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Facilitation Techniques as Predictors of Crew Participation in LOFT Debriefings

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Summary

Based on theories of adult learning and airline industry guidelines for Crew Resource Management (CRM), the stated objective during Line Oriented Flight Training (LOFT) debriefings is for instructor pilots (IPs) to facilitate crew self-analysis of performance. This study reviews 19 LOFT debriefings from 2 major U.S. airlines to examine the relationship between IP efforts at facilitation and associated characteristics of crew participation. A subjective rating scale called the Debriefing Assessment Battery was developed and utilized to evaluate the effectiveness of IP facilitation and the quality of crew participation. The results indicate that IP content, encouragement, and questioning techniques are highly and significantly correlated with, and can therefore predict, the degree and depth of crew participation.

1. Introduction

This study evolved from a larger project in which we are studying the content and conduct of Line Oriented Flight Training (LOFT) debriefings (Dismukes, McDonnell, Jobe, & Gregorich, 1995). Most of the major U.S. airlines use LOFT as the key training tool in their ongoing Crew Resource Management (CRM) training programs, and the pilots in most major U.S. airlines are required to go through recurrent LOFT training every year. Helmreich and Foushee (1993) assert that in order for the LOFT training to be meaningful, it is essential to debrief after each session. At all of the airlines studied, the organizations' stated objective for LOFT instructors is to act as facilitators, enabling the crew members to perform their own analysis of their performance. Unfortunately, LOFT instructors are given very little guidance on what facilitation is or about how to facilitate and this contributes to the common problem that debriefing sessions generally don't reach their full potential (Chidester, 1993; see also Butler, 1993; Helmreich, Chidester, Foushee, Gregorich, & Wilhelm, 1990).

Although it is widely assumed that facilitation is the best debriefing strategy, there does not appear to be much empirical research on how facilitation of group interaction can enhance group performance (Hirokawa & Gouran, 1989) or on specific techniques conducive to facilitation which may be applicable to the debriefing of airline crews. Most of the literature found and cited here consists of assertions for which no empirical evidence is presented. Another problem is that most of the evidence that is available does not necessarily generalize to the LOFT environment because there are important differences between instruction in commercial aviation and that in the educational setting, from which most of the research comes (Reynolds, 1992; Telfer, 1993). Consequently, this study will review actual LOFT debriefings in order to examine the relationship between IP efforts at facilitation and associated characteristics of crew participation.

1.1 Crew Resource Management

Crew Resource Management was defined by Hawkins (1987) as the management and utilization of all available resources on the aircraft, including people, equipment, and information. The underlying philosophy of CRM training is that cockpit performance can be improved through a heightened awareness of CRM skills (Smith, 1994), such as communication, coordination, and task and workload management. The ultimate goal is to increase the safety, effectiveness, and efficiency of flight operations (Gregorich & Wilhelm, 1993). According to the Federal Aviation Administration (FAA) this goal is achieved through the integration of technical proficiency and the human skill of crew coordination (Driskell & Adams, 1992).

CRM training has been utilized since 1979 when United Airlines developed the first formal CRM training program (Smith, 1994). As a precursor to formal CRM training, NASA and

Northwest Airlines began to develop the training of airline pilots as crews by about 1975 (Hawkins, 1987). The idea of crew resource management evolved from studies conducted by NASA researchers in the 1970's that attempted to determine the factors underlying air carrier accidents. The FAA reports that interviews with airline pilots indicated that a consistent component in accidents was what pilots perceived as inadequate training in crew coordination (Driskell & Adams, 1992). This finding led to research such as Ruffell-Smith's (1979) simulation study which found that crew coordination was significantly related to safety. Specifically, most problems were related not to technical knowledge and skills, but to breakdowns in crew coordination (Smith, 1994). Statistics from 1959-1989 on the causes of airline accidents indicate that over 70% of worldwide public transport accidents were due to flight crew error (Helmreich & Foushee, 1993). Billings and Reynard (1981) found that over 70% of a large group of incidents they analyzed that were anonymously reported to the Aviation Safety Reporting System (ASRS) contained evidence of errors in information transfer, the most common (37% of the incidents) being failure to initiate communication.

Findings such as those above led to the 1979 NASA/Industry Workshop on Resource Management on the Flight Deck, which converged the efforts of NASA , the military, and the commercial airline industry to address these issues (Driskell & Adams, 1992). The FAA also recognized the value of CRM training and changed the Federal Aviation Regulations (FARs) regarding crew proficiency training, thereby approving CRM/LOFT training sessions as a substitute for certain crew proficiency checks (Driskell & Adams, 1992; Hawkins, 1987). The FAA further projects that CRM may one day be a requirement in all aircrew certification programs (Driskell & Adams, 1992).

