.

CAPT. FRINK: Thank you very much. That is the conclusion of the formal reports.

- 1. SOCIAL AND COMMUNICATIONS**
- 2. LEADERSHIP AND MANAGEMENT**
- 3. PLANNING**
- 4. PROBLEM-SOLVING**
- 5. DECISIONMAKING**

Figure 1.- Skills required for resource management.

- **INTERPERSONAL RELATIONSHIPS**
  - **MECHANICS OF COMMUNICATION**

Figure 2.- Social and communications skills.

- **DELEGATION OF AUTHORITY**
  - **ESTABLISHMENT OF PRIORITIES**
    - **ACHIEVING CREW COORDINATION AND CREW COOPERATION**
    - **ALLOCATION OF DUTIES**
      - **DISTRIBUTION OF WORKLOAD**
        - **RECOGNITION OF COMPETENCY AND STRESS**
        - **SUPERVISION OF ASSIGNED TASKS**
          - **MONITORING**
          - **ACCEPTANCE OF RESPONSIBILITY**

Figure 3.- Management skills.

- **SITUATION AWARENESS**
  - **STAYING AHEAD OF THE AIRCRAFT**

Figure 4.- Planning skills.

- **PROBLEM RECOGNITION**
  - **SOLUTION STRATEGIES**

Figure 5.- Problem-solving skills.

## PANEL DISCUSSION

CAPT. CARROLL, United Airlines: One of the comments that you made, Bob [Houston, Group 2] was that we should be questioning the adequacy of the resources made available by the company. Do you have any recommendations or any conclusions that evolved from your group discussions as to how you might determine the adequacy of the resources that are currently available?

DR. HOUSTON, American Airlines: I don't think we have any recommendations, Ed. It just came out in our discussion that we do provide our crewmembers with an awful lot of paperwork. Some of it might be redundant, and some of it might not be designed as clearly as it might be. If we expect them to use this as resource material, then it's incumbent upon management to insure that they have the essential material, that the information is readily retrievable, is not overly redundant, and so on — just kind of a caution for management.

There was a comment from one of the speakers about the flight papers that he takes with him from Dispatch, and proceeds to throw away. That was in jest, but if we expect the crewmembers to use that printed material, then it behooves us to make sure that it's really effectively presented.

CAPT. CARROLL: I'd like to suggest that perhaps it is something that would fall in an area for John Lauber's people to pursue. That if there are differences, and I'm aware of a few differences, at any rate, in the paperwork activity — not only in the volume of the paperwork that's involved, but the activity in the cockpit relative to paperwork. The procedures differ between airlines, and it may well be that that's something that John and your people could pursue to improve the efficacy of some of the procedures that have to be followed; we might all benefit from addition or deletion. As long as your group did not have anything specific in mind, I'd like some feedback, if we could get that sort of thing, as to whether we're encumbering our people more than we should, or whether we're supplying them with the right material.

DR. HOUSTON: The Ruffell Smith study made some comments about the difficulty in reading the approach plates and the unsatisfactory levels of illumination, as well as the legibility of approach plates and all the other paperwork that we give the crewmembers. It's a multifaceted problem.

CAPT. FRINK, Pan Am: Paperwork is an interesting piece of the workload. Of course, interestingly enough, there is another side to that, particularly for the long-range operators. We find there's an overload situation and also an underload situation. We haven't talked about that here because it really isn't pertinent to the general operation, but there does come a time in a long, 8-12 hour operation at 35,000 to 39,000 feet, where an underload does occur. For this reason we actually find an operation that is less than the best, and it creates a level-flight complacency, if you will. It's a subject that those of you who are involved in long-range operation might want to discuss some day.

It's an interesting phenomenon that, if we didn't provide something relatively important for that man to do procedurally during that 8-10 hours with this level-flight operation, mistakes would be made more often than if we do provide some paperwork.

I noticed that two presentations made on the subject of selection and initial training had a number of similarities as well as some differences, and perhaps some of you would like to comment on those. I noticed that in regard to the selection process, they both indicated that we are not doing it well now, even those airlines which have done a lot of research on this. I think it was particularly interesting that even at United, a company that has done a great deal of work on selection and has done a lot of investigation of the best methods and procedures to use — forgive me if I quote you wrong, Ed — but I believe that it was stated that the business of resource management really was not looked into well as part of your selection process. Would you like to comment on that, Ed?

CAPT. CARROLL: I believe Bob made that comment in his summary, so I'll defer to Bob.

CAPT. CRUMP, United: I think it's true; we looked right past that. We looked at some of the things that are part of resource management, but after several years of investigation and looking at all of the different aspects of selection, we never zeroed in on this particular subject per se.

I think we've got good people but I think we have them because of other reasons. We've got people who are going to be able to accommodate quite well to resource management training because they are experienced and intelligent. We're going to come out pretty well with our present group, but if we get into a period when our candidates have lower qualifications, I think we would find out that we had a deficiency in our selection system. We will go back now with what we've learned here and begin to modify the program to include an evaluation of resource management capabilities and potential.

CAPT. FRINK: I think it's very interesting to mention that right off the bat we're focusing on initial training whereas I'm sure we all came in here without the idea of command training as part of this. If we go out of here with nothing more, we know that what we have learned is that resource management extends all the way from the top to the bottom of our aviation careers, and we have a very definite responsibility to carry on training right from the beginning.

It's interesting also to note that with the limited amount of time that we have had, the quality of the discussions that have been stimulated has been outstanding. The rapid rate at which we have reached consensus on the need for this workshop is also interesting. There have been some differences expressed this morning, and I hope that by your questions and comments on these differences we can explore further the how of training for resource management.

Is there anyone who would like to comment further on that? Are there any questions about some of the differences? There was a suggestion, for instance, that we might play back audio tapes of accidents in order to demonstrate the problem of lack of proper communication in the cockpit and its contributions to accidents. It occurred to me that this is a very sensitive thing. Bob, did your group have any discussion on the availability of such tapes; that is, whether they might be made generally available?

DR. HOUSTON: This is a technique that is being used, and we raised that question. Bill Traub, would you like to comment on that by any chance?

CAPT. TRAUB, United Airlines: I merely pointed out that during our recurrent training now, we replay the Salt Lake City accident including the tapes that are available, communications with ATC, and with the company. In addition to the tapes and audio program, we show the position of the airplane during approximately the last 20 min of the flight. I think it's gone over very well.

CAPT. FRINK: I can attest to that. I think that we owe United Airlines a real debt of gratitude for making up that audiovisual program, and making it available to the industry. Every airman in our company has seen that, with an appropriate commentary that this could be you; it's been very effective and very well received.

There's no question in my mind whatever, and I'm sure the others here will agree, that such programs are very helpful. The problem is how do we get them? Everyone isn't going to be quite as generous or quite as able to prepare that kind of program. Perhaps this is something NASA or someone else could do for us.

DR. HOUSTON: I don't think you mentioned the fact that you just play the tape back. You don't make any critical comments, you don't point fingers, you just let the crewmen listen to this and make their own judgment, and that's the message.

CAPT. TRAUB: There's no editorial comment whatsoever; it's extremely effective.

CAPT. FRINK: That's right, it's very effective. This is purely and simply the cockpit voice recorder being played back, with some override of the tower tapes and some visuals to go along with it to illustrate the case. Very, very effective program.

MAJOR BURCH, USAF: We don't have the voice tape capability, but we do do this. We have about four different anatomies of accidents that we go through primarily for crew coordination, checking altitudes, checking different things, from accidents that have happened. And we basically go through the screwup with the slides, then stop and discuss. This has gone over very well, and it brings the problems out. We don't know if it helps much after that, but it does bring everybody's attention to it.

CAPT. FRINK: That's very true, I know most of the airlines have an accident report capability, and airmen eat that up. And it is a form of management training — there's no question about it — resource management. And you see the lack of use of that dramatically in its effect.

CAPT. GILSTRAP, United Airlines: I think there are some precautions that you have to take which I think we did. We waited until all this information was public knowledge anyway, so there's no divulging of any information that wouldn't otherwise be available. In fact, the tapes and the presentation only make public knowledge more accurate by its presentation. Therefore, any crewmembers who see it are only looking at the most accurate presentation of what really took place. It's much more accurate than previous information they might have heard, obviously much more accurate than newspaper accounts or anything. Consequently, it's an updating on a permanent basis of the most accurate type of presentation you can get of what took place at a disaster. As a result, it becomes more acceptable for crew consumption than it would if it were in any way inflammatory, even though the nature of it might be slightly so because of what took place. But, at least, we're doing it with great, great care for accuracy, and I think that's very important for the protection of pilots as a group in the profession.

CAPT. FRINK: I agree with you. As I mentioned before, that was very, very well done. Is there anyone else who would like to comment on anything else to any of the other members of our panel this afternoon?

CAPT. CRUMP: Our group was interested in finding out how our recommendation on this research project that we outlined was received by other groups. If you remember, we were interested in having a neutral organization, specifically, NASA, do this research in establishing standards for resource management, both in measuring the level of applicants and also the potential. I wondered if there is any comment from anyone in any of the other groups about how you received that idea? We are wondering whether this entire group would subscribe to that, would endorse it. If it did, I think the recommendation would have more weight, and the possibility of a research program taking place might be significantly improved.

CAPT. FRINK: Does anybody have any comment on that? How do you feel about NASA looking into this?

CAPT. TRAUB: I think you proposed, Bob, a joint Industry/NASA committee, right?

CAPT. CRUMP: That's right.

CAPT. TRAUB: I like that idea.

CAPT. FRINK: How would such a committee be selected? This is something that, basically, two groups almost disagreed on. One group was specific on a group of characteristics that they felt ought to be looked for in the selection process as related to resource management, whereas the other group says we are in the dark about that, effectively, and said it ought to be researched.



Do you think that there is a need for researching this, or do you feel confident from what we have come up with, that you can go back to your airline and, based on the information that we have gleaned from these few days, develop a better code for the selection process? Or do you feel that it is necessary for NASA and others to get into some research on this?

MR. WHITE: You'll remember, I said in the report on our working group discussion, that it goes right back to selection. When we were discussing selection, we happened to have Bob Helmreich right in with us. We had already listed all these training requirements in communications and problem solving and so on and so forth that I mentioned, and we asked him if it was possible to have any measurement for selection under those areas and he said yes. So obviously some research has been done.

MR. COEN, FAA: I'm all for following up. That was our group's recommendation, that we do put NASA to work. And we came up with many good programs here. We see that some people are already working on some programs, and some are not working on it. Some have good programs, some have mediocre programs, but there is no standard in the industry.

I believe that with some recommendations from somebody like NASA or an Industry/NASA committee to develop an industry standard, it would give you people in training a bigger stick to go back to your company and say, "This is what the industry as a whole is doing." We often hear that we can't get the money from top management, that we need some stimulus to apply to them. Following this workshop I think most of the people here will go back and do something. We'll still wind up with a good, better, and best, but I think that by coming up with an industry standard, we can all at least derive a mark pretty high above the middle.

CAPT. FRINK: George, while you're there, I wanted to mention that it has been mentioned to me by a few people that there is a danger, a risk in coming up with, what should I say, an industry recommendation for something like this; that this will be latched onto by the regulatory agencies, and become a requirement in some form. A new regulation will come out and instead of Appendix E and F, we'll have E, F, and G. Would you like to comment on that? I said, "No, it wouldn't happen," but maybe I'm naive.

MR. COEN: That's always a risk, Al. Incidentally, I think one of the things that came out here, that a lot of people were not aware of, is the fact that we did go ahead and make a spot change in that regulation just to allow LOFT training, and we did this quite some time ago. I know there's a lot of people in this room who are not aware of that. Some of the papers referred to exemptions, the Northwest exemption, and Captain Beach, of course, hoped to get an exemption. So that was a good regulation. It loosened things up, gave you three choices of ways to perform your proficiency training.

But I don't intend to go back and recommend that somebody come up with a new regulation to make a standard, although we are out already with a bulletin that we sent to our principal inspectors, telling them to recommend

to the company that they do come up with some kind of resource management training for the captain, or command training, call it what you will. We are already on record as recommending that, but we didn't go any further.

Of course, what NTSB does sometimes has some of our people jump through a hoop. We try to jump out again sometimes, but I don't really see any regulatory process resulting.

CAPT. FRINK: Actually, I think that the FAA does have an obligation to pay some attention to this subject; I don't think it's anything they can ignore. On the other hand, if we let ourselves be deterred in fear of specific regulations, I think that we, ourselves, are ignoring our responsibility. If we have two battles on our hands, then we have two battles on our hands. We have to face the issue of a recognized need, and I think that's what we are doing in this forum. I hope that we all intend to go back and apply it.

I don't want to needlessly extend this discussion. If those of you who are here feel that the reports this morning can stand on their own feet, and that they should be given to NASA for analysis and for review and for recommendations, we can carry on with that. I know that John has some other matters he would like to get to, and I will turn it back to him if there are no other comments.

CAPT. JOHANNESSEN, Scandinavian Airlines: Will we get these reports distributed? Will you multiply them and send them to us afterwards?

CAPT. FRINK: Yes, this will be done. It will take some time because there's a long editing process that will have to be done and I would guess it would be a matter of three or four months before....

DR. LAUBER: Not that long, but it's going to take a while.

CAPT. FRINK: But there will be a report out from this meeting, yes.

CAPT. TURLINGTON, Pan Am: One of my points is I just hope that NASA stays involved in this thing. I can imagine all individual airlines returning to their own bases and embarking on these programs on their own, but I can't imagine that that's the most effective way to get the most out of the resources that we have collectively. That's the big difference I've seen today. I hope they stay in the program.

DR. LAUBER: That raises a question that you brought up this morning, Al, that I'd like to hear some clarification on. At one point, you indicated something about other airlines who weren't present. Would you care to expound on what you had in mind by that?

DR. BILLINGS, Ames Research Center: You said very specifically that you would — I wrote it down — will be asking NASA for something for other carriers.

