

THEORY UNDERLYING CRM TRAINING: PSYCHOLOGICAL ISSUES IN FLIGHT CREW PERFORMANCE AND CREW COORDINATION

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INTRODUCTION

I had the pleasure of attending and speaking at the first NASA workshop on flightdeck resource management and have been involved in research related to the area from that time (Helmreich, 1979). As the program for this second workshop so clearly attests, a great deal has happened since 1979. What were then exciting ideas are now exciting programs. This enthusiastic endorsement of a concept is particularly meaningful to those of us who are psychologists because the issues in resource management and crew performance are core topics for social, personality, and organizational psychologists.

In this session, we will try to summarize what psychological theory and research can tell us about training in cockpit resource management. In doing this, we hope to provide a framework for the critical analysis of current approaches to CRM training. I will begin by reviewing background factors and definitions critical to evaluating CRM. This will be followed by a discussion of issues directly related to CRM training effectiveness. Finally, I will conclude by describing some of the things we *don't* know about optimizing crew performance and the research that is essential to making our efforts as effective as possible.

DEFINITIONS AND BACKGROUND

I have already used the terms "resource management" and "crew performance" and would like to make a distinction between them. I use the term performance to refer to a global concept, the total effectiveness of an individual or crew in achieving the goals of safe and efficient flight operations. Superior performance, both at the individual and crew level has two distinct components; first, technical proficiency and competence and second, resource management or crew coordination. I feel that crew coordination is the cornerstone of resource management, by which I mean the effective coordination and utilization of all available resources in the service of the flight. These resources are both inside and outside the aircraft and are both material and human, including especially the knowledge, judgment and decision-making skills of all crewmembers and the ability of the crew to bring them together in optimal fashion. While this workshop is focused on the second, resource management, and we may tend to accept technical competence as a given, we must never lose sight of the fact that the technical component is critical to overall performance.

In the research my colleagues and I have been conducting on flightcrew performance, we have attempted to assess both technical performance and crew coordination using trained Check Airmen as evaluators. There are several important facts about the performance data obtained. The first is that the Check Airmen we have worked with display a high level of agreement or reliability not only in their assessment of technical proficiency, which is to be expected, but also in the evaluation of resource management during both line checks and LOFT. This is especially interesting because the majority of Check Airmen with whom I have worked during the research have initially expressed considerable uneasiness with the idea of evaluating crew coordination. While completely comfortable with assessing technical performance, they tend to feel less adequate in this domain. The data clearly demonstrate that the majority have this ability. An important implication of this is that we can be confident in the validity of such assessments. This suggests that the formal assessment of crew coordination as part of proficiency evaluations is feasible. Consideration of the pros and cons of requiring such assessment in the future is an important task for the workshop.

The second important characteristic of the performance data is that although the two dimensions of performance are positively correlated, they still show substantial independence. This means that a pilot high in technical ability may or may not display effective crew coordination as a separate and distinct component of flightdeck performance. The research related to crew performance is summarized in a series of papers (Chidester, 1986; Helmreich, 1982; Helmreich, Foushee, Benson, & Russini, in press).

It is also essential to our training task that we specify the characteristics of individual pilots that are related to overall performance. We can identify three broad categories of characteristics. The first is individual technical ability or aptitude; the second, personality, the enduring characteristics and motivation of the individual; and the third, attitudes about personal capabilities and the proper management of the flightdeck.

ABILITY-PERFORMANCE RELATIONSHIPS

As we have noted, technical competence is a cornerstone of effective pilot performance. In addition to the obvious links among ability, training, and technical performance, there may be indirect effects on resource management. For example, a less technically-able Captain may be highly defensive and may try to preserve a self-image of competence through the maintenance of unrealistic, self-deceptive attitudes about personal competence and resistance to stress and the lack of need for support and coordination among crewmembers. This Captain may try to project an air of all-knowing confidence and independence when, in fact, the opposite is true. Such behavior may have a highly adverse effect on crew coordination.