1.2 Line-Oriented Flight Training

LOFT is a component of CRM training in which pilots teamed together as flight crews fly realistic real-time scenarios in a mission-oriented simulator and use CRM principles to complete the flight successfully (Foushee & Helmreich, 1988; Smith, 1994). The development of LOFT is credited by Hawkins (1987) to the realization that it is not sufficient to look at individual proficiency alone for skills that need to be practiced in group activities (Smith, 1994). In the cockpit, overall performance is the outcome of the interaction of crew members, including their communication, coordination, and workload management (R. K. Dismukes, personal communication, September 19, 1995); therefore, team proficiency needs to be assessed.

The purpose of the LOFT in CRM training is to allow flight crews to work together as teams to solve problems that occur (Hawkins, 1987). In the LOFT, as human and equipment errors occur there is no intervention. They are allowed to occur just as they are on a real flight, and it is up to

the crew to manage their resources effectively to resolve the errors. The goal of the LOFT is to improve the effectiveness of crews in managing their resources on the flight deck, including the management of human error (Hawkins, 1987).

1.3 Debriefing the LOFT

An essential element of the LOFT session is the debriefing. Debriefing is defined by Thiagarajan (1986) as "the process of helping people reflect on their experiences to derive meaningful lessons." According to Helmreich and Foushee (1993) the debriefing of LOFT sessions is critical to achieving an impact on flight crew behavior. In order for the debrief to be most effective, some authors recommend that the discussion be led by the crew themselves using the instructor/facilitator and the videotape of the LOFT session as resources for the self-critique (Butler, 1993; Hawkins, 1987; Smith, 1994). The self-analysis of the LOFT which results from a crew-led discussion has been asserted by Butler to be highly effective in improving the CRM performance of airline pilots.

The assumption that self-analysis is the most desirable and successful debriefing strategy is supported by Duval and Wicklund's (1972) Theory of Objective Self-Awareness. This theory proposes that objective appraisals of oneself are often forced by self-focusing stimuli, and that such appraisals may lead to attitude and behavioral changes (Smith, 1994). From this theory, it logically follows that since the goal of CRM training is to reduce human errors in the cockpit, CRM skills should be explored by the participants themselves rather than lectured by an instructor. Such objective self analysis enables pilots to examine their own management skills and to try other CRM techniques that may be more effective than the ones they currently use (Butler, 1991). The hope is that by debriefing themselves during LOFT, pilots will develop this important skill and begin to debrief themselves with increasing frequency on the line (Butler, 1993; Smith, 1994).

The LOFT facilitator. As indicated above, the LOFT facilitator is one of the two key resources crews need to utilize to debrief themselves. Because the debriefing process is truly self-learning, the CRM instructor is commonly referred to as the "facilitator" (Byrnes & Black, 1993). In the role of facilitator, the Instructor Pilot (IP), is expected to guide crews to self-realization and reinforce instances of effective team behavior, not lecture to them about deficiencies or errors that may have occurred (Helmreich, 1987; Helmreich & Foushee, 1993). According to the original LOFT guidelines, the LOFT instructor is not really a teacher, but a moderator whose role is to do everything possible to foster self-analysis and to guide the debriefing session so the crew can explore the full range of potential solutions to the problems encountered (Lauber & Foushee, 1981). Gibb (1982, p. 16) asserts that the basic philosophy underlying facilitative training is that there's no such thing as teaching, only the facilitation of learning, and that

"involvement, accountability, and feedback are essential elements of effective adult learning." Thus, participants are expected to accept responsibility for their own learning, and facilitators are expected to recognize that the active involvement of the participants is essential (Gibb, 1982).

In its handbook on LOFT facilitation techniques, Continental Airlines (1992) has presented a clear and useful hierarchy for the effective facilitator based on the concepts of discovery and ownership. According to Continental Airlines, the facilitator's preference is always to have the trainees recognize what they did well and what they need to improve (discovery), and to make a commitment to continue and/or begin using desired behaviors and to stop using undesirable ones (ownership). At the top of the hierarchy is "they see it, they say it." This is the ideal in which the trainees recognize and analyze their own performance. In the middle is "you help them see it, they say it." If the trainees are not able to recognize where they did well and where they can improve, the facilitator can lead them to self-analysis through questioning. Finally, at the bottom of the hierarchy is "you help them see it, you help them say it." When the crew is unable to recognize or evaluate their performance the facilitator must evaluate for them to ensure that they understand what went well or poorly, and why.