CAPT. FRINK: I think it's obvious that my meaning there was I think there's a great deal of value in this, and it's a value that extends to all the industry. They all could not be here for various reasons. Some of them don't have the capability to send members of their staff here, and some of them are not really aware enough of the importance of this to attend. Which doesn't mean that if we do an effective job of reporting, that they won't develop an interest. And if we come out with some recommendations, it will assist them in improving their programs in response to NASA's guidance. So, yes, there are many airlines that are not represented here that will and should benefit by the proceedings.

MR. DANAHER, NTSB: Further to that, I would assume that copies of the proceedings will be available and might suggest, at the risk of the obvious, that we try to insure that a copy gets to all scheduled air carriers in the U.S. and perhaps do something through IATA toward making them available for international airlines. Is there a plan?

DR. LAUBER: Yes. The details of the distribution remain to be worked out, but we certainly would like to make it as widely available as possible. We'll have to work with you and IATA and others to determine how to go about doing that.

CAPT. FRINK: It appears to me that we have a tendency at this stage of the game to say, "This is great, NASA has told us what we ought to do." I don't think that's a satisfactory conclusion.

I know from conversations with at least three of the airlines that are represented here, that there is every intention of going back home and putting some staff work into this to see what we can come up with ourselves. I do think that it would be helpful to conduct our individual airline staff work, and coordinate that work with NASA, so that the benefits of the work and the findings that we get individually can be made available to the rest of the industry. I think that it might be appropriate if someone would come up with a suggestion as to exactly how to do that, if that is a worthy method of doing things. What do you think, John, do you think there's a way we can get together and come up with recommendations on this?

DR. LAUBER: Yes, I suspect that's possible. We'll have to work out the mechanism by which we do so.

CAPT. FRINK: Can you tell me what you anticipate the role of NASA would be? George Coen mentioned that if we do everything that everyone has suggested, we would have given NASA enough work to do for the next century, and Al Chambers is worried. What did you see as your role on a continuing basis on the subject of resource management? Al, would you like to answer that?

DR. CHAMBERS, NASA: I think that to some degree Charlie is going to address that subject, at least in terms of the items that have been raised here in the last few days. But there may be a couple of areas in which I

think we can provide some help immediately. One is to continue to be a facilitator for activities like this one, which will help keep some momentum going toward really getting good programs instituted.

I think the other may be one where we try and sharpen the tools that we use to measure how effective a particular activity would be, be it a LOFT-type simulation or be it some audiovisual aids or some other type of classroom activity; all of us would like to have a better feeling that those things that we are doing are truly effective. And it may be that we can provide some insight into the effectiveness of those different techniques which then you could use with more confidence in planning your own programs.

I think each airline will, in the end, probably institute a program that is specific to its own needs, its own type of operation. In that case, NASA can perhaps best play a role in giving you some tools to work with.

CAPT. FRINK: I tend to agree with that. We are going to get some help in the form of these proceedings that will make available to all the airlines the thoughts that have been expressed here. We have been made aware of the outside agencies that are ready to assist in the development of programs and in the determination of the effectiveness of different types of programs, and we will be able to utilize that help.

But I think the message that we must grasp at the individual airlines is that, basically, it is our responsibility to use the information that we have received in the last few days, and that we will receive from NASA as a result of this meeting, and develop our programs. And we will continue to communicate through ATA and IATA and their committees as to the effectiveness of our various programs.

CAPT. BEACH: Could I address this to John. From this meeting there will be prepared a digest of all that we have said and done. I would like to see specific items listed there, for instance, American Airlines transactional analysis program, so that we might communicate among ourselves without going up through NASA and back down on the kinds of things specifically that are of interest perhaps to my carrier. I think they can perform a service as a clearing house of information to be made available to us, conveying other points of view we may not have considered. I'd like to see that specifically when the final product comes out of this meeting.

DR. LAUBER: Your use of the word clearinghouse is most appropriate; that's one of the roles we see ourselves playing and that is exactly the intent, to make these proceedings a source book so that others can, for example, learn that Jack Mansfield, of American, has an interpersonal skills training program and go directly to him. We don't intend to be in that path at all.

CAPT. BEACH: Further, I think it might be of value, once we examine our current programs, to get back to you on how we have changed it. In that way we could see the trends that the industry may be taking, what we felt we got from this meeting that influenced us to do it differently from now on.

CAPT. CARROLL: That specifically, I think, came out in our working group deliberations. The point is that although you are going to be a clearing house, John, for collating all this information and dispensing it to us, it shouldn't end there. There should be some timely or periodic contact that you now make with all airlines and you would say, "We gave you this information, we understood you had certain plans for implementation. Please advise us of the progress you have made or the problems you have run into," and you would again disseminate that information. That's how we discussed it.

Otherwise, we would get to the point where we sat and jawboned forever about this and nothing further would be done because of the pressures we are under, the economic considerations we are confronted with, or the work load. I'd like to see a continuing reflection of clearing-house operation.

CAPT. FRINK: That's exactly right. This is what I meant when I asked you, John, about your ongoing intention. This is the sort of thing we have to have.

DR. LAUBER: One of the questions (on the questionnaire) has to do with whether additional workshops of this kind might be an appropriate thing. Of course, that is one way of doing it rather than us going out to the carriers, that is, to bring the carriers in as a group on some recurrent basis to periodically review progress and new problems, new developments, and whatever.

One of the things we'd like some feedback on is how to accomplish that. The workshop approach is only one possible way; there are many other things that might be possible, and your suggestions on how we might best do that would be appreciated.

CAPT. CARROLL: That's always good and I think I'm in favor of continuing a vehicle of this type. But not everyone can avail themselves of this, and we don't want to keep it in one small group. We want to extend it to others, both for their advantage and for feedback.

CAPT. FRINK: I think that workshops like this are outstanding to stimulate the kind of interest we have had in the last few days. Now it behooves us to go back and start getting programs into being. Then we will periodically be in contact with you and work with you, and determine what of United's work, Pan Am's work, American's work, has been effective, and what they have done. We'll be in touch with you in a year. And if we don't get in touch with you directly as individual airlines, then a questionnaire should be sent by you asking what we have done and how effective it has been. The response to that questionnaire from all the airlines would be helpful.

I fully agree that there is a tendency for all of us, regardless of our good intentions, to go back and get locked up in our problems. It's difficult to put some of these things into practice in the manner in which we intend to do so, and some spurs to that would be helpful. Also, I'm sure

everyone here agrees that we can't afford to waste efforts, we can't afford to go the wrong way, we can't afford to go into methods that are not effective.

I intend to study all of this material, and there's going to be some that the expertise in this room has agreed would be a good way to go. That's probably the way we'll start, with the solid, safe, agreed-upon best methods, but then I want to find out what other people are doing and what is effective. Sometimes that's hard to measure. As American Airlines indicated, there is no way that they can directly measure the effectiveness of their interpersonal skills programs. But we are agreed that such programs are good, and that we should let each airline develop it in its own way.

CAPT. CRUMP: I just want to point out that there are not very many aviation psychologists in this country; that's an area of expertise in my experience that is really lacking. The gentlemen that were here, both Bob Helmreich and Lee Bolman, were not aviation psychologists; they were people who work in associated fields. But there is probably as much expertise within NASA in this area as there is in the rest of the country combined, and I think we should focus on that. We're talking about each of us developing our programs. I know how hard it is to find people in that field who are truly expert, to give you the kind of information that you need to measure the program that you're developing.

We can measure it against our expertise and against what other people are doing, but in some cases, it's the blind leading the blind. I would certainly hope that NASA would consider doing some basic research in this whole area of resource management. Maybe I'm harping on that same old thing again, but we don't have a lot of choice when it comes to looking for people who can give us the kind of expert help we need. I think we should do what we can to urge the NASA organization to participate in this way, as well as be a clearing house and the other things we have asked them to do.

MR. COEN: I guess the question is how much time and manpower can NASA put into something like this within their budgetary and manpower restraints without some sort of a charter from industry. Somebody is going to have to mandate this. I don't think they can just go along.

CAPT. FRINK: I agree, it's something we are going to have to talk about. There may be a way of doing that; I don't know exactly what it is. Al, do you have anything to say about that?

DR. CHAMBERS: I'd rather leave that to you and George. It's a very serious problem. I guess it's the reason why we are here trying to listen, to understand what it is that you think is most important, because there are lots of things to work on. They need to be prioritized in some way, some sort of message be passed on to NASA as to the ones that are most urgent. I'm talking about NASA in its formal sense. Headquarters should be told that these are issues that the industry and that our sister agencies feel are

important issues, and that they would like to have NASA take a look at them. But certainly you should help us get the support that we need to, in turn, support you people.

CAPT. FRINK: I was going to call on George Cooper in just a moment anyway because I wanted, before we terminated our discussion this afternoon, to ask George how he feels about the way things have gone. George really is the mentor of this meeting. We have him to thank for the fact that we are here at all, and I want to know whether you are satisfied with your efforts, George?

MR. COOPER, G. E. Cooper Associates: Well, "satisfaction" doesn't express my feelings adequately because from what I have observed this has gone way beyond my greatest expectations. As a matter of fact, we are dealing in an area that's difficult to get a hold on, and if it hadn't been for the direct input that we received from a number of you people in the industry, encouraging us in this direction, why I doubt that I would have had the audacity to propose that we do it. It's a situation of helping you to solve your own problems and, of course, doing whatever we can gives us satisfaction as well.

CAPT. FRINK: Did you have a question?

MR. COOPER: I didn't have a question; I had a statement with respect to how to get the support for what you want NASA to do. It just so happens that right now there's a meeting going on at Goddard of the Aeronautical Research Council of NASA. This year they have reinstituted many of the research technology advisory committees and subcommittees on an ad hoc basis, to treat this very subject of what should NASA be doing. There's been a lot of effort put into it.

One way to get your input into the system, if you have specific recommendations, is through people like J. D. Smith, of United, who is Chairman of the Committee on Operating Systems and Safety. That's one way. Of course, there are other ways, I wouldn't leave it just to that.

CAPT. FRINK: I'm going to just sum this up in a couple of words, and say that in the last three or four days we have learned a lot. We have also learned what we don't know, and what we haven't done, and I think that that's almost as important as the specifics that we have learned. We've gotten a start, and we know where we have to go.

The task that is left to us right now is an extremely important one. We identify an area in need of training, as we have so clearly identified this one, and we have identified how important it is to the safety of our operations. We have identified that the need for training goes right from selection, through the upgrade training and recurrent training, and throughout the airman's career. It's a new factor in flight operations, and it's one that, now that we know it, imposes upon us a very serious responsibility.

The details that we have received here are important. I'm sure we are all going to study them carefully, and that we are going to do something about it. Now, what we have to do is to resolve to follow up and see that something is done, so that this lack is resolved. With that, I'm going to ask John to come up and terminate the proceedings.





## SESSION 4

### CONCLUDING REMARKS

John K. Lauber, Chairman

### SUMMARY OF THE WORKSHOP

Charles E. Billings, M.D.

### CLOSING REMARKS

Capt. A. A. Frink



## CONCLUDING REMARKS

John K. Lauber<sup>\*</sup>

Thank you, Al. And I'd like to thank you and all of the working group chairmen for doing an outstanding job. We gave you a very difficult task, knowingly, but I indicated, too, that we picked our working group chairmen with a great deal of care, and it quite obviously paid off. I think all of you did an outstanding job with what was really a very difficult assignment. As Al and many others around me know, a lot of us had some reservations about how well that process would work. My impression of it at this point is that you people found it useful, and Charlie Billings is about to tell you we found it equally useful. I'd like to have Charlie briefly summarize our view of some of the research issues and priorities that have come up in this workshop, and then we'll close the proceedings.

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## SUMMARY OF WORKSHOP

Charles E. Billings, M.D.\*

Thank you, John. There have been a great many comments made here in what I feel is probably the strongest single set of presentations with the fewest weak spots that I have ever encountered in the 25 years in which I've been going to various conferences. The quality of the presentations has been superb and, obviously, the amount of work that many of you put into them is extraordinary.

John has given me a task that seems as impossible as summarizing the world in 30 minutes. I'm not going to subsume the world. But a number of things have struck me over the last 3 days that I'd like to chat about. Some of them have been alluded to this afternoon in the discussion just completed.

The first is that the three keynote speakers, Bob Helmreich, Lee Bolman, and Mike Garvey worked virtually independently of each other. Yet all of them, in trying to get their hands around this thing as they understood it, given that they did have certain background and briefing materials in common, found it necessary to set up a kind of two-way matrix to try to conceptualize the problem. Bob, who talked first, talked about "instrumentality" or "goal orientation" and sort of suggested, without actually drawing us an x-y grid, that that was kind of orthogonal with "expressivity." "Group orientation," I believe, was his phrase for that.

Lee Bolman actually drew us a little two-by-two diagram in which, on his x-axis, if you will, he put "advocacy," and then almost equated it to "goal orientation." His y-axis was "inquiry."

And then Mike yesterday talked about "production" which he put on his x-axis. That was clear enough. Then he sort of categorized the rest of the world as "people," and put "people" on his y-axis. I don't know whether there's any significance in the fact that all three of these gentlemen, having had training in psychology and in experimental methodology, chose as their independent axis the productivity or production element and put people on the dependent axis. I was a little bit amused by the fact that that was the way it was drawn. I was interested in the fact that none of the speakers in these three days have talked a lot about the productivity element. I'm going to come back to that in a second.

One of the things that I think we ought to consider is that I don't want to, and I hope that you won't, get hung up on the methodology, the 9-1, 1-9 business. It may be the greatest conceptualizing device since sliced bread, but it's nothing more than that. I wondered whether the expressivity or inquiry or people element of these three very effective people who have given this a lot of thought was the same element. Are these the same factor?

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The x-axis appears to be instrumentality, and I think we can safely equate advocacy with productivity. But I'm not quite sure about the ordinate, whether those other three are the same thing. If they are different, I'm not sure whether the differences are semantic or real, and I'm not sure if it makes any difference either, because each of these is only a technique for trying to get your hands around a concept that is anything but easy, as John and his co-workers have found in the last several months.