PERSONALITY-PERFORMANCE RELATIONSHIPS

The role of personality traits as determinants of flight crew performance needs a thorough re-examination. Although personality factors were implicated as determinants of flying performance during the massive World War II research program on pilot selection conducted by Army Air Force psychologists, subsequent research has often shown inconsistent or weak relationships, leading many researchers and operational managers to discount the utility of personality factors in pilot selection and performance (Griffin & Mosko, 1977; Melton, 1947). However, a recent study conducted by our research group suggests a possible resolution of this dilemma (Helmreich, Sawin, & Carsud, in press). In a study of job performance beginning with training and continuing through months of daily performance, it was found that personality factors *did not* predict performance in training but became increasingly good predictors of actual task enactment. The results were interpreted in terms of a "honeymoon effect"--the tendency of all individuals to try hard during the excitement of training for a new position. Over time, however, as the novelty wears off and the job becomes more routinized, underlying personality traits begin to influence the quality of performance. The facade of cooperativeness and eagerness to learn of the pilot trainee may crumble during line operations, revealing a hostile, arrogant, interpersonally insensitive individual who cannot work effectively with fellow crewmen. Having surmounted the selection and qualification hurdles, motivation to hide the "true personality" is likely to fade.

The honeymoon effect may be particularly salient for investigations of personality-performance relationships in pilots since the research in both the military and civilian sectors has almost exclusively employed performance during training or the simple completion of *training* as the criterion against which personality was judged. In other words, there may have been a continuing tradition of testing for personality effects in the setting where they are least likely to be found. In research that has used ongoing line performance as the criterion, consistent personality effects are much more evident (Helmreich, 1982; Chidester, 1986). For example, among other things, a combination of high measured achievement (a desire to work hard and master new and challenging tasks) and a high level of sensitivity to the reactions and concerns of others was associated with superior line performance. In summary, personality may play a much larger role as a determinant of flightdeck behavior than we have realized.

ATTITUDE-PERFORMANCE RELATIONSHIPS

During early NASA investigations of cockpit resource management, a set of crewmember attitudes relevant to flightdeck behavior and crew interaction was isolated (Cooper, White, & Lauber, 1979). Building on this work, I developed a questionnaire measure of performance-related attitudes, covering such areas as Captain and crew responsibilities and roles, crew interaction, and reactions to stressful events (Helmreich, 1984). Subsequently, these attitudes have been found to be significant predictors of crew coordination in *line* operations (Helmreich, et. al., in press). We now have attitude measurement on more than two thousand pilots from five airlines and the Military Airlift Command. A consistent finding is that the attitudes of Captains, First Officers,

and Flight Engineers differ significantly on a number of issues regarding the appropriate management of the flightdeck (Edwards, 1986; Helmreich, Wilhelm, & Siem, 1985). Disagreement among crewmembers about how the flight deck should be run suggests that less than optimal crew coordination may be found and that achieving consensus regarding management would be a highly desirable training goal.

PSYCHOLOGICAL ASPECTS OF CRM/LOFT TRAINING

The preceding point marks a logical transition to a discussion of what psychology can say about the potential of CRM/LOFT training. A good starting point is to define the capabilities and limitations of training programs as means to effect the modification of behavior. As we noted earlier, three individual characteristics are major determinants of pilot performance: ability, personality, attitudes. Obviously, training cannot provide an individual with raw ability that he does not possess. It can, as we will discuss, help the individual better utilize his abilities and improve his skills.

A true limitation on the potential impact of training lies in the area of personality. No training program other than intensive psychotherapy will effect substantial change in personality. Thus to the extent that resource management and performance are determined by personality, this is an area where we cannot expect results. The pilot with a hostile, aggressive personality or a withdrawn, defensive personality will continue to bring those characteristics to the flightdeck.

The fact that we cannot change personality or ability represents a limit on training but by no means implies that training cannot effect dramatic change in resource management. It is in the third area, attitudes, that we can achieve substantial change in observable behavior. We are also fortunate in that there is a large research base regarding attitude formation and change on which we can draw. The data on pilot attitudes clearly suggest areas where training can be beneficial and it is reassuring to note that most of these are addressed by the programs with which I am familiar. These include decision making, interpersonal communication, leadership and leader responsibilities, and personal characteristics and reactions. For example, with regard to personal reactions, a high percentage of pilots report that their decision making capabilities are unimpaired by high stress or fatigue--something that is patently untrue. Changing attitudes about personal limitations may well result in much more adaptive behavioral strategies and coordinated behavior in critical situations where maximum effectiveness is a life or death issue.