The videotape. In addition to the facilitator, the videotape of the LOFT session is an important resource for the crew to use to enhance the debriefing. The facilitator is expected to mark relevant events on the tape during the LOFT session so he or she can draw the crew's attention to important points for discussion (Mellor, 1993). R. K. Dismukes (personal communication, September 19, 1995) asserts that a primary contribution of videos may be to remind crews what transpired at critical segments during the LOFT, because it is often difficult for participants to remember specific details of the typically long and stressful sessions. Although the effectiveness of video use in LOFT debriefings has not been studied empirically, the use of videos is assumed to be valuable because videos enable crews to review their actions and then examine and gain insight into their own behavior with the detachment of observers (Helmreich, 1987; Helmreich & Foushee, 1993). Nelson-Jones (1992) reports that videos can encourage self-assessment by participants by helping them identify behaviors that were both helpful and harmful to the final outcome. The realistic feedback that videos provide can make it easier for facilitators to involve the entire crew in a discussion of their team performance, thus enhancing the overall potential of the training session (Orlady, 1993).

1.4 Adult Learning Theory

The industry guidelines for facilitation are derived largely from adult learning theory. According to Cornwell (1979), most experts agree that adult learning is self-directed, and thus adults learn more in guided discussion than they do from lectures. Recent research by Smith (1994) has gone a step closer to demonstrating that the benefits of guided discussion may apply to the LOFT environment. Smith discovered that guided self-analysis produced strong gains in ratings on the Line/LOS (Line Operational Simulations) checklist, which evaluates performance of CRM skills both on the line and in the simulator, for a single experimental crew consisting of two undergraduate students in a CRM training course.

A body of research based largely on survey studies of what adults dislike in the classroom and what constitutes good and bad meetings has resulted in several implications for training which have been adopted by the airline industry (Zemke & Zemke, 1981). They include the findings that adults strongly dislike long lectures; that their self-esteem is on the line because they tend to take things personally; that they can learn well, and more, from discussions with their peers; that new knowledge must be integrated with old through active participation; and that it is critical to articulate and clarify all expectations up front (Continental Airlines, 1992; Zemke & Zemke, 1981).

1.5 Level of Mastery

For LOFT crews to achieve their main debriefing objective of analyzing the situation and evaluating their performance in depth, it is necessary to utilize a high level of cognitive processing. According to B. S. Bloom (1956) there are six levels of mastery, which are arranged hierarchically by the level of mental complexity involved in doing them (Downing, 1995). The six levels from least to most demanding are knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, 1956; Downing, 1995). It can be assumed that pilots involved in recurrent training have already mastered knowledge and comprehension. Participation in the LOFT is an example of application; in new situations crews are expected to apply what they have learned. The debriefing provides the opportunity for crews to take mastery to the higher levels. The stated debriefing objective of having the crews analyze and evaluate their LOFT performance is consistent with Bloom's taxonomy of achieving the highest level of mastery. The emphasis of analysis is for participants to break down the overall scenario into individual parts and explore the relationship between the parts (Bloom, 1956; Downing, 1995). In the LOFT setting crews explore the relationship between events in the scenario and specific CRM topics and how these affect the outcome. Evaluation requires making judgments. In the LOFT setting crews are expected to evaluate their performance and explore ways they can improve.

1.6 Facilitation

According to Gow and Kember (1993) facilitation is oriented toward helping individuals develop problem solving and critical thinking skills. Facilitation is the foundation of many commonly used counseling techniques, several of which may provide insight into potentially effective LOFT facilitation techniques. To encourage participation and to influence content, Hackney and Nye (1973) recommend avoiding interrupting participants, which can undermine their participation; using silence to make it clear that the participants are responsible for the discussion; using active listening, which demonstrates that the facilitator is listening and provides "significant reinforcing value" (p. 58); and using probing questions, which prevent yes/no and other minimal responses. Additional facilitation techniques recommended in the counseling literature include letting participants know at the beginning that participation is expected, encouraging participants to talk to each other (interaction), and inviting participation by asking for general input (Nelson-Jones, 1992).

The above counseling strategies, as well as the adult learning literature, suggest several techniques that can be utilized during LOFT debriefings to facilitate active and in-depth participation. Particularly relevant techniques include the introduction, active listening, questions, and silence.

Introductions. Introductions are important because clarifying the role of the facilitator (Casey, Roberts, & Salaman, 1992) and indicating that participation is expected (Nelson-Jones, 1992) are reported to set both the trainer and the group up for success (Gibb, 1982). According to the literature, adults need to know what is expected of them, so it is critical to clarify the expectations of both the trainer and the trainees before training begins (Continental Airlines, 1992; Zemke & Zemke, 1981).