As I said, we've heard a lot of talk in the group meetings and elsewhere about the social skills, communications skills, etc., and much less about production. And I wonder whether this is simply because we do get the job done pretty well. We get the job done extremely well under most circumstances, but there are still enough bits and pieces of crumpled aluminum floating around to indicate that we don't get it done quite well enough. And we still get enough ASRS reports of accidents that didn't happen because of chance alone to make us feel a little bit queasy about being comfortable with how well we're doing.

One member of this group, not present here at the moment, argued that procedures represent our only effective approach to the productivity side of this box. He argued that we can't expect to change personalities, we can't really modify a great deal the way in which people think, and that, therefore, we have got to do it with procedures. It occurred to me, in thinking about it, that I don't know what proportion of the total anomalies that occur in air carrier operations are those for which we already have procedures, either implicit or explicit, and what proportion of things that occur in line operations are truly unforeseen anomalies. I say unforeseen advisedly because if it had been foreseen somebody would have written a procedure for the thing. It probably isn't indexed in the flight manual, but somebody has written a procedure just the same, because we have a tendency to operate the system this way. The FAA writes rules, we write rules, everybody writes rules.

In Bolman's construct, it's of primary importance to provide people with tools that help them recognize when there's a difference between espoused theory and theory in use: to help them recognize and act on what I'd like to call discord, and to resolve the discord with more information. This business of being able to recognize discord certainly requires social skills because we have got to create an environment in which any crew member or any resource, whether it's on the ground or in the air, is used effectively. Certainly, ASRS has taught us that air traffic controllers under certain circumstances are the most effective recognizers of discord that we have. Just as you people, if you retain a properly suspicious mind, can be excellent recognizers of discord in the ATC system.

Yes, you've got to have social skills to create the environment in which anybody who notices discord can and is expected to announce its presence. But there may be many ways to create that kind of an environment. No one approach to this business is going to work in all carriers, because we have seen the very pronounced differences in management style and allocable

resources. We've heard about some rather distinct differences in allocable resources for this kind of job between some of the European and some of our U.S. carriers.

But of equal importance, no one approach will work for all captains or all crewmembers because they are individually different. Probably there are many more differences among these people whom you have hired and who are working out there than there are among air carriers. The goal here, and I think there is certainly a consensus on this, is to assist aircrewmembers to recognize that discordant situations can exist, to assist them to create an environment that maximizes the likelihood that they will be recognized, and to assist them to create an approach that will permit them to diagnose such discord, to find the reasons why everything doesn't quite add up.

That brings up a number of interesting problems, both in training and on the line. One of them, which has been alluded to this afternoon, is that it is difficult for an individual (painful, even) to recognize the difference between what he thinks he is and what he actually is. Between, if you will, espoused theory and theory in use.

One of the beauties of LOFT is that the captain and the crew get to dig their own hole. But I suspect that when we have gotten into this far enough, one of the most serious problems with LOFT, for those people whose resources for dealing with those kinds of holes are marginal, is going to be helping them out of the hole, helping them to recognize why they fell in the hole in the first place, and helping them to fill in the hole. And all three of those have got to be done. This, to me, places a very considerable burden on the LOFT instructors and on their training. I don't know whether we should call them instructors, observers, or maybe counselors, but I think there are going to be some people, when we've evaluated enough people, that we are going to end up counseling, rather than training or observing.

I think the LOFT observer or instructor or counselor or whatever you want to call him has got to be able to recognize the difference between a crewmember who falls in a hole because of a proficiency problem, and one who falls in a hole because of a psychological problem. Remember, we're not aiming at the top 5 percent of our airline. We don't know any way to help them, you don't know any way to help them, and they don't need the help. "If it ain't broke, don't fix it." We're talking about the bottom 15 or 20 percent. It is important to recognize the difference between a psychological problem and a proficiency problem because the treatment of the two may be very different. Treating the one with things that work best for the other may do more harm than good. That, I think, is a potential problem in this area.

Another one. I suggested that I don't think any one approach is going to work for everyone. The North Central pilots made it very plain that they wanted prescriptions. They were upset about the fact that more prescriptive material wasn't presented in that very excellent approach to this problem. Well, prescriptions may help, but one of the things you learn in medicine is

that all drugs have side effects, that you never get something for nothing, and that nothing is going to work for everybody. And therein lies a very distinct danger in the area of prescriptive remedies.

I think it brings up again the importance of instructors with flexibility, instructors who have not been taken through a cookbook kind of course in how to teach resource management, but instructors who understand what they are talking about, and that there is more than one way of dealing with it.

I don't think it's going to be enormously difficult to elucidate the goals of resource management training. I think that can be done. A great deal of it has been done at this conference, and it will be far easier as a result of this conference. We may even be able to standardize the goals somewhere down the line.

The justification for resource management training is, I think, abundantly clear. The reason I think so, as does John and the rest of us, is because you people have told us. You started telling us in 1974 in our initial pilot interviews, to which John referred. We didn't understand by any means all of what you were telling us, and I'm not sure we understand all of what you were telling us now. But these ideas, what you have seen embodied in this conference, what John, George, Maurie, and Pat Ruffell Smith put together for this, came straight from you people. If it's right, it's right because you told us in an effective way, and if it's wrong, it's your fault too.

So I think we can handle the goals and the justification for resource management training, but then we get to the methodology and that's going to be very much more difficult. And it's going to be difficult because we've got to find approaches that can be sold to managements that have got to buy the concept and then buy the package. And managements are funny when it comes to buying stuff. You know far better than we do what's going to sell to your managers.

As I indicated, there's an enormous difference in management and crew styles across carriers and even within carriers. There are those carriers that have been involved in mergers involving quite dissimilar crew styles. There are very pronounced differences in styles within air crew groups, and I think it's true within domiciles as well within carriers.

Maybe what works for one kind of group is not going to work for another kind of group, and maybe the person who tries to figure it out better have enough flexibility to recognize that in advance. I think that's going to pose some interesting problems for carriers in the process of merging over the next couple of years.

Carriers are going to have differences in resources that can be devoted to the programs, and I think that while some can't buy all of it, they may be able to buy 80 percent of it for a cost of 50 percent of it.



That's one of the areas where I do think more research is needed, but I'm not sure it's the kind of research that NASA can do. It may well be in this instance that half a loaf is a pretty big piece of bread. There are going to be differences in the perception of the training department by flight personnel, differences that are going to influence what the training department can offer in this area and get away with.

There's another problem, I think. It's easy to become captivated by social and interpersonal issues. There's a little bit of the psychiatrist in all of us. We've heard questions here, generally answered in the negative, about whether you can change personality. Trieve suggested to me this morning that that probably is a moot point, that it probably doesn't make a lot of difference whether you can change personality. But one thing we do know, and you people know it very well indeed because it's one of the things you do for a living, you can change behavior. You can change behavior by making it very pleasant to behave one way and very unpleasant to behave in another way. Incentives, positive and negative incentives.

Now, if you can change behavior, and if the desirable or the desired modes of behavior can be taught, and I don't think there's any question that they can be taught, then that becomes the goal of this kind of training for those persons whose behavior is substandard.

Training must take into account the worst case, and resource management training is really no exception. And yet training has got to take the worst case into account without becoming completely deadly for better people. It seems to me that if resource management is going to be of help to a crew somewhere in a bad situation, that the kind of crew that is most going to need that help is going to be the kind that incorporates a relatively inexperienced captain who may not be too sure of himself as a manager and a new first officer and a second officer who are either weak or new or old and infirm or something of that sort, because that's just the way it seems to happen. And it's those people who are most going to need the skills and, therefore, those people whom you must reach most effectively. And you've got to figure out a way to do that without boring everybody else to death.

I think these scenarios need to be designed with this in mind. This is one of the things that worries me about standardized scenarios. I think it's entirely possible that the simulator instructor should have some options with respect to constructing scenarios such that people can go through tribulations and succeed rather than simply fail. Captain Beach talked about this with regard to graded scenarios. Perhaps we should be able to do a certain amount of ad hoc grading on the spot — I'm not sure. I know the current operating permits do not permit us to do that kind of thing. I've got some problems with that. We're paying flight instructors to instruct and take into account individual limitations and capabilities. I think that to tie their hands may be an unwise thing, although I can quite understand the reason why those regulations were written. But I think we may need to do some playing around with that.

And then I think we've got one other problem to think about. I think somewhere out there in that world that you people inhabit, there are going to be a few pilots who can make it as long as we keep making them do the jumping-through-the-hoop routine every six months, but who aren't going to make it if we introduce this training. I think you've got some guys who can fly the airplane, who can fly emergency procedures, who can pass the standard PC, but who may not have the flexibility to take on this kind of a caper. What are you going to do with them? You better know before you get to them. I don't know the answer to that one. I don't think that's a researchable issue. But somebody better do a little pragmatic thinking about it, and I think it would be highly desirable to think about it before the guy shows up on your doorstep, and says, "I just busted this thing, what are you going to do now?"

There are a number of researchable issues in this area. Whether they all need to be researched or not is another question. You people brought most of them up. Validation. We kept hearing about validation, and this morning in two very effective presentations dealing with what I had thought was a totally unmanageable can of worms, you managed to dispose, in really quite elegant prose, of the selection aspect of all of this. We need criteria. It was pointed out very clearly today, but the best way of coming up with them is another issue.

Training, another researchable issue. How do we evaluate the effects of what we're doing? I am still loath to wait 15 years to accumulate sufficient major accident experience within an air carrier so that I can decide whether I've been doing better for that 15 years than the previous 15 years. And then you get an airline like Qantas where you can't do it that way either, because they don't have any accidents. But there's got to be some way. We collect an inordinate amount of data, and I just have the feeling, as was the case with the Apollo program when people started looking at all the bits and pieces of telemetry they had gathered, that there may be some bits and pieces of data that tell us things about how people perform on our airlines. And so I posed the possibility that validation might be possible using data currently available, if we were just a little more ingenious about how we used it.

We've got to evaluate the effects of this training while it's being given. We've got to evaluate the effects of this training on those who have just had it, and we've got to evaluate the effects of this training long after it has been given.

I think we ought to pay some attention to whether LOFT is a method of training or a method of evaluation, or both. I think we've heard about LOFT as an evaluation method, we've heard about LOFT as a training method, everything but LOFT as a selection method — nobody has mentioned that. I'm really somewhat surprised nobody did, because there are certain things that are common to flight across a variety of different kinds of airplanes. As a matter of fact, Bob, am I not correct that you people have been using simulation during your selection process?

CAPT. CRUMP: We also have, instead of a PC, used the LOFT program during the probationary year.

DR. BILLINGS: That would scare me. Methodology, again. A number of areas that may or may not need formal research but which certainly need coordination. If we've heard nothing else we have heard you people loud and clear with respect to that. What works best for whom and why.

Regarding the relation of the selection criteria to the training methods: is it just possible that there are some kinds of people who are selected by the air carriers for whom LOFT is not perhaps the most effective? And the other issue: LOFT with a full crew is enormously expensive. Does it have to be a full crew? Again, I can understand why the FAA restrictions, but somebody's got to grab that by the horns, too. LOFT would be a lot less expensive if we didn't have to have a full crew. Is it conceivable that we don't? I don't think anyone knows at the present moment.

The issue of simulation realism and simulator acceptance was brought up here. I don't doubt that there's any question that for certain crews, those same crews who always know that they are driving a simulator as opposed to getting wrapped up in the thing, this kind of training technique may have some serious shortcomings because it just isn't an airplane for those guys. How do we get around that?

We presently still check pilots, not crews really. Is there perhaps a way of reinforcing the value of resource management training and the resource management approach by making crew integration a specific criterion in checks? Now, I realize that crew coordination is one of the items that is evaluated, but I'm talking about a situation in which the captain's performance is specifically evaluated in terms of how effectively the crew helped him. I wonder if perhaps that might do something to reinforce the value of this training?

Are we training command skills or are we training social skills? That's an issue about which there's been considerable looseness in our thinking and in some of the statements here. I think it's important that we figure out which it is because if we're training command skills, that, I think, certainly militates that we place the training somewhat differently in the career progression, and probably that it have a content somewhat different from the placement and the content if we're training essentially social and communications skills.

And finally we get back to what I think is the most expensive and perhaps the most critical issue, which is why I was most interested in these presentations that indicated that it was being taken in hand first, the training of instructors. What do we train them in? How do we train them? How much training do we give them? How often do we reinforce it? And if you'll forgive me for being a flight surgeon for a minute, how clinical is that training going to be? There's a cost associated with making these guys counselors as well as instructors, but I would ask you whether there may be

a larger cost associated with not giving them a thorough understanding of the dynamics of the training process as it will be when we get heavily into resource management training.

There have been a number of questions asked here about audiovisual methodology, feedback, computer assisted instruction, films and video for orientation and that sort of thing. I think that's got to be looked into and I think one of the other things that somebody is going to have to look into is selling methods, because I think sooner or later we're going to come up against some tough customers when we try to sell this concept.

I haven't answered any of the research issues here and I didn't intend to. We're not being very prescriptive either, because there's no magic in any of what we presented here. I'm sure Lee, Bob, and Mike would be the first to say so. Whatever gets the job done, whatever gives you a construct that you can wrap yourself around and assimilate, is probably an effective concept for getting into this area.

Now, with regard to NASA's roles, I have said to my colleague sitting over here on my right looking very serious at this point, that we have gotten more mileage out of resource management with less research than any other project NASA has ever done. That's not perhaps totally fair because George and Maurie and Pat Ruffell Smith have, in fact, done some research. Miles Murphy has been working with John looking at the NASA ASRS data. We have done research of a type, but it certainly is a far piece from the kind of research that NASA is ordinarily accused of doing. Nor, with limited resources, are we capable of devoting all of our resources to research, and a large part of our resources to facilitation, and acting as a catalyst, as we hope we have done in this conference.

We have to be very careful about this because people have a way of asking us in some of these areas for recommendations, and when we give recommendations based on consensus instead of data, we're on very, very soft turf. It's a problem that is going to lead to some frustration for you people as you come and chat with us and ask us about things, things about which we do not have data. Recommendations without research can be pretty hollow recommendations.