Research in the attitude area also provides useful information on the likelihood of change and optimal strategies for effecting and maintaining change. While attitudes can certainly be changed, they also have considerable inertia and resistance to modification. (This is a good characteristic; if attitudes were highly malleable, we would be vulnerable to every commercial, advertisement or pitchman we encounter!). Attitude change also has much in common with the phenomenon of religious conversion. The new believer is vocal and enthusiastic about his/her experience, but backsliding is an all too common phenomenon. From these characteristics of attitude change, we can extract several guidelines.

First, the training effort must be credible, powerful, and active. Recipients must believe that the program is meaningful and likely to produce personally useful results. Some early attempts at resource management training were dismissed by line pilots as "charm school"-attempts to change personality and create harmony. We are not talking about getting everyone together and "holding hands in hot tubs." Participants with such attitudes tended to discount the whole process. Overall, I think the outstanding work by NASA and the NTSB has made the concept visible and credible in the industry, making the training task much easier. Nonetheless, there is still an army of doubting Thomases who must be convinced and a group who may never be convinced, given their personalities and defenses. With regard to power and activity, the trainee needs to be personally involved and actively participating in the process. The classic lecture/text instructional format does not provide the involvement and personal learning necessary to effect real change. In this context, LOFT with videotape feedback is one of the most powerful tools we have. I am convinced that CRM training without the chance for practice and self-observation that comes with LOFT will be relatively ineffective. There is also a danger that LOFT scenarios will become widely known and communicated, leading participants to pre-program. I would recommend serious consideration of this threat during our working group sessions.

Second, the Instructor/Facilitator/Trainer role is critical. The concepts involved and complexities of human behavior are formidable. The well-trained, sensitive instructor can make an enormous difference in impact and outcome. We need to devote considerable attention to the selection and training of program personnel. This also implies that we develop strategies to monitor and evaluate the effectiveness of the trainers we choose.

Third, CRM training must be continuously reinforced and omnipresent. For the religious convert, life in a world of sin and temptation without constant reinforcement leads to backsliding. Similarly, flying in an organizational climate that devalues resource management and does not reinforce its goals and practices will lead to the decay of the training impact and business as usual. This implies that one-shot CRM training, even with a powerful LOFT will not produce enduring change. It is also likely that providing the training for only one crew position, for example, Captains, will greatly degrade program effectiveness. It is critical that the concept be endorsed wholeheartedly by management, pilots' organizations, and opinion leaders in the pilot force to provide a climate in which the practice will flourish. It is also essential that CRM training be an integral part of the total training and checking process including initial, transition and upgrade as well as recurrent. Line Check Airmen can also play a crucial role by providing feedback and guidance in resource management during daily line operations--which is where it really takes place. This suggests that the Check Airmen force should become an integral part of the CRM training process, perhaps with special attention to selection and training.

In summary, from a psychologist's viewpoint, I am extremely enthusiastic about the potential of CRM training as a means of effecting real change in the bottom line of safe and efficient operations. The goals are attainable and we have the technology to reach them. Having just said that, I must make two qualifications. The first is that there are limitations on what the training can accomplish, as noted in the case of personality. The second is that there are serious gaps in the knowledge base necessary to make the

training as effective as possible and I would like to close by mentioning some of these.

While we have enormous resources in terms of knowledge and skill in training, we are trying to effect change in complex behavior where there is often no single best procedure. As Professor Hackman will stress in his discussion, we know much less about evaluating the performance of *groups* than we do about individuals. Let me simply list a few questions that need answers so that we can make the training most potent. How much change do we produce in day-to-day resource management on the flight deck? How enduring is the change produced? Do individuals revert to old, maladaptive habits under conditions of high stress? Who are the individuals for whom the training is ineffective? (If we can isolate these individuals, we could explore special training strategies. Perhaps even more importantly, we should be able to make considerable improvements in the pilot selection process.) How do we select and train the most effective trainers? What topic areas produce the most marked change in behavior? What training techniques are most effective?

The preceding list is by no means exhaustive, but as you can see it implies a very substantial research endeavor with a high potential payoff. It would be extremely helpful if at least partial answers were available *before* specific requirements for this type of training become part of the Federal Aviation Regulations. After drafting these remarks, I was particularly pleased to read the National Transportation Safety Board Aircraft Accident Report (NTSB/AAR-86/01) covering the Galaxy Electra crash at Reno. The report presents a sophisticated analysis of the crew coordination difficulties developing from a mechanical abnormality on take-off and reiterates a call for research on the most effective means to train all flightcrew members in cockpit resource management. It further recommends that guidance on topics and training in CRM be provided until research data suggest optimal regulatory action. This report provides us with a good framework for deliberation while emphasizing the need for definitive research.