Active listening. While facilitators need good speaking skills to be effective, good listening skills are also critical (Gibb, 1982). According to Gibb, active listening is one of the most useful tools the facilitator can utilize to encourage continued participation; it shows the crew that the facilitator is listening and understands what they are saying. Active listening can range from a simple "uh, huh" or "okay" to echoing or reflecting in one's own words what the participants say.

Questions. According to the Socratic method, learning is facilitated by questioning, encouraging exploration, and pushing for explanation; not by lecturing and telling the answers (Casey et al., 1992). Various types of questions that can aid self-assessment include "Can you give me a specific example?" "How did you and the other person actually behave?" and "What were your thoughts in the situation?" (Nelson-Jones, 1992). There are general guidelines for effective questioning that are recognized as standard, particularly in educational and counseling settings, but

few clearly defined and exemplified techniques. Mills and Roberts (1981) assert that ideally, questions should be brief; open (i.e. non-restrictive, don't imply opinion or judgment); and begin with who, where, and when for factual responses, or what, how, and why for more in-depth and detailed answers.

The use of probing questions can be particularly effective in encouraging active and in-depth participation, which is the main goal of the LOFT debriefing. Successful probing has been found to result in increased depth of discussion by getting participants to further explain and justify their responses (Jacobsen, Eggen, & Kauchak, 1989). Mills and Roberts (1981) established seven types of probes which can be used to encourage continued participation. The seven types are non-verbal (e.g. a nod); short verbal ("Uh, huh?"); "W" words (especially what, how, and why); statements like "Tell me more."; echoing of participant words; reflection of what the participant said with different words but the same meaning; and specialized reflections that imply more than stated by the participant (Eitington, 1986; Mills & Roberts, 1981).

Silence. When questions are not answered immediately, a three to four second wait-time has been found to improve the quality of responses (Rowe, 1986; Jacobsen, et al., 1989). Though periods of silence may seem awkward, there are numerous beneficial effects of increasing wait-time to three or four seconds from the usual one second wait-time. Not only do the length and confidence of responses increase, but initiation in the form of unsolicited responses, interactive participant responses, and participant questions increases. In addition, responses from slower participants increase, speculative responses and evidence-inference statements increase, and failures to respond decline (Ornstein, 1990; Rowe, 1974).

1.7 Industry Guidance

According to the FAA (Driskell & Adams, 1992), there is no one right way to implement CRM training. Each of the airlines develops its own program to match its own needs and organizational culture. However, there are several fundamental principles of CRM which are essential to effective training programs. First, effective performance depends on a combination of technical and interpersonal skills, so both technical and CRM skills need to be included in the overall training curriculum. Second, CRM focuses on the attitudes and behaviors of crew members, and a primary focus of CRM is to develop effective team coordination; therefore CRM must include the entire flight crew to be effective. Finally, to acquire effective CRM skills, the active participation of all crew members is required. Active participation and practice, including LOFT simulations, are considered essential to gaining effective resource management skills (Driskell & Adams, 1992, pp. 8-9).

2. Purpose and Rationale

The purpose of the larger study of which this study is a part was to determine (a) the extent to which what the crews actually do during LOFT debriefings is consistent with the airline industry objectives of active participation and in depth analysis, (b) whether the techniques the instructors use are consistent with the objective of facilitating these crew objectives, and (c) how effective the facilitation techniques used by the instructors are at eliciting active crew participation and in depth analysis of LOFT performance. The overriding goal of the larger study was to develop guidelines for facilitation, incorporating recommendations for specific techniques with examples of how to apply them, that the airlines can use to teach their instructors how to be effective facilitators.

The main focus of the present study is to develop a tool to assess the effectiveness of IP facilitation and to determine whether this tool can be used to predict the desired aspects of crew performance, namely active participation and in-depth analysis. This tool should enable us to identify specific instructor techniques that correspond with active crew participation and in depth analysis of LOFT performance.

3. Method

3.1 Subjects

Archival data from nineteen LOFT debriefing sessions, composed of all male airline pilots assembled for recurrent training at two major U.S. airlines, were used in this study. All sessions were led by one to two IPs, and the crews consisted of line pilots assembled as either two or three person crews. All 19 crews included line pilots acting as a Captain (CA), and a First Officer (FO). Three person crews also included a line pilot acting as a Flight Engineer (FE), or, if a line pilot was not available, an instructor playing the role of the Flight Engineer (FEI) in both the LOFT and the debriefing. Specifically, eleven of the sessions included one IP, a CA, and an FO; one session included two IPs, a CA, and an FO; one session included one IP, a CA, an FO, and an FE; two sessions included one IP and one FEI, a CA, and an FO; and four sessions included two IPs, a CA, an FO, and an FE. These groups were formed randomly, and in this respect the training is representative of line operations, in which crews are newly formed each month.