It is not impossible, however, for coordinated programs in which you do the research, and we try to help design it, and evaluate it and interpret it. It is not at all impossible that some of the programs that you are already doing or planning, if planned or done just a little bit differently, would result in a better yield of data which could be useful not only to you but to other people. And we have some people who know quite a lot about experimental design and are really quite capable of living within the constraints of the real world.

So I think one of the reasons for coordination is to try to get maximum use out of the data that you and you and you may be collecting if you decide to stick your foot in this particular swimming pool. That is probably a

better reason for coordination than any other. I think that may well represent in this area the major service that NASA can perform in the long run, that of helping to act as a central point for information and of helping you to maximize the effectiveness of the experiments you're doing. We are doing this in a different area of training at the present moment, thanks to Al and his colleagues on the ATA training committee. We are trying to help a carrier do a piece of research that it wants, that we want, and that all of us feel should be done, to evaluate the data, to interpret them. I think that perhaps has some real promise in this area of resource management, where a number of different approaches may be found to be about equally effective. I think that really is about what I think I've been hearing here the last three days.

Once again, we are enormously grateful to all of you for the time, because you all had other things to do, for your attention and for your input which has been enormously helpful to us. I have learned a very great deal here and I'm grateful for that.

## CLOSING REMARKS

Capt. A. A. Frink\*

Before John closes the proceedings, which is next on his list, I believe, I want on behalf of all of the representatives of industry here, to thank you — Al, John, Charlie, George, Maurie, Trieve — and all the rest of the NASA group that has tackled a very, very difficult problem in a way that is not the usual way, as Charlie indicated, that they like to do things. But they have done us a tremendous service and I think that on behalf of the industry we should give them a very rousing vote of thanks.

I also want to say that one of them could not be here, Pat Ruffell Smith, who contributed heavily to the development of this program. Pat is seriously ill and we certainly want to include Pat in our thoughts.

DR. LAUBER: Thank you, Al. There are a great number of people who made inputs, a lot of valuable inputs, into this program, about which I think we heard some reasonably good and positive feedback on. All of the speakers were super. The working group chairmen did superbly, and Al Frink, as the industry chairman, as you have just seen, gave an excellent performance in that capacity. Louise Cooper and Miriam White did a superb job too with the wives' program and we should appreciate their efforts in that regard.

A lot of NASA people have put a lot of effort into this, as Al just said. All of the NASA assistants were not just assistants during the 3 days of this workshop; rather, they have been involved very closely with the program for a long period of time, and have made substantial contributions. For example, I notice that in the working group reports this morning, Miles Murphy's breakdown of the categories of skills and behaviors involved was used quite frequently. And that's an indication of just one of the things that a lot of people have done.

Trieve Tanner was responsible in large part for getting Lee Bolman and Bob Helmreich on the program and coordinating with them. I've heard some very positive comments about those papers and I think that in large part the success of those was because of Trieve's working with them. And, of course, Maurie and George — Al was not exaggerating when he said George is truly the mentor of this workshop, truly in all senses of the word. And, of course, Pat Ruffell Smith, who, as Al just indicated, was unable to be with us because of serious illness.

George had a cable this morning from England saying, "Best wishes for a happy and productive workshop." I think all of us are going to be able to relay to Pat that we have, in fact, had a happy and productive workshop. I'm sure if any of you want to convey that message to Pat, it would be greatly appreciated.

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\*Pan American World Airways.

One final challenge before we close. My dissertation advisor rarely said anything that I agreed with, but one of the things that he did say was that an idea, if good, is probably not very new, and if it's new, it's probably not very good. I said it the other way around, but the concept is the same. Len Holdstock handed me a paper earlier today which he said you might find interesting. It's titled "Crew Management, a Captain's Viewpoint." It goes on to say that an accepted truism is that management and leadership go hand in hand. It's been so in some of our outstanding crews, good crews, and only some fair ones. Although it may never have been so stated, this variation in crews is directly related to the qualities of leadership displayed by the captain. Leadership that produces success is reflected by the crew to the passengers and not only enhances the image of the crew but also more strongly that of the airline the passengers have selected to use.

And it goes on to talk about some of the characteristics expected from a good captain, including consideration to each individual crewmember as a mature professional, honest, just and fair treatment, loyalty, to be kept oriented and in the loop when decisions may involve an emergency, and so on and so forth. Sound like familiar words. The paper that Len gave to me was a little bit yellowed and frayed. He said he found it in the bottom of a drawer, and probably it was on the order of 10 years old. And I was just wondering if, when we meet in 1989, we're going to be talking about the same concepts or if we will have made some progress. That, of course, is the challenge that Al made to all of us.

Thank you all very much. The proceedings are closed.

## APPENDIX A

### WORKSHOP PARTICIPANTS

Joan Barriage	FAA
Capt. Berton E. Beach	Eastern Airlines
Charles E. Billings, M.D.	Ames Research Center
R. L. Bisbee	American Airlines
Lee Bolman	Harvard University
Capt. Gordon Born	Republic Airlines
Capt. M. G. Bridge	Cathay Pacific Airways
Les Brown	Singer-Link
Major Joe Burch	USAF
Capt. J. E. Carroll	United Airlines
Carl H. Castore	USAF
Alan B. Chambers	Ames Research Center
George T. Coen	FAA
George E. Cooper	G. E. Cooper Associates
Capt. Sherman Cornell	Republic Airlines
John M. Costley	KLM Royal Dutch Airlines
Capt. Robert Crump	United Airlines
Renwick E. Curry, Jr.	Ames Research Center
James W. Danaher	National Transportation Safety Board
Duncan Dieterly	USAF
Peter B. Dupret	Air Transport Association
F/O Jon Ertzgaard	Scandinavian Air Lines System
Capt. W. W. Estridge	American Airlines
Edgar C. Fell	FAA
Capt. Stanley Fickes	Allegheny Airlines
Capt. Gramer Foster	Republic Airlines
Clay Foushee	U. of Texas
E. V. Fretwell	ALPA International
Capt. A. A. Frink	Pan American World Airways
Capt. Charles Fristoe	United Airlines
Michael C. Garvey	Michael C. Garvey and Assoc.
Richard Gerszeuski	FAA
William C. Gilbert	Texas International Airlines
Capt. Rod Gilstrap	United Airlines
James Grewe	United Airlines
Capt. Nik Grob	Swissair
Robert Helmreich	U. of Texas
Capt. M. R. Hoagland	United Airlines
Capt. L. F. J. Holdstock	British Airways
R. C. Houston	American Airlines
James L. Jacobson	The Boeing Company
Capt. Tor Johannessen	Scandinavian Airlines System
Capt. Noel Jones	Cathay Pacific Airways
Peter Kearvell	IATA



John K. Lauber  
 Robert R. McEmber  
 J. L. Mansfield  
 Capt. Katsuyuki Maruyama  
 Miles Murphy  
 Capt. H. Nagano  
 Carl A. Peden  
 Capt. John Perkinson  
 Robert J. Randle, Jr.  
 Thomas H. Rockwell  
 Major Jeffrey E. Schofield  
 Capt. J. V. Sclifo  
 Capt. S. R. K. Seaver  
 Capt. Ronald M. Sessa  
 Capt. Wally Simons  
 Robert Smith  
 Amos A. Spady, Jr.  
 Trieve Tanner  
 Capt. W. H. Traub  
 Capt. Dwain Turlington  
 Capt. Vern Wastman  
 John D. Wells  
 Lawson White  
 Maurice D. White  
 G. E. Wilson  
 Col. Al Worden

Ames Research Center  
 Eastern Airlines  
 American Airlines  
 Japan Airlines Co., Ltd.  
 Ames Research Center  
 Japan Airlines Co.  
 McDonnell Douglas Aircraft Co.  
 United Airlines  
 Ames Research Center  
 Ohio State Univ.  
 Ohio State Univ.  
 Texas International Airlines  
 Qantas Airways  
 Allegheny Airlines  
 Pan American World Airways  
 United Airlines  
 Langley Research Center  
 Ames Research Center  
 United Airlines  
 Pan American World Airways  
 Flying Tiger Line  
 Lockheed-California Co.  
 IATA  
 G. E. Cooper Associates  
 United Airlines — ALPA  
 Al Worden, Inc.

## APPENDIX B

### SUPPLEMENTARY WORKING PAPERS

Initial Upgrading from Copilot to Captain

Capt. G. Grünewald, Swissair

Training — Economic and Safety Considerations

Capt. R. E. Norman, Jr., Airline Pilots Association

Calculated Risk or Blind Assumption?

Gerard M. Bruggink, National Transportation Safety Board

Managing Emergencies in Jet Transport Operations

Gerard M. Bruggink, National Transportation Safety Board



INITIAL UPGRADING FROM COPILOT TO CAPTAIN  
(Prepared by Capt. G. Grünewald, SWISSAIR)

Zurich, June 1979

## INITIAL UPGRADING, PART I

### INTRODUCTION

The step from Copilot to Captain can certainly be described as one of the most significant achievements in the professional life of a civil aviation pilot. Not only the greater demands but also the emotional state associated with the Initial Upgrading give the training course for future Captains a meaning, which in the individual phases can have even a detrimental effect on the performance of the course participant.

The aim of this paper is on the one hand to describe the course structure and on the other hand to go into the various related problems, such as method, failure rate, complaints, efficient preparation for the upgrading, etc.. In the third part, some envisaged future programme changes will be briefly described.

### TRAINING OBJECTIVES

The training objectives are established in accordance with the Standards of Performance, which clearly define the flying capabilities, knowledge and personality of a Captain.

### COURSE STRUCTURE

The Initial Upgrading is divided into two main parts, namely the so-called Captain's Course (CC) and Upgrading (UP). The CC falls within the responsibilities of the Training Department, whereas the UP lies in the hands of Line Operations.

In Autumn 1973, the concept of the training of future Captains was defined anew, mainly with the intention of compensating for the reduced training of long distance pilots by means of an extended course structure. The most important difference, as compared with earlier courses, lies in the fact that a Copilot ex B-747, DC-10 and DC-8 is trained as Copilot on the DC-9, goes through an approximate 2-month introduction into the characteristics of the short distance route operation and only then, after this introduction phase, does the actual training as PiC take place.

The basic features of the individual phases from CC and UP are described as follows:

#### CAPTAINS COURSE

Theory "Flight Procedures"  
(1 day / 6 hours)

Explanation of flight procedures, mainly with regard to T/O, APP with abnormal configuration, CAT II.

Simulator (pre-flight)  
(5 days / approx. 9 hours sticktime)

Familiarisation with the left seat and the resulting new duties. Discussion and practice of all abnormal flight procedures.

In flight training  
(3 days / 4-5 hours)

As the trainee is already acquainted with the a/c, the emphasis in this part of the course is laid on carrying out VMC work and IMC approaches with abnormal configurations.

Simulator (post-flight)  
(3 days / approx. 10 hours  
crew time)

The objective of these 3 days is to give the future Captain the opportunity to fly the DC-9 in conditions which cannot, or at least not realistically, be achieved in the a/c (e.g. hydraulic failure, electrical failure, etc.).

Here the emphasis is on the systematic work organisation, clear and precise actions and consistent supervision of the assisting pilot; in short, in the sphere of flight management in its broadest sense.

Performance throughout the last eight days (whenever possible under the same flight instructor) determines the CC qualification. In this qualification, in addition to performance, the progress must also be assessed. Apart from the final result, which is of course of vital significance, it must be seen how this was achieved.

Should the final qualification be "Not Qualified", the UP cannot be started.

After the pure flying part, the so-called Captain's Theory Course now begins. The first phase of this course lasts 5 days (approx. 34 hours) and the following subjects are dealt with:

- Organisation SWISSAIR;  
Orientation Finance & Partnerships;  
Orientation Product Planning & Marketing;  
Orientation Branch Offices Abroad, Customer Service  
and the PiC, Problems of the Station Manager abroad;  
Noise Abatement Zurich Airport.
  
- Organisation and work distribution within Flight  
Operations;  
Operations Planning;  
Flight Area Manager Europe;  
Technical & Maintenance Department, Orientation  
and Inspection Maintenance Control;  
Station Zurich, Orientation and Inspection.
  
- Movement Control, Inspection, Cooperation with  
the PiC;  
Dispatch Zurich; Crew Planning and Control,  
Organisation, Problems, Cooperation;  
Medical Department:  
Catering Service, Orientation and Inspection.
  
- The Work of the Cabin Crews;  
Position and Responsibility of the PiC, Cooperation  
with the PiC;  
ATC, Orientation and Inspection, Discussion;  
Security, Orientation and Discussion.
  
- The Fears of the Passenger;  
The good Public Address;  
Speech Training.

Following this first part of the Theory Course, the  
actual training in line operation begins. Under the



guidance of the Route Instructor, that which has been learned in flight and theoretical training is put into practice. At the same time, the new elements of operational problems must be assimilated.

Route Training is divided into three phases: Instruction, Consolidation and Proficiency, with a total duration of 120 - 150 hours. The objective of the three phases is selfexplanatory. After 70 hours, the Route Instructor no longer sits in the RH seat, the Captain-to-be works with the Copilot in a normal working capacity.

In the last part of the UP comes the second phase of the Theory Course. This lasts three days and usually takes place in the seclusion of the Training Centre for Swissair Management. The course deals mainly with the subjects "The PiC as boss" and "The conduct of the PiC in specific situations". The emphasis in this course is therefore laid on the managerial duties of the PiC.

Upon successful completion of the Route Training comes the appointment as Captain.

## INITIAL UPGRADING, PART II

This part is limited to the various problem areas related to the structure and implementation of the Captain's Courses.

### ARE THE DEMANDS TOO HIGH ?

Again and again the whole course, or certain phases of the programme, are thought to be unrealistic or generally too difficult, whereby the frequently cited "problem free line operation" is used as criterion. Taken point by point this may be the case. However, bearing in mind the training objective, which should not consist purely of assimilating knowledge and skills but should consider the training of correct behaviour, we must so devise our programmes that this behaviour or conduct can be taught, practised and examined. Apart from the purely specialist training, the course must be planned so as to make possible the development of those personal qualities which enable the Captain to carry out his duties calmly and decisively.