There are several points I would like to make concerning the needed research and the evaluation of the effectiveness of CRM/LOFT. I have already noted that personality factors of crewmembers may provide some limits on what can be accomplished. Second, the climate and constraints in the organization and environment where the training takes place will heavily determine the impact the training has. The bottom line is that it may be extremely difficult to document the true effects of these programs in the short run. Does this mean that the research is not needed or important? Absolutely not! In fact, knowing in advance that there are undoubtedly limitations on training efficacy makes it even more critical that we establish baseline data on the resource management practiced *now* and let the data inform us how to increase our effects on all fronts. The necessary research cannot be conducted in the quiet splendor of the laboratory. It will have to be accomplished in the complex arena of daily flight operations and will have to consider the effects of training in the total context of the organization and the regulatory environment. Conducting meaningful research on these questions necessarily raises issues of great sensitivity regarding the protection of individuals and organizations along with concerns for maintaining the highest level of safety. To be valid, detailed data must be collected on all aspects of flight operation and related to training practices. This means, of course, looking at defects and instances of sub-standard performance in a non-punitive way to make sure the data reflect the true state of the system. NASA's

Aviation Safety Reporting System is an example of such an approach to data collection, but it is not typical of the way organizations keep data on flight operations and proficiency. Good research can be done if those who need the results most critically, including line pilots, managers, and regulators, cooperate to develop a comprehensive and competent strategy.

The questions before us are many and complex, but looking at progress since the 1979 convocation in this room, I am confident that the collective efforts of this group will produce a comparable effect.

REFERENCES

- Chidester, T. (1986) *Mood, sleep and fatigue effects in flight operations*. Unpublished doctoral dissertation, The University of Texas at Austin.
- Cooper, G.E., White, M.D. & Lauber, J.K. (Eds.), (1979) *Resource management on the flight deck*. NASA Conference Publication 2120.
- Edwards, V.J. (1986) *Flightdeck management attitudes: A cluster analysis*. Proceedings of the 10th Psychology in the Department of Defense Symposium.
- Foushee, H.C. (1984) Dyads and triads at 35,000 feet: Factors affecting group process and aircrew performance. *American Psychologist*, *39*, 886-893.
- Griffin, G.R. & Mosko, J.D. (1977) *Naval aviation attrition 1950-1976: Implications for the development of future research and evaluation*. Pensacola, Florida: Naval Aerospace Medical Research Laboratory.
- Helmreich, R.L. (1979) Social Psychology on the flight deck. In Cooper, G.E., White, M.D. & Lauber, J.K. (Eds.), (1979) *Resource Management on the flight deck*. NASA Conference Publication 2120.
- Helmreich, R.L. (1982) *Pilot selection and training*. Paper presented at the American Psychological Association, Annual Meeting, Washington, D.C.
- Helmreich, R.L. (1983) Cockpit management attitudes. *Human Factors*, *26*, 583-589.
- Helmreich, R.L., Foushee, H.C., Benson, R., & Russini, W. (in press) Cockpit resource management: Exploring the attitude-performance linkage. *Aviation, Space, and Environmental Medicine*.
- Helmreich, R.L., Sawin, L.L. & Carsrud, A.L. (in press) The honeymoon effect in job performance: Delayed predictive power of achievement motivation. *Journal of Applied Psychology*.
- Helmreich, R.L., Hackman, J.R. & Foushee, H.C. (1986) *Evaluating flightcrew performance: Policy, pressures, pitfalls, and promise*. NASA/University of Texas Technical Report 86-1. Austin, Texas.
- Helmreich, Wilhelm, & Siem (1984) *Mood, sleep, personality: A preliminary report*. Austin: NASA/University of Texas Technical Report, 84-6.
- Melton, A.W. (1947) *Army Air Force aviation psychology program: Report No. 4: Apparatus tests*. Washington, D.C.: Defense Documentation Center.
- National Transportation Safety Board (1986) *Aircraft accident report*. Galaxy Airlines, Inc., Lockheed Electra-L-188C, N5532. Reno, Nevada. January 21, 1985. Washington, D.C. NTSB/AAR-86/01.