3.2 Materials

Audiotapes and transcripts. Audiotapes and matching transcripts of real LOFT debriefings collected and produced in the study by Dismukes et al. (1995) were utilized for this study (see Appendix A). The identities of individuals and airlines involved in the study were coded to maintain confidentiality.

Debriefing Assessment Battery. The Debriefing Assessment Battery is a subjective rating scale for use by subject matter experts. The battery was developed for this study to characterize IP effectiveness at facilitation and the nature of crew participation in LOFT debriefings in a systematic way. The Debriefing Assessment Battery is based on a combination of adult learning and facilitation literature, existing rating scales by M. M. Connors (1995) and R. H. Moos (1994), face valid assumptions of what constitutes good facilitation, and the airline industry's guidance to their instructors on how to facilitate LOFT debriefings. The battery incorporates a seven-point Likert scale ranging from poor (1) to outstanding (7). The purpose of the scale is to evaluate IP performance on several dimensions central to facilitation, to evaluate the extent and character of crew participation, and to explore the relationship between what the IP does and what the crew members do. Appendix B presents the complete Debriefing Assessment Battery.

The Debriefing Assessment Battery contains 28 items grouped into seven composite categories consisting of four items each. Five of the categories rate the IP while the remaining two rate the crew. The five IP categories are introduction (letting the crew members know what is expected), questions (to focus on topics and provoke the crew to participate deeply), encouragement

(the degree to which the IP encourages and enables the crew to participate actively and deeply), content of discussion (getting the crew to analyze and evaluate their own CRM performance), and videos (to remind the crew of what happened and enable them to evaluate their performance objectively). The two crew categories are content of discussion (the depth to which they analyze and evaluate the situation and their performance) and activity (how actively and thoroughly they participate in and initiate discussion).

3.3 Procedure

Two expert raters independently rated the IPs and crews from each of the 19 debriefing sessions using the Debriefing Assessment Battery (see Appendix B). The raters listened to each LOFT session audiotape while reading the verbatim transcripts to preserve the subtle effects of vocal inflection and other nuances of verbal communication that are essential to accurate interpretation. Both raters took notes while they reviewed the sessions to assist in scoring the battery and support the derived ratings. For each of the first 10 sessions, after independently completing the battery, the raters compared and discussed their ratings on the individual battery items before going on to the next session. During each discussion, if either of the raters believed their ratings needed to be changed based on issues raised by the other, they revised their scores accordingly, although no effort was made to reach consensus on each item. This process was implemented in order to resolve any discrepancies in the interpretation of events that transpired during the sessions or the meaning of the battery items. For the final nine sessions the raters completed the batteries independently without discussion. For all 19 crews the final individual and composite scores were obtained by averaging the raters' scores.

The composite scores for the five IP and two crew categories were calculated by adding the combined raters' scores for the four items in each category. For videos, however, the composite score was calculated for only three of the four items because the fourth item was added to the scale after several crews had already been rated. The combined scores on each item can range from 2-14, so the regular composite scores can range from 8-56 (6-42 for videos) while the combined IP facilitation score can range from 24-168.

4. Results

The research findings indicate that crew performance scores can be predicted from IP performance scores on the Debriefing Assessment Battery. The degree and quality of crew participation are highly correlated with several techniques utilized by IPs to facilitate discussion. Also, the findings that the obtained composite scores varied among IPs and crews, and that this variance is agreed upon between raters, suggest that the rating scale reliably measures differences in IP and crew performance. In this section, interrater reliabilities will be presented first, followed by data based on the comparison of IP and crew scores, and finally results of the correlations of IP and crew measures. Pearson product-moment correlation coefficients (r) were used for all correlation analyses.

4.1 Interrater Reliability

In order to test the interrater reliability of battery scores, Pearson correlation coefficients (r) were calculated. Scores initially assigned by both raters, prior to discussion and adjustments, were used for the calculation of the reliability coefficients. For the first five sessions from Airline Z, interrater reliability was moderate for overall IP scores (r = .60) and high for overall crew scores (r = .83). For the final four sessions reliability increased substantially for overall IP scores (r = .96) and remained high for overall crew scores (r = .81). For all 10 sessions combined, the reliabilities for overall IP (r = .82) and crew scores (r = .77) were both high. For the nine crews from Airline Y, interrater reliability was high for overall IP scores (r = .77) and moderate for overall crew scores (r = .53), though both were lower than the reliabilities for Airline Z. This decrease in reliability may be attributed to the fact that the sessions were longer and more complex for Airline Y. Finally, the reliabilities for all 19 sessions from Airlines Y and Z combined were high for both overall IP (r = .78) and overall crew scores (r = .73), as were the reliabilities for scores on each of the IP and crew measures (see Table 1).