The Initial Upgrading programme valid at present can be considered integrated and well balanced as regards both degree of difficulty and duration. Not without satisfaction, perhaps even with a certain feeling of relief, we discover that our opinion is confirmed by the majority of course participants.

### TOO MUCH STRESS ?

Many Captains-to-be enter into a conflict of rôles, especially at the start of their training, resulting in

psychic difficulties. The aspirant gets into a situation in the course where mental powers of resistance are required of him. With the mobilisation of these powers, so much energy is burned up that, where flying is concerned, a frequent drop in performance is noted.

Stress situations in CC are basically unavoidable, although varying in extent from person to person. The mastering of the various situations of routine flying demands also later a certain resistance, which simply belongs to the pilot's profession.

We do not attempt to artificially produce any stress anywhere. We know that the task faced by a PiC aspirant holds sufficient stress situations in itself. We can do without vexations, tricks or special effects.

#### TOO MANY TESTS, TOO LITTLE TRAINING ?

This accusation, which always crops up, is probably as old as flight training itself. In the CC it applies to the fact that certain knowledge and skills are expected of the aspirant, e.g. aerodynamic basic knowledge or the ability to fly a normal VMC circuit. These requirements, however, are usually too little defined and are therefore for the participants not clearly recognisable. In this area there are still possibilities for improvement, which we want to realise as soon as possible.

All that which is "new ground" for the future Captains is taught during the course and can also be practised. A CC without mistakes is Utopia, apart from the fact

that in a learning process mistakes are necessary, even desirable.

The limits set for the required performance, instruction and examination will always remain somewhat indistinct, particularly in the CC, for it cannot be ignored that the CC also has a last say in the selection. Copilots who have had more than sufficient opportunity to prepare themselves for this duty, yet who are unable to cope with the demands made upon them, have obviously not developed sufficiently enough the qualities necessary.

Seen purely statistically, there will always be such isolated cases and it would therefore be wrong to completely eliminate the filter effect of such an "initiation". If the CC were to contain absolutely no examination means anymore, one would have to reckon with unsuitable captains being appointed occasionally, despite the high quality of the selection methods and the basic training.

#### FAILURE RATES

The failure rate in the past was relatively high, between 17 % and 35 % yearly, whereas from 1976 onwards the failure rate has remained at approximately 15 %.

The degree of difficulty of a course - and thereby one's own chance of success - is often measured by the failure rate. To point out that every aspect should be taken into consideration does not have much effect. As high failure rates can have really undesirable psychological consequences on performance abilities and because they are unpleasant, not just for those

directly concerned but also for Swissair (for human and economical reasons), it was important to probe into the deeper lying reasons for these failures. Were the stress and performance demands too high?

An investigation into the matter revealed that most failure cases involved two special areas: the participant either could not cope with the stress resulting from his duties or he lacked the mental flexibility necessary to carry out the various tasks.

#### HOW CAN ONE PREPARE ONESELF ?

To prepare himself, a person has to know exactly what is expected of him, i.e. the learning objectives must be determined as clearly as possible. Furthermore, those areas which always present difficulties should be known, so that preparation can be optimised by means of objective measures.

For the past three years, all Captains-to-be have been informed some time prior to beginning the course as to course structure, learning objectives and suggestions as to effective preparation. The content of this informative day programme will presently be examined with regard to its suitability and the experiences of the last three years will be evaluated. Finally, from time to time we shall indicate to our line Captains how essential it is for the best possible intensive and initiative cooperation in the cockpit to motivate Copilots, by means of continual educational work, towards self education. Copilots should already think as Captains before they do a Captain's Course and the Captains should make this possible for them. A Copilot should prepare himself with each flight for his career

as Captain. Should he have too little support in this respect he could, during a longer period of time as Copilot, be in danger of deterioration as far as his level of performance is concerned.

### INITIAL UPGRADING, PART III

The training towards becoming a Captain, who bears the responsibility for the passengers entrusted to him, for the crew, for the aircraft and, last but not least, also for the reputation of his company, cannot consist, even in the future, only of supplying knowledge and skills but rather the education towards and appropriation of behaviour and attitudes. The training of the Captain as manager will be intensified, the personality training must be brought somewhat more into the foreground. Also cognitions in the wider field of so-called "human factors" must be increased and must enter into our programmes more systematically. Finally, the constantly changing environment, with its varying kinds of repercussions on the rôle and demands of a Captain will be observed carefully so that any important changes can be recognised and brought into the training programme in time.

## TRAINING - ECONOMIC AND SAFETY CONSIDERATIONS

by

Captain R. E. Norman, Jr.  
Chairman, Pilot Training Committee  
Air Line Pilots Association

Continued development of flight simulators and visual systems is a key factor in the solution to many safety problems and to the economic health of the air carrier industry. The use of flight simulators has made it possible to attain a near-zero training accident rate in the past several years compared to the high loss of lives and aircraft during earlier years of the jet age when most training was accomplished in aircraft. However, recent aircraft accidents have occurred during increased pilot training in the aircraft due to the expansion of the number of pilots and the lack of available simulator time, which highlights the current value of simulator training. Flight simulators can provide valuable and realistic training for pilots to cope with or avoid the circumstances that continue to cause accidents in airline operations. The consequences of any fatal accident, in these times, can result in an economic disaster for any air carrier. The fact that many air carriers, as well as simulator and aircraft manufacturers, are expending considerable funds on new visual simulators and training studies verifies our observation that: Safety and economic considerations can complement one another and satisfy the air carrier operational requirements and ensure their economic survival.

Fuel savings resulting from the use of simulators are also significant. For example, it is estimated that present aircraft proficiency checks for Part 121 carriers will save more than 100 million gallons of fuel annually through the use of flight simulators. For all types of training, it has been estimated<sup>1/</sup> that more than 200 million gallons of fuel are saved each year. Along with the benefits of fuel savings, other expenses associated with aircraft operation are reduced. These include aircraft maintenance and depreciation, airport charges, and aircraft and personnel scheduling expenses. Aircraft should be kept on the line producing revenue, not flying around with an empty cabin.

We estimate that more than 100 visual attachments have been purchased by the industry in the past three years. Advancements in digital computers make it technically possible to perform all flight training in visual flight simulators. Development of the Computer-Generated-Image (CGI) visual systems has made it possible to provide an acceptable and highly reliable visual scene for takeoff and landing maneuvers. In our estimation, the goal of total simulation is well within the technical capability which exists today. With all of this computer technology and hardware available, why then are we waiting for simulators to become a total substitute for aircraft training?

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<sup>1/</sup> "Flight Simulators Impact on U.S. Airlines", by D. C. Killian, American Airlines, Aviation Magazine, January 1979, page 31 - 33.



The answer is simple. Criteria for simulator approval have not kept up with the rapid technical advancements which have occurred in simulator technology over the past several years, and only recently have the human factor aspects of design and use in approved training programs been considered in simulator design.

#### TECHNICAL CONSIDERATIONS

The ALPA Pilot Training Committee's interest in flight simulators and approval procedures extends back many years. During this time, the Committee has recommended on many occasions that:

- (1) Industry and government proceed with a comprehensive evaluation of existing training methods and criteria used for the design, approval and use of flight simulators.
- (2) Technical criteria should be developed for certification of a flight simulator. The goal of this certification process would be a simulator with performance representative of the airplane's aerodynamic responses and handling qualities under stated atmospheric conditions. With the achievement of this goal, flight simulators could be utilized in lieu of the airplane for formal training and checking maneuvers.

Research and development funds available in 1970 for flight simulation studies were not used because of opposition by a few people in government and industry. The problems of developing human factors and technical data for approval of total simulation must now be solved primarily by air carriers, pilots and simulator manufacturers. Government approval of total simulation must be based on "hard data" rather than the subjective judgment methods that have proved to be inadequate in the past. The recent FAA approval of simulators for the landing maneuver by two air carriers has shown the value of good data and is another step toward total simulation.

Development of airplane performance data for programming simulators, especially for older airplanes, will require some flight testing with instrumented airplanes. Areas where more aircraft data is needed include the influences of ground effect on performance and handling, flare characteristics, stopping and directional control forces and rates on contaminated runways, and effects of wind and precipitation on aircraft performance. Reduction of flight test data to computer programs depends on more quality information to eliminate unknown factors that influence the complex interrelated aerodynamic characteristics of jet aircraft.

#### HUMAN FACTORS

Human factors analysis in the computer programming of flight simulators may prove to be the most difficult part of total simulation. Developments in human factors analysis also have a potential to produce the greatest long-

term benefits in the design of training programs, operating philosophies and economic efficiency in training programs.

Some of the important human factors areas that must be considered in development of total simulation include:

- (1) Analysis of the visual cues necessary for a pilot to consistently land an airplane under normal and adverse weather conditions. New methods of training may be needed to overcome some of the limitations of visual systems.
- (2) The effects and necessity for simulator motion during various flight maneuvers and in particular for landings.
- (3) Methods of programming and development of training exercises for the circumstances that are likely to cause accidents such as turbulence, wind shear, low visibility approaches, visual illusions, etc.
- (4) The coordinated crew concepts of operating aircraft with more emphasis on the real world problems of airline operation. A careful and thorough analysis of air carrier accidents over the past several years will reveal those areas where improvement is required in providing aircrews with a sound basis for coordinating their flight deck activities.
- (5) Reevaluation of check-oriented controlling regulations to permit more training emphasis on methods of handling or avoiding the circumstances that cause accidents.

Early and easy solutions to the above problems would appear to be difficult; however, we believe research already completed and projects in progress can provide much of the necessary information. We detect a renewed spirit of cooperation and a sense of urgency within the industry in the development of safety and training programs. We have actively participated in and reviewed a number of industry projects that have or will eventually influence the structure of pilot training programs and flight simulator approval processes. Some of the projects most important to training are:

- (1) Safety awareness programs.
- (2) Low visibility approach studies.
- (3) Human factors studies.
- (4) Renewed interest in visual illusions.
- (5) Simulation studies of wind shear.
- (6) Operationally oriented proficiency training programs.
- (7) FAA exemption to requalify pilots in flight simulators.
- (8) FAA approval of simulators for takeoffs and landings in visual simulators.
- (9) Persistent efforts by pilots and air carriers to revise and update controlling regulations.

Dissemination of timely and useful information from the above and other studies is a recognized problem. Publication of the results of low visibility simulator studies has long been delayed because of opposition to the probable conclusions. Information from wind shear accidents is finally being developed for inclusion in training programs. Other problems of instrument failures, turbulence encounters and unusual weather conditions during approaches are being considered by some carriers for inclusion in training programs. Since many of these training exercises are not adaptable to checking, there is controversy over the value as well as the methods of providing realistic simulator training in these areas. Programming a training exercise that may result in loss of control is one method where a pilot can learn to recognize and possibly avoid an impending disaster. "Negative training" is the usual comment from those who oppose investigation of human factors in training and they seldom have constructive alternative proposals.

We are convinced that new methods of training will evolve from human factors studies completed and already in progress. One air carrier has been granted a waiver to conduct an "operationally oriented" proficiency training program rather than using the Appendix F requirements. Short segment real world situations are programmed with realistic abnormal and emergency situations inserted for the crew to solve in real time. Pilots are enthusiastic about this line-oriented crew concept of training. The trend of recurrent training and checking will definitely follow a similar concept. We believe line-oriented crew coordinated concepts will eventually be adopted by most of the industry. Attachment 1 provides a brief outline of what we think would be a large step forward in recurrent crew training programs.

#### FUTURE TREND

The future of pilot training programs depends on the adoption of new philosophies and the technical expertise of an air carrier's training and technical staff. With the newer developments in simulators and visual systems, we are not referring to the usual "big airline" staff of many engineers and technicians. Simulator manufacturers can provide relatively well developed and reliable machines that can be maintained by a minimum technical staff. The important consideration is the long-range economic advantage plus the fact that visual simulators provide the only logical method of accomplishing training exercises in the areas that historically have caused accidents.

Since certain air carriers (others are expected to follow) have received approval of their simulators for the landing maneuver and additional use of approved simulators will be made as we approach total simulation, simulator time is becoming very valuable. Better planning for the use of simulator time will be required since there is a shortage of approved simulators.

Various pilot groups have indicated considerable interest in flight simulation, visual systems and human factors studies. We recommend that all pilot groups participate with their companies in the development of more productive training programs. Whether it be revised recurrent

training, new simulators or a total simulation program, we believe pilot interest and support will be welcomed by most air carriers. In these times, training funds must be used in a productive manner so that the ultimate goal of safety and efficiency in everyday line operations can be achieved.

## ATTACHMENT 1

In 1974, a survey of our most experienced safety and training representatives indicated overwhelming agreement on the necessity to revise required recurrent proficiency training and checking. Recurrent training was proposed on an annual basis for all pilots as a fuel saving measure and as a solution to several safety problems. During the intervening two years, additional information has developed that supports the need to consider improved recurrent air crew training. Air carriers, pilots and others have recommended that recurrent and other programs be revised to reflect a line-oriented and crew coordinated concept of training.

We propose the following briefly stated outline as an improved method of conducting recurrent training for flight deck air crews:

- (1) Recurrent pilot training should be conducted on an annual basis in an approved flight simulator.
- (2) Flight simulator training should include a review of instrument approaches and selected abnormal and emergency procedures.
- (3) The training will be designed to realistic line operational concepts with emphasis on crew coordination.
- (4) Training may include selected weather, wind shear, turbulence and unusual approach conditions or other circumstances that are likely to cause accidents.
- (5) Annual training for flight deck crew members should include appropriate review of aircraft systems, aircraft performance and emergency procedures, including ditching if over water.
- (6) Annual training for flight deck crew should include a review of recent or recurring problems for the aircraft type and additions or revisions to the navigation and instrument equipment or air traffic control procedures.

We estimate that the above procedure would require approximately six hours of ground training and four hours of flight simulator training.

Several simulator sequences are recommended and would be revised and approved on an annual basis.

The preceding briefly stated outline provides more training for air crews than is now required by the regulations. The training would be more useful than the present stereotyped check requirements. Training equipment would be better utilized and scheduling of flight crews for training would be simplified and more efficient.

## CALCULATED RISK OR BLIND ASSUMPTION? \*

by  
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Bureau of Accident Investigation  
National Transportation Safety Board  
Washington, D.C. 20594

In May, 1952, the U.S. President's Airport Commission, chaired by James H. Doolittle, defined calculated risk as "A willingness to embark deliberately on a course of action which offers prospective rewards outweighing its estimated dangers". There can be no doubt that this definition reflected the attitude of pilots like Doolittle who contributed so much to the development of aviation into a public transportation system. However, when we look at some of the accidents in recent years it appears that the art of risk-taking is slowly becoming a lost art. That is the only conclusion one can draw from mishaps that could have been prevented by using only a modest degree of skepticism in estimating the danger of a particular course of action or inaction.

Our affliction could be the ironic consequence of operating in a system that achieved a high degree of reliability by reducing dependence on individual decision-making - including risk assessment - through a proliferation of managerial controls, regulations, and computer inputs. Actually, in the process of eliminating some of the traditional human factors problems we may have created a new one: the inability to sense when "the systems" protective mantle no longer covers us. The safety publication of a major U.S. carrier identified a similar problem when it referred to "a highly structured operational environment which invites follow-the-leader complacency and discourages departure from routine." We can go one step further and make the blunt observation that we operate in a climate that is more conducive to the development of blind faith than risk awareness.

## THE ACCIDENT RECORD

Elements of inadequate risk perception can be found in almost every accident and at all levels of the aviation industry. Unfortunately, that stage-setting aspect of an accident sequence is seldom discussed in unambiguous terms in accident reports because the underlying reasons may be too elusive or too embarrassing for analytical treatment. This frustrating limitation

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\* Presented at the Orient Airlines Association Flight Safety Seminar, Manila, 9-11 May, 1979.

of our accident investigations is eloquently summarized in the introduction to a NASA study \* dealing with human factors in aircraft operations. After referring to our lack of understanding of the error mechanism involving well-trained professionals at critical points in flight the authors state: "Neither do we understand, except in isolated cases, the factors which may be responsible for (the crew's) failure to recognize and react to presumably clear warnings, or to intervene under circumstances which seem to clearly require such intervention".

The universality of this problem can best be illustrated by briefly reviewing the risk-management aspects of some recent accidents. The headings of these summaries refer to the segment of aviation commonly associated with the identified risks. This treatment of these accidents is used for accident prevention purposes only; there is no intent to imply culpability or to question the official cause determination of these accidents.

### Operator

About four years ago, a jet transport collided with rising terrain as the aircraft descended below safe altitude due to the crew's incorrect identification of their position with regard to the airport. There were no survivors. The investigative authority attributed the premature descent to "dependence on Doppler and weather radar systems on board the aircraft which left room for misinterpretation".

This was the only aircraft in the operator's fleet with off-standard cockpit instrumentation. The Doppler computer indicator and the computer system were not of the same make. As a result, only the 100-miles indication on the distance-to-go presentation was correct; the positions of the ten and one miles indicator disks were "more or less arbitrary". The operations manual had the following remark under the illustration of the computer indicator: "Distance-to-go not Active". The investigative authority was of the opinion that it would have been more appropriate to mask this indicator "so that the chances of crew misinterpretation would have been completely eliminated". That the crew relied on the distance-to-go counter was strongly suggested by their reports of being "one three zero miles out" and "one four miles out". The aircraft struck a mountain 40 miles from the airport, at 4300 ft msl.

The weather radar system was also off-standard in that the range markings differed from those used in the operator's other aircraft. This difference was not explained in the operations manual. The investigative authority concluded that the crew could have received misleading information if they were using the terrain mapping features of the weather radar to cross check their position

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\* NASA TMX-62,472.

with regard to the airport (located near a coastline).

What do these cases have to do with risk awareness? The answer to this question is governed by our understanding of one of the fundamental concepts in accident prevention: always try to make it easier for the other person - and ourselves - not to make an error. This requires imagination and awareness of what goes on on the dark side of human behavior. We are creatures of habit with a built-in tendency to rely on what seems to conform with past experience. Therefore, the assumption that a cautionary note about a non-standard piece of equipment will protect a crew from reverting to ingrained habits in a high workload situation must be viewed with suspicion.

### Air Traffic Control

In November, 1975, two wide-bodied jets were on the same jet route and approaching each other head-on, at night, at a closing speed of 863 knots; one was maintaining flight level 350, the other was climbing through FL 350 to FL 370. The radar controller, who had full data blocks available, realized that a potential conflict existed but expected that the climbing aircraft would reach FL 370 before passing the other flight. According to the official accident report he "assumed that, by keeping an eye on the situation, he would be able to take timely steps if the anticipated separation did not materialize".

When this controller relied on automation technology rather than on positive steps to insure separation, the safety of the 306 persons aboard the two flights was governed solely by his continuing awareness of the developments on his radar scope. This presumed safeguard failed when he allowed secondary duties to interfere with his observation of the clearly displayed conflict.

A last-second warning from another controller, the alertness of the captain of the climbing aircraft, and his vigorous evasive maneuver kept the aircraft separated by no more than 100 feet.

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This case is a classic illustration of one of the cardinal sins in aviation: UNCRITICAL ACCEPTANCE OF UNJUSTIFIABLE ASSUMPTIONS. This is the type of assumption that can easily be avoided by a slight exercise of the imagination in the form of a question: "What are the consequences if my assumption is false?"

### Manufacturer and Administration

In late 1974, the crew of a jet transport initiated a take-off with the leading edge (LE) flaps retracted because the pneumatic system which operates them had not been turned on. The aircraft became airborne in a partially stalled condition and settled back to the ground, beyond the runway. There was a post-



crash fire; 67% of the occupants survived.

Two years earlier, another operator of the same type aircraft experienced an incident involving a take-off with the LE flaps partially retracted. Realizing the significance of this incident as a potential accident cause, the operator alerted the manufacturer and the certificating authority. In conjunction with the manufacturer the operator modified his own aircraft by including the LE flap position in the take-off configuration aural warning system. No further action was taken because the certificating authority and manufacturer considered the occurrence an isolated incident that could have been prevented by adherence to existing cockpit procedures.

It should be noted that, at the time, the incorrect positioning of the LE flaps was indicated by the absence of a green light. The adequacy of a warning system that relies on the absence of a stimulus needs no comment within the context of this seminar. What should be stressed is the fact that the existence of the modification, proposed and adopted by the operator who experienced the first reported incident, was not officially mentioned to other operators of the same type aircraft. Furthermore, following that incident there occurred eight known, similar incidents which, for one reason or another, never reached the certificating authority or the manufacturer until after the accident, two years later.

To sum it up, this accident is a demonstration of:

1. Unimaginative risk assessment compounded by
2. The inadequacy of the international incident reporting system.

### Crew

About five years ago, a jet transport struck mountainous terrain while the crew was executing a letdown procedure as part of the NDB approach to a sealevel airport, located on an island. The accident occurred at night; all occupants died.

The investigative authority determined that the crew started the letdown when one of the ADF needles in the cockpit swung while the other remained steady; based on a reconstruction of the flight track, this needle swing occurred while the flight was still about 30 miles from the NDB (located on the airport). The crew reported that they were over the station and clearance for letdown was given. Due to the displacement of the descent pattern, the letdown was made over the mountainous island instead of over open water. The aircraft flew into rising terrain at 3000 ft msl.

Although the accident report does not provide enough information to evaluate the crew's response to the single ADF needle swing, it appears that this accident was caused by the acceptance

of doubtful position information. Since the topography of the situation should have made it obvious that a letdown started before reaching the station carried an unacceptable risk, the crew should at least have waited for verification from the second ADF. Furthermore, an operating VOR was located 6 miles from the station. There are no indications that the crew made an attempt to use this additional navaid.

This controlled-flight-into-terrain accident was one of three, in the same year, that destroyed three jet transports and killed 390 persons on mountain slopes in the vicinity of destination airports. One would expect that descents and initial approaches that leave no margin whatsoever for navigational or procedural errors would be characterized by the crew's readiness to react protectively to the first doubt about their position in time and space.

### DISCUSSION

The representative examples in each of the four categories should be sufficient to support the premise that our risk-taking behavior, occasionally, shows serious flaws. Those who are not yet convinced of this should take a hard and objective look at the international accident experience, including some of aviation's worst disasters so far.

This apparent weakness in the recognition and handling of risks probably finds its origin in a misunderstanding about the role of trust in any transportation system. No society can have mobility without a certain level of trust, that is, the conviction that a particular person or thing will perform as promised. This trust must have a sound foundation; it cannot be equated with hope or blind faith. There is no such thing as trusting that a badly-worn tire will sustain another 1000 miles of high-speed driving; this is not a calculated risk but one of the lowest forms of gambling.

Although there are some notorious exceptions, proven high-risk situations are generally treated with the respect they deserve at the individual as well as the administrative and corporate level. For instance, no pilot in his right mind would attempt an approach into Kai Tak, with weather at minimums, unless he has complete trust in his aircraft, his instruments, the nav aids, his own competence, and his crew. As long as this trust is not contaminated by self-serving considerations we are dealing with an acceptable calculated risk.

Between the desirable and undesirable extremes of decision-making - calculated risk and blind assumption- lies a transition zone in which our proximity to either extreme is governed by the quality of our trust. With regard to this intangible index of the probability of success of our endeavors it should be noted that there is nothing absolute about it; trust can only be measured in terms of its justifiability. To put it differently, nobody

can give one hundred percent assurance that a particular flight will be accident-free. We can only bend the odds in favor of safety. Such a conscious attempt to justify our trust differentiates the calculated risk from the mindless assumption.

Some of the factors that predispose towards the taking of risks that have no basis in trust have familiar names:

- Economical or reputational considerations
- The pressure of schedules or duty time limitations
- Fatigue, be it self-induced, system-induced, or the result of uncontrollable circumstances
- Reluctance to divert, or to go-around, for a variety of reasons
- A cockpit atmosphere that discourages unsolicited expression of doubt or concern

These factors have been identified repeatedly in accident reports. However, the pertinent findings never seem to have reached those for whom the bell tolls next. Apparently, there is a small number of persons, in all segments of aviation, who remain blissfully ignorant of the risk they take, or impose on others, because they believe that years of uneventful routine operations do away with the need to listen to woeful tales. This false sense of security is the biggest obstacle in our attempts to exploit what is bad in aviation to make what is good about it better.

### CONCLUSION

Occasionally, one hears talk about aviation's "incredible safety record." The really incredible part about it is that we get away with so much uncalled-for risktaking. The few accidents that still occur suggest that most of them involve an underdeveloped, or temporarily inactive, triggering mechanism for the timely perception of risk at the individual, managerial, or regulatory level.

One has to conclude that the haze of invulnerability through which too many approach a career in aviation can best be dispersed by discussing the facts of life - and death - in aviation in unadulterated terms. That means we need a merciless communications system that deprives every principal in our deceptively safe environment of the excuse to proceed on blind assumptions.

About 300 hundred years ago, when his troops were about to cross a river, Cromwell told them: "Trust the Lord but keep your powder dry." In aviation we need a similar message after each take-off clearance: "Trust the system but keep your options open."

MANAGING EMERGENCIES  
IN  
JET TRANSPORT OPERATIONS \*

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The rare occurrence of serious emergencies in jet transport operations - combined with the prevailing trend to gloss over, or ignore, the unpleasant - makes it difficult to broach this subject without being considered an alarmist. The sheer volume of technological irregularities covered in the emergency section of our handbooks discourages any doubt about our preparedness. We may even derive a sense of security from these catalogued responses in our flightbag, without realizing that some emergencies don't follow the printed scenario and may not leave time to consult the book or a checklist. Worst of all, there is no way to predict how the sudden demands of a life-size emergency may cripple the certificated and renowned ability of our cockpit team to master adversity.

Over the years we have seen some spectacular "saves" of aircraft by flight crews who managed to bring a disabled aircraft in for a successful emergency landing at an airport. Since one cannot argue with success, it is not customary to question the decisions of a crew who made it despite avoidable delays in landing an aircraft whose airworthiness could not be guaranteed by anybody. As a result, the thinness of the string that may have held things together until a safe landing could be made is seldom the subject of open discussion.

To the extent that an excuse is needed to rattle our self-confidence, a review of some of the uncomfortable knowledge stored in aviation's closet should suffice. Actually, this paper pretends to be no more than an invitation for introspection intended to stimulate the development of protective instincts in those who recognize the brittle elements in our aviation system.

To provide some semblance of order in an otherwise unwieldy subject, the decisionmaking process and the manner in which it may be affected by the urgency of an emergency situation will be discussed first. This will be followed by some suggestions dealing with the prevention of emergency situations. Finally, a

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The views expressed by the writer do not necessarily reflect those of the National Transportation Safety Board

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controversial subject will be treated: the option to sacrifice the aircraft in a survivable, off-airport crash-landing.

### DECISIONMAKING

Although we may not always be consciously aware of it, decision-making implies having a choice. The manner in which we perceive a choice, or an option, is governed by the quality of the information at our disposal and the quality of our interpretation thereof. Most textbooks on human behavior give the impression that this is a rather orderly process of weighing the pros and cons of available options and then deciding on the action that best suits our purposes.

The problem with some emergencies is that they do not allow the luxury of a by-the-book decisionmaking process. The available information may be incomplete or misleading. The phase of operation where the unusual occurs may leave enough time only for an immediate reaction, a response that is governed more by what might be called a sixth sense developed through training and experience, than by the process of reasoning.

#### Take-Off Emergencies

The interesting part of emergencies requiring an immediate and irreversible decision is that they are often handled better than those that leave time for apprehension and changes in plans. The go-no-go decision during the takeoff roll is a case in point. Most of the reasoning inputs are cranked into the go-no-go formula well before takeoff. This takes into account such items as runway length, condition of runway and overrun, nature of terrain or obstacles beyond airport boundary, the aircraft's stopping capability, and visibility conditions. The principal variables are the nature of the emergency and the crew's instantaneous evaluation of its seriousness. Considering the criticality of the time element and the problems in assessing some emergencies, the immediate no-go decision of a crew who senses reasonable doubt about the aircraft's ability to become - and remain - airborne has to be accepted and respected, regardless of the outcome.