4.2 Comparisons of IP and Crew Scores

In order to determine whether there are significant differences between the mean scores of the two airlines, t-tests were calculated for the means of each IP and crew variable across airlines. It was determined that there are no significant differences in means, and therefore the scores from the two airlines will be combined for all remaining analyses (see Table 1). The only exception is videos, for which there is a statistically significant difference between the means of the two airlines, $t(17) = 2.25$, $p < .05$.

Table 1

Interrater Reliabilities, Mean Scores, and *t*-values Across Airlines

Subjective variables	N	Interrater reliability	Z Crews (n = 10)		Y Crews (n = 9)		t value
			Mean	SD	Mean	SD	
IP							
Introduction	18	.92	10.80	3.26	16.38	10.35	1.47
Questions	19	.72	33.20	15.70	40.22	5.26	1.33
Encouragement	19	.79	30.90	15.37	40.67	5.29	1.89
Content	19	.82	33.30	13.98	40.11	5.46	1.42
Videos	18	.77	33.30	7.17	25.25	8.03	2.25*
Overall IP	19	.78	141.50	49.94	162.63	27.65	
Crew							
Content	19	.74	33.20	14.70	38.00	6.86	.93
Activity	19	.70	35.30	15.03	40.56	8.88	.94
Overall Crew	19	.73	68.50	29.40	78.56	15.04	

* $p \leq .05$.

In order to determine the distribution of IP and crew scores on the assessment battery, frequencies were tabulated for each variable (see Table 2). While the majority of IPs scored poor on introductions (very few gave one), there was more variation among IPs and crews on the remaining variables, with scores averaging in the good range.

Table 2

Frequencies of Rating Scores on the Debriefing Assessment Battery

	Rating Scores (Average of the two raters)						
Subjective variables	Poor	Marginal	Needs Improve	Adequate	Good	Very Good	Outstanding
IP							
Introduction	12	4	1	0	1	0	0
Questions	1	2	1	4	4	7	0
Encouragement	2	2	0	2	8	5	0
Content	1	2	0	3	9	4	0
Videos	0	1	3	3	2	8	1
Crew							
Content	1	2	1	3	8	4	0
Activity	1	0	5	1	5	6	1

4.3 Relationships Among IP and Crew Scores

Relationships between subjective Debriefing Assessment Battery variables.

In order to determine whether subjective ratings of crew activity and crew content can be predicted from subjective IP scores, Pearson correlation coefficients were calculated between all IP composite scores (predictor variables) and the two crew composite scores (criterion variables) on the Debriefing Assessment Battery (see Table 3). For each variable in the study the sample size is 19, except introduction and videos, for which N = 18 (the audio recording began after one session had already started, and the video equipment was non-functional for another session). An alpha level of .05 was used for all statistical tests in this study.

Table 3

Correlations Between Subjective IP Variables and Subjective Crew Variables

	Subjective Instructor variables[a]				
Subjective[a] Crew variables	Introduction	Questions	Encourage	Content	Videos
Activity	-.17	.54 *	.68 ***	.57 *	-.14
Content	-.10	.70 ***	.77 ***	.76 ***	-.08

[a] See Debriefing Assessment Battery (Appendix B)

*p ≤ .05. **p ≤ .01. ***p ≤ .001.

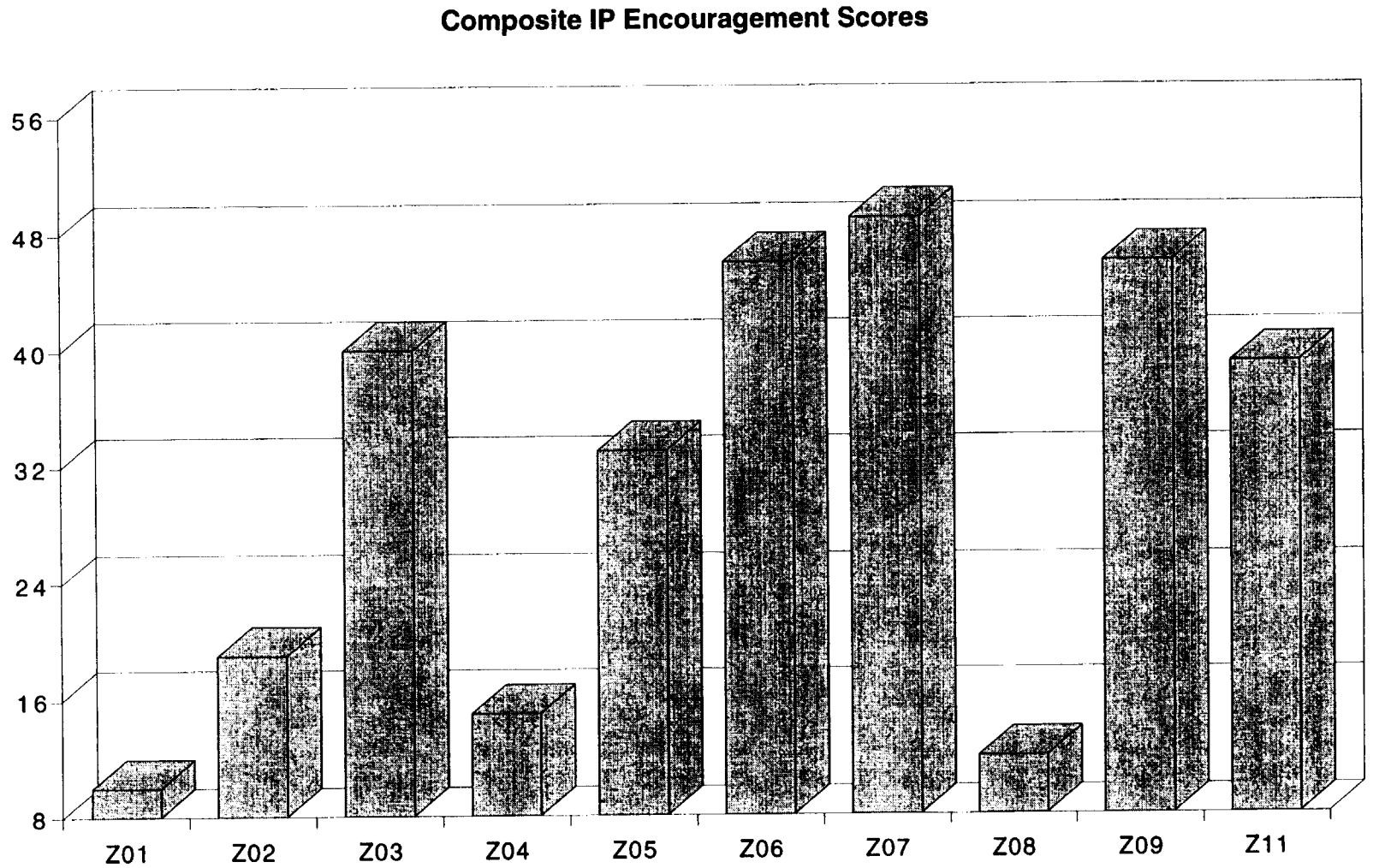

Figure 1. Composite IP encouragement scores for Airline Z on the Debriefing Assessment Battery

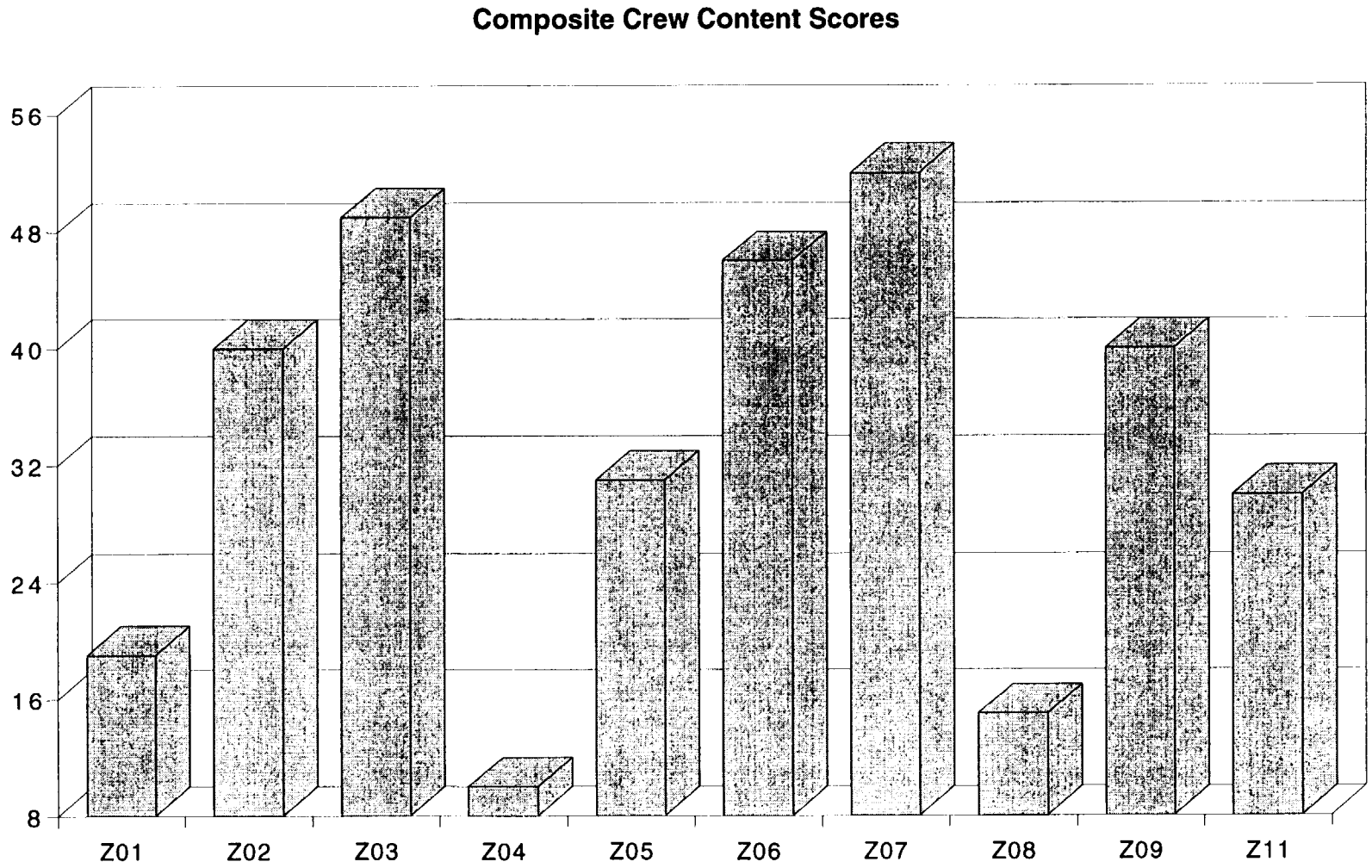

Figure 2. Composite crew content scores for Airline Z on the Debriefing Assessment Battery

The correlations of crew activity with IP questions (r = .54), IP encouragement (r = .68), and IP content (r = .57) are all moderately high and statistically significant. The correlations of crew content with IP questions (r = .70), IP encouragement (r = .77), and IP content (r = .76) are high and are also statistically significant. The correlations of crew scores with IP introduction and video scores are not statistically significant (r = -.17 and -.14 respectively for crew activity; r = -.10 and -.08 respectively for crew content). The similarity of the patterns of these IP and crew scores can be seen by comparing Figures 1 and 2, which present the actual encouragement scores for each IP from Airline Z and the actual content scores for each crew from airline Z. These figures demonstrate how closely the IP and crew scores correspond with each other across sessions..

To determine how closely related each subjective IP score is to the others, a correlation matrix was computed for intercorrelations between the subjective IP measures (see Table 4). Questions, encouragement, and content are all highly and significantly correlated with each other at the .001 level. This indicates that the effects of one variable cannot be separated from the others, so correlations of each of these variables with crew variables and objective IP variables may be indirectly affected by the others.

Table 4

Intercorrelations Between Subjective IP Variables

Subscales	1	2	3	4	5
1. Introduction	--	.35	.30	.40	.15
2. Questions		--	.94 ***	.94 ***	.16
3. Encourage			--	.89 ***	.03
4. Content				--	.08
5. Videos					--

*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$.

Correlations between subjective variables from the Debriefing Assessment Battery and objective variables from study by Dismukes et al. (1995). Pearson correlations were calculated to determine the relationship between subjective scores on the Debriefing Assessment Battery and objective measures from the study by Dismukes et al. (1995). Definitions of the objective IP and crew measures are presented in Appendix C.

First, correlations were calculated to determine the relationship between the subjective IP scores and five objective measures of crew participation (see Table 5). The only significant correlations are for the objective measures percent of crew participation (r = .57) and number of crew analyzing utterances per hour (r = .58) with the subjective measure of IP encouragement.

Table 5

Correlations Between Subjective IP Variables and Objective Crew Variables

	Subjective