A conservative approach in making the earliest possible decision to keep an aircraft on the ground in questionable circumstances seems sound policy. In March 1968, a B-727 was totally destroyed when the crew continued a night takeoff roll despite a takeoff warning horn that started to sound a few seconds after the thrust levers were advanced. The crew assumed they would be able to identify and correct the condition that caused the warning signal. The aircraft was rotated at Vr and lifted off. Immediately thereafter the stickshaker was activated. Concern about this ability to keep the airplane in the air, and to clear a nearby freeway, prompted the captain to put the aircraft back on the ground. The undiscovered, unsafe condition that triggered the warning horn was a 2° flap setting.

In October 1977 the crew of a stretched DC-8 successfully discontinued the takeoff just before lift-off when they heard a

loud noise and the aircraft started to list. Actually, a disintegrating wheel rim had cut a large hole in an integral fuel tank and the spilling fuel was ignited immediately. An alert fire department managed to control the fire but not until it had caused substantial damage.

Assuming that a slight change in the timing of the critical events had allowed the aircraft to become airborne with a fire in a wheelwell and the wing root, some interesting questions can be raised:

- What immediate indications would the crew have had about the true nature of the problem?
- How could they have assessed the urgency of the situation based on information available in the cockpit?
- Could the disabling of alarm systems by fire or other events have given them a false sense of security?
- To what extent is the cabin crew trained and positioned to observe and report unusual occurrences involving aircraft structures or systems that are beyond the purview of the flight deck crew?
- How long would it have taken the wing to fold after being weakened by the fire, or, how long before an explosion in the wing would have ended the flight?

These questions deal only with the technical aspects of the information a crew needs to make intelligent decisions. Other aspects of our information-processing capability in an emergency situation are often so complex that their influence can only be surmised. For example:

- The manner in which we sort out and "prioritize" multiple stimuli in a stress environment.
- The manner in which training and experience condition our perception and reflexes.
- The absence of a familiar feedback loop so that we can no longer judge the effectiveness of our actions. The feedback may also be misleading.
- The manner in which subsurface psychological and physiological stresses - including fatigue - may degrade cockpit discipline and the performance capability of individual crew members.

A B-707 accident that occurred several years ago illustrates how easily the routine response to a "standard" emergency can be disrupted by well-meaning but uncoordinated crew members. Less than a minute after takeoff, a disintegrating compressor disc in the No. 2 engine severed the main fuel line to that engine. The crew felt and heard a combined shock and bang and saw the No. 2 engine instruments running down. The flight engineer moved the thrust lever back and pulled the landing gear horn cancel switch, while the first officer pressed the fire bell cancel button.

A check captain occupying the forward jumpseat reported at this time that there was a serious fire in the No. 2 engine and suggested an immediate landing. Although the No. 2 engine fire shut-off handle was illuminated, and the captain had ordered

"Engine Fire Drill", the No. 2 shut-off handle was never pulled, because of confusion about what action had been completed and what still needed to be done. As a result, fuel under pressure kept feeding the fire at a rate of about 50 gallons per minute until after the landing. During the well-executed, expedited approach to the nearest runway the burning No. 2 engine fell away from the aircraft, but the fire in the remains of No. 2 pylon forward of the wing persisted. Shortly after a successful landing there was an explosion in the left wing. Five occupants were unable to escape in time from the burning aircraft.

Here is another cliffhanger. An ingested seagull disabled the No. 4 engine of a B-747 immediately after lift-off for a long ferry flight. The captain called gear-up but his command was not heard by the first officer who started assisting the flight engineer in securing the engine. The captain concentrated on maintaining vertical separation from buildings in the takeoff path, while climbing at  $V_2 + 20$ . At a height of 800 feet "flaps 5" was selected. At about 1100 feet the 5-minute limitation on takeoff thrust was reached and thrust was reduced. At this time it became impossible to climb or accelerate beyond  $V_2 + 20$  and the captain ordered the immediate dumping of fuel. Performance gradually increased and the flaps were retracted in stages. It was not until after the situation lost its criticality that the first officer discovered that the gear was still down.

These last two incidents highlight a universal shortcoming in emergency training: our inability to duplicate the unmitigated stress of a real or imagined threat to survival and its potential effect on individual and team behavior. One of the best safeguards under these conditions is the captain's firm and immediate exercise of command authority and the entire crew's strict, methodical compliance with pertinent procedures. The enforced orderliness of the initial reaction to an emergency may be the most important factor in channeling the adrenalin flow in the cockpit into the desired direction.

### Inflight Emergencies

By their very nature, inflight emergencies tend to allow more time for analysis and corrective action. In November 1977, the crew of a B-707 experienced a nosedown runaway stabilizer trim, and other unusual indications, while at FL 390. At the same time, one of the cabin crew reported flooding of the forward toilet. (The washbasin had overflowed due to a defective faucet.) Water had entered the electrical bay and affected electrical equipment. The runaway stabilizer drill was completed and the flight continued manually. In this case, a readily discernable cause/effect relationship, combined with the moderate rate of the trim deviation and the high altitude, created no serious problems.

Incidents involving smoke or fire should be treated with the highest respect from their very beginning. In July 1973, the crew of a 4-engine jet transport asked the approach controller for an emergency descent since they had "a problem of fire on board." The flight had completed an 11-hour transatlantic crossing and had routinely descended to 8000 feet. Five minutes after the emergency

was declared, smoke in the cockpit made the situation so intolerable that the captain decided to make a forced landing. He had to open the sliding cockpit window to maintain ground reference. The aircraft was skillfully landed in open farm land, about 3 miles from the destination runway. Unfortunately, by that time most of the cabin occupants had already been incapacitated by the inflight smoke and were unable to leave the intact fuselage which was subsequently destroyed in the ground fire.

The probable cause of this accident was a fire in one of the aft toilets. The ignition mechanism could not be pinpointed; it may have been an electrical problem or carelessness in the form of a discarded cigarette. Whatever went wrong, it took only about 10 minutes to create toxic conditions throughout the fuselage and to convince the captain that the only reasonable decision under the circumstances was an immediate crash landing.

In November 1973, the crew of a cargo jet carrying hazardous materials lost control of the aircraft while attempting to make an emergency landing at a major airport. About 35 minutes earlier the flight had reported an accumulation of smoke in the electrical bay and had started emergency drills for an electrical problem. Actually, improperly packaged chemicals in the cargo probably started leaking and reacted spontaneously with the packaging material. This created a continuous and uncontrollable source of smoke which permeated the cockpit. There were no indications that the crew was aware of the amount and type of hazardous materials on board.

About 20 minutes before the flight's abrupt end, a traffic controller volunteered to the crew information that they were passing a military air base. At that time the flight was about 45 miles from the airport where the crew planned to take the aircraft and where company maintenance facilities were available. According to the accident report, had an electrical problem in the electrical bay indeed been the source of the smoke, as suspected by the crew, the logical decision from a logistics viewpoint was to land the aircraft at the nearest airport with company facilities. However, while sympathizing with this crew's baffling predicament, we should not hesitate to put selfpreservation in its proper perspective by drawing this conclusion: when the origin of smoke or fire is unknown, and when checklist actions fail to identify and correct the problem, land as soon as possible or bring the aircraft down to a level from which an immediate emergency landing or ditching can be made. If this sounds like grim advice, consider the alternatives reflected in these two isolated mishaps.

Misinterpretation of unusual instrument indications can lead quickly to a critical situation. In December 1974, the crew of a jet transport was unable to regain control of the aircraft after stalling it at about 24,000 feet as a result of attempts to reduce an abnormally high airspeed and rate of climb. The crew attributed the high readings to the aircraft's light weight and weather conditions. Actually, the flight was climbing through forecast icing conditions and the pitot heads became blocked by icing, because the crew had neglected to turn on the pitot heater switches.



There were no indications that any of the crew members suspected the true nature of the problem and there was no apparent attempt to revert to attitude flying. This is a disturbing discovery since one expects that every pilot has been taught to recognize, and cope with, problems in the pitot-static system. It is one of the many pieces of knowledge that should be stored in the subconscious, ready for recall through the process of association. There is another name for this store of knowledge: "The pilot's bag of tricks." There is no standard inventory of what should go into this bag. The size and quality of its contents are probably governed as much by what we "soak up" from our own experiences, and those of others, as by formal training.

It does not require an emergency of monumental proportions to reduce the margin between success and failure to zero. In January 1969, a DC-8 was flown into the water during an instrument approach while the captain and the flight engineer were ascertaining the position of the landing gear following the failure of the gear indicator lights. In December 1972, a similar, "fifty-cent" distraction in the cockpit led to the first fatal wide-bodied jet accident.

It appears that in the process of cluttering cockpits and traffic control rooms with warning devices we run the risk of dulling the sensitivity of our internal warning systems to the point where we are becoming victims of our own cleverness.

In some modes of transportation serious thoughts is given to using technology in such a manner that even the most irresponsible cannot hurt themselves. Aside from the question whether any society can afford the price of a foolproof transportation system, the nature of aviation is such that it will probably be the last to fall victim to the utopian idea that you can design individual responsibility completely out of our freedom of mobility. Therefore, true safety in aviation continues to require an operating intelligence and conscience.

#### PREVENTING EMERGENCIES

It is not unusual for an emergency to start with our failure to listen to an aircraft which is trying to tell us it has a problem. These self-inflicted emergencies often start with the placebo: "Groundcheck OK" or "Carried over." In August 1977, the No. 1 engine of a four-engine transport went into full reverse at FL 300. Ten days before this jolting incident, the No. 1 engine reverse operating light started acting up. Maintenance personnel could not find anything wrong with it. During the takeoff on the day of the incident the reverse light illuminated again, then went out.

The lesson is obvious: if you want to protect yourself against unpleasant surprises from a system problem that stymies maintenance, have it isolated; if the system is essential to flight, don't accept the aircraft.

Compromises with regard to the intent of the minimum equipment list (MEL) fall in the same category. Consider the predicament of the crew who found itself without electrical power shortly after a night takeoff into instrument conditions. The aircraft had been operated for 42 hours with the No. 3 generator inoperative

(permissible by MEL). Shortly after lift-off, a fire warning in the No. 1 engine forced the crew to shut down that engine. (No evidence of an inflight fire was found in the wreckage.) Shortly after shutdown of the No. 1 engine, all power from the remaining (No. 2) generator was lost. The standby electrical system was not activated or failed to function. The crew lost all attitude reference and an accident was unavoidable.

As a result of this accident the MEL was revised and an independent, standby attitude indicator became mandatory for all turbojet aircraft. Some innocuous questions: Do you have to do anything to keep this last-resort instrument operating and illuminated in case of total loss of electrical power in your aircraft? How long will it operate on its own power?

While on the subject of warning lights and signals, it might be well to point out that for a flight crew there is no such thing as a false warning; every warning has to be taken seriously. In March, 1977 the crew of a 4-engine transport experienced simultaneous fire warnings on the No. 2 and 3 engines at FL 330. The fire drills for both engines were completed and the flight was continued successfully on two engines. It was later determined that both warnings were false. A sealing washer was missing from a connector in the No. 2 system. Crossed wires on a relay unit caused a sympathetic warning in the No. 3 system. What is a crew to do who has a similar experience after takeoff at max gross, or in the middle of a Pacific crossing? How many persons and aircraft have been lost - in all forms of flying - because of false warnings? The solution of this problem is in the hands of designers and maintenance personnel.

The prevention of emergencies - and accidents - has a lot to do with what we learn from the tribulations of our colleagues. Some examples:

- The No. 3 engine of a B-747 stalled and flamed out when the aircraft encountered the jet wake of another B-747 at FL 300.
- The fan assembly of the No. 3 engine of a DC-10 disintegrated 36 seconds after the crew started experimenting with the autothrottle/speed control system for no other reason than their own curiosity. The aircraft was at FL 390. Fragments of the No. 3 engine penetrated the fuselage, the No. 2 engine nacelle, and the right wing. During the total cabin decompression, a passenger was forced out of a cabin window that had been broken by an engine fragment.
- A wide-bodied jet struck approach light supporting structure after lift-off at the very end of the runway. The aircraft was damaged substantially; 3 of the 4 hydraulic systems became inoperative. The late lift-off was associated with the use of incorrect takeoff reference speeds. There had been a change in departure runway, which required a flap setting of 20° instead of 10°; however, the speed bugs were left at their original settings.

- Shortly after a night takeoff, and while entering an overcast, the crew of an L-1011 experienced a severe nose-up tendency that could not be relieved by using all available electrical trim. Although the yoke was held against the forward stop, the pitch passed through about 22 degrees and the air-speed went down to 140 knots. By skillful manipulation of power and flaps the crew was able to control the flight path and make an ILS approach, followed by a successful landing. It was later determined that failure of a bearing assembly in one of the elevator drive systems resulted in jamming of the left elevator in the UP position.

### THE FINAL OPTION

One of the most ignored truisms in aviation is that the ability to fly an aircraft has to be complemented by the ability to crash it competently, should the need arise. Equally ignored is the logic that all pilots must possess a working knowledge of crash dynamics although only a fraction of one percent of each generation of transport pilots faces a situation where the aircraft ceases to be a flying machine. That does not mean that our outlook should be one of morbid preoccupation with what might happen. As stated earlier, preparedness in this regard involves only an honest attempt to grasp the underlying concepts and storing them - out of sight but within reach - in our bag of tricks.

Despite all its negative connotations, world-wide accident experience has provided one comforting insight: the modern jet aircraft's impressive ability to protect its occupants even during severe crash decelerations. It is not unusual to see an aircraft slide to stop in relatively rough terrain, during a landing or takeoff mishap, without extensive traumatic effects on the occupants. The obvious conclusion is that a pilot who has some understanding of the minimum requirements for an off-airport emergency landing site is in a much better position to insure the success of a crash landing.

#### Terrain Selection

The length of a field that will accommodate a jet transport depends on the condition of the soil. The smoke-filled B-707 that was successfully crash-landed by a pilot who had to look out of a side window slid 1800 feet on dry, hard farmland. Softer terrain, such as a cornfield, would probably reduce this distance. About 2000 to 2500 feet of open terrain should be adequate for most transports at typical landing speeds. However, it must be remembered that this is ground distance. If the approach has to be made over an obstructed area, a considerable larger field is desirable to compensate for judgment errors, especially when no power is available. Every effort should be made to prevent the aircraft from striking solid obstacles before the touchdown point is reached. If contact with serious obstacles is unavoidable, due to the limits of available space, it is best to have such contacts occur at the low speed associated with the end of a ground slide.

The field does not have to have the qualities of a WW II grass strip. It can be gently rolling, crossed by fences and small ditches, and covered with crops and small trees. But it should not have destructive obstacles like large trees, solid structures, boulders, ravines, and powerlines in the intended path. Since the aircraft may swerve as it slows down, lateral space in the second half of the field is more important than in the first half.

Jet aircraft ditch well when flight manual instructions are followed. Therefore, a water landing can be a good alternative when the only other choice is obviously unsuitable terrain. The principal considerations for a ditching are: water temperature and surface conditions, proximity to land, access to water-survival equipment, and the time available to prepare the occupants.

During ground-level emergencies terrain selection may consist of nothing more than a brief opportunity to nudge the aircraft into the least undesirable direction. For instance, when a takeoff or go-around has to be rejected, the pilot should attempt to use the remaining control over the aircraft to achieve the most favorable crash heading. Knowledge of conditions and obstacles beyond the runway is vital in this regard. A few degrees of change in heading may make all the difference in the outcome of such an emergency.

### Approach and Landing

The destructive energy that is brought to bear on the structural integrity of an aircraft is governed by the abruptness of the stopping process which, in turn, is proportional to stopping distance and velocity squared. Since we are concerned with ground-speed only, wind direction and velocity can become critical factors. An aircraft landed with a tailwind of 20 knots at an indicated air-speed of 130 knots has almost twice as much destructive energy as an aircraft landed into a 20-knot headwind; assuming identical rates of deceleration in both cases, a tailwind landing would extend ground travel by a factor of nearly two. However, wind direction and velocity become decisive factors only when time and circumstances pose no overriding considerations. A controlled touchdown in less-than-ideal terrain is preferable to the chance of losing control in an attempt to reach an airport.

The proper aircraft configuration always includes the use of flaps, if available, since they lower the touchdown speed. The best position of a retractable landing gear is subject to question, except in case of a ditching when it definitely should be retracted. The advice to crash-land with the gear extended in off-airport landings should be weighed against its possible consequences, as shown by actual accident experience in one jet transport. The subject flight manual recommends that the landing gear be extended for crash landings since it absorbs considerable energy. It goes on to say that, even if the gear is carried away, the integrity of the fuel-containing portion of the wings will not be affected.

One aborted takeoff in this model aircraft resulted in an extensive post-crash fire when an extended landing gear was sheared off in a ditch in the runway overrun area. The fuel spillage was

attributed to disruption of an integral fuel tank when the main landing gear supporting structure was torn away. The impact forces on the main fuselage and the occupants were minor.

A similar aircraft made an extremely hard, unintentional touchdown on flat terrain during an attempted go-around in windshear conditions. Almost all occupants sustained some form of decelerative injuries; 14 of them were immobilized and had to be removed by rescue personnel. The fact that there was no fuel spillage - and no catastrophic post-crash fire - can probably be ascribed to the retracted position of the landing gear at impact.

The latter mishap provides some interesting insight in the preferred manner of touchdown in a controlled crash-landing. For obvious reasons, the vertical speed is reduced to zero immediately upon ground contact if a gear-up landing is made. Except for compression and deformation of the fuselage bottom, there will be no cushioning effect. This means that the pilot should attempt to maintain enough controllability to reduce the rate of sink to practically zero at touchdown. If he reaches the selected touchdown area at excessive forward speed, and field length is critical, he should consider forcing the aircraft onto the ground despite the higher-than-normal speed. This advice does not apply to ditchings which should always be executed at the lowest possible speed, but without stalling.

A commonly overlooked factor in the emergency section of flight manuals is the manner in which the crew can reduce the greatest hazard of an otherwise survivable accident: a post-crash fire.

The seriousness of fuel spillage depends on the quantity involved and the location. In the case of wing-mounted engines there is a possibility that one or more engines will be torn away even during a well executed gear-up landing on suitable terrain. If the nature of the obstacles makes major wing damage unavoidable, it is preferable to have this occur symmetrically and simultaneously, that is, equal sections of outboard wing panels should be severed at the same time. This helps to maintain the desired impact heading and keeps the fuselage from sliding sideways into obstacles.

Statistically, Jet-A type fuels (kerosene) seem to have a safety advantage over the more volatile B-type fuels. This applies to inflight incidents (including lightning strikes) as well as ground mishaps. This advantage is lost when impact conditions cause spraying (misting) of fuel.

The most obvious and beneficial step toward the reduction of ignition sources, is the immediate shutdown of all engines as soon as it is apparent that they can no longer prevent a ground mishap or contribute to control over the stopping process. This step should be taken any time the aircraft's expected ground trajectory will involve other than runway surface. The time between shutdown and the damage process may be sufficient to cool the hot section of turbine engines below the ignition point of spilled flammables. Furthermore, this action precludes the possibility of continued engine operation when fuselage damage disrupts control from the cockpit.

Another source of ignition is the electrical system. However, this system should not be deactivated until its services are no longer needed for aircraft control, instrumentation, and other vital functions.

As soon as time permits after a significant incident, cabin crew and passengers should get a message from the cockpit assuring them that the flight crew is at least aware of whatever unusual event occurred. Following that announcement, the cabin crew should be kept informed of any development that may require an unscheduled or emergency landing. This additional knowledge gives the cabin crew the opportunity to plan, coordinate, and implement passenger preparation in a timely and effective manner.

This discussion touched only on the first requirement for crash survival: a deceleration process that helps insure impact survival by leaving the occupiable portion of the fuselage as much as possible intact. The second requirement, timely evacuation, falls beyond the scope of this paper.

### CONCLUSIONS

The need to be reminded of our vulnerability to emergency situations has a parallel in our need to suffer booster shots to maintain immunity against certain diseases. Unfortunately, too often we expect to maintain immunity by keeping track only of those emergencies that resulted in widely-publicized accidents. These are just the visible tip of an iceberg of learning experiences in the form of numerous daily incidents that occur without ill effects. In most cases it is the tolerance built into the system, or the competence of an alert crew, that takes the sting out of potential threats. In some cases it is the random timing of the event that makes it harmless. However, practically all cases demonstrate the fallibility or ingenuity of the human element throughout the aviation system.

The overused expression that we'd better learn from the mistakes of others since we won't live long enough to make them all ourselves is still as valid as the first time it was used. For a pilot this means that he derives more personal security from a publication that exposes him to the imperfections in his operational environment than from one that tells him how to invest his money. Some of the outstanding safety publications that use this concept are: "British Airways Air Safety Review" and PanAmerican's "Cross-check."

In addition to using our lifelike simulators to prepare pilots to jump the customary hoops as part of their recurring certification process, we should encourage the programming of real-world ordeals into them. A one-time, unanticipated exposure to incidents such as an iced-up pitot-static system, or total loss of electrical power, would make a pilot more responsive to actual problems in these areas. This type of training promotes enlightened decision-making in unusual situations without downplaying the constraints of standard operating procedures.

By giving emergency awareness the level of realism and respectability it demands, we also encourage the world-wide sharing of experiences that should form the basis of our preparedness for uncommon challenges.



## INSTRUCTIONS FOR WORKING GROUPS

### INTRODUCTION

The key to the success of this NASA/Industry Workshop on Resource Management on the Flight Deck is the small working groups that all conference participants have been assigned to. Each of the invited presentations was selected to provide you with some tools to work with-- ideas, concepts and approaches. It is the application of these tools, through the discussions and deliberations of the working groups, which will produce new ideas, new concepts and new approaches as well as identify current approaches which should be continued or expanded. Because of the central importance of the working group concept, we have given careful consideration to developing workable, productive objectives and approaches for these working groups, and to their structure and composition. The information below was assembled to assist the working group chairmen, the NASA Assistant and the individual members of the working groups in organizing their attack on their assigned problem.

### OBJECTIVES

The objective of each working group is to generate a report containing the following information:

1. What are the specific resource management skills, behavior and proficiencies which should be developed in flight deck crewmembers?
2. At which point in an airman's career is it most appropriate to incorporate resource management training?
3. What are the most appropriate techniques for conducting this training?

The following discussion is intended to amplify each of these objectives.

The objective regarding specific skills, behavior and proficiencies is central to the whole concept of resource management training. The ultimate success of any training program is largely dependent upon the development of detailed, precise specifications describing the desired end product. Furthermore, these specifications will, in large part, determine the content and structure of the training program, and will also form the basis for specifying criteria which can be used in assessing airman performance.

Some possibilities have been suggested in the formal presentations. Examples include: (1) The Captain must insure positive delegation of various duties and responsibilities during all flight operations; (2) All crewmembers must immediately inform their fellow crewmembers of any significant question or doubt about the content or meaning of clearances, instructions or other information relevant to the conduct of the flight; (3) The Captain must establish clear and open lines of communication between all flight deck crewmembers. These are given here as examples only-- it is up to the individual working groups to determine whether these are appropriate training objectives, and to develop others as necessary.

In some ways, the question about the most appropriate phase of an airman's career in which to give resource management training may be misleading, because it implies that resource management training would be given at only one point. It seems far more likely that elements of resource management training might be incorporated into existing phases of aircrew training. In other



words, rather than defining a resource management training program, your deliberations as working groups may result in specific recommendations to the effect that elements of resource management training might be incorporated in various types of training, from selection and Initial training through Upgrade and Transition training to Recurrent training and Line Operations. Put still another way, it seems likely that this workshop will develop recommendations for augmenting existing training programs. Please note that this does not preclude a recommendation that a specialized resource management training program be developed-- this is for you to determine.

Finally, for each of the recommended training objectives developed in your discussions the question of "How" should be addressed. It is anticipated that the simulator, particularly full-mission simulation, may play a major role in resource management training. However, many other techniques are also applicable to various elements of this problem. Accordingly, during your deliberations, you should consider the range of techniques and media available, and consider which elements of this training might be conducted in classrooms, small group discussions, as part of an audio-visual training package, or through other approaches, including things like Safety Awareness programs, and Flight Operations and Safety publications.

There are two other considerations to keep in mind when considering the "How" of resource management training: Economics and Regulations. With regard to the former, you are in the unique position of being able to assess the potential economic impact of your recommendations, and we need not say more. With regard to the latter, we do have representatives from FAA Flight Standards present who are in a unique position to discuss current and future regulatory considerations. Please call upon the FAA people for help and guidance on this matter.

#### PROCEDURES

Each working group has an assigned chairman from the industry, and a NASA Assistant who will serve multiple functions, including host, resource person, technical and scientific advisor, and recording secretary. Operating procedures have been left to the discretion of the working group chairmen.

Working group assignments were made by NASA on the basis of several considerations. Please note that although we have assigned one of three specific areas (Selection and Initial Training, Transition and Upgrade Training, and Recurrent Training and Line Operations) to each Working Group, we do not mean to strictly limit the scope of any one group's discussion to the assigned area. Instead, consider the assigned area to be an indication of the primary area of consideration. If you wish to make recommendations in any other areas, you certainly may do so after a thorough development of the primary area.

Working group assignments, along with meeting rooms and assigned topics are listed on the Working Group Assignment Sheet enclosed in your registration package.

Please note that seven participants do not have individual working group assignments: Capt. Al Frink has agreed to serve as the industry chairman, and will circulate among all the groups throughout their discussions; the others

consist of three two-person teams: one NASA person, and one of the three non-industry speakers. The non-NASA team members are Drs. Bolman and Helmreich, and Mr. Garvey. The NASA representatives are Drs. Billings and Tanner, and Mr. Murphy. These teams will circulate among the working groups, and should be considered as resources available to assist your deliberations in their particular areas of expertise. Again, it is up to each Working group to determine how it wants to make use of these "mobile" resources.

You should also consider each of the industry speakers as being available to assist on any given problem. Although these speakers have been assigned to specific working groups, the working group chairmen will temporarily release these individuals upon request from another group.

Also note that we have other resources available should you need them: FAR Part 61 and 121; the Airmen's Information Manual; some ASRS reports, and selected aircraft accident reports. Your NASA Assistant will be able to locate this material should you desire it.

#### WORKING GROUP REPORT FORMAT

It is the responsibility of your NASA Assistant to help the Chairman draft the Working Group Report which will be submitted to the general assembly. To ensure a uniform format, we ask that these reports follow the format suggested below.

Each report should consist of three major sections: (1) an Introduction; (2) Recommendations; and (3) a Summary. The Introduction should consist of a maximum of two pages which should describe general features of the approach taken to the assigned issue by the working group, and other material of a general introductory nature.

The Recommendations section is the heart of the report. This section should be quite specific. Each recommendation should consist of at least two, and in some cases, three, parts: (1) Training Objectives; (2) Training Approach; and, if appropriate, (3) Research Issues. The Training Objectives should be stated in specific terms, and the Training Approach should consider the dual issues of How to train to the stated objectives, and When in an airman's career this training should be conducted (or into which existing training program or phase the recommended training should be incorporated).

Whenever there are Research Issues identified in connection with any specific recommendation, these should be stated, along with some statement about the relative priority of each research issue.

The Summary section should be limited to a maximum of two pages, and should attempt to summarize the results of the group's discussion. Any major areas of disagreement, minority opinions and other similar information should be placed here.

Remember that each report must be succinct. We realize that, in some cases, this is going to preclude full discussion of the issues. There will be an opportunity to amplify and clarify these points during the panel discussion and general discussion Thursday afternoon. Furthermore, an opportunity to further develop these issues will be given during the preparation of the Workshop Proceedings. A Draft of the Proceedings will be circulated to the Working Group Chairmen who will be able to edit, modify, expand or delete sections of the Working Group reports.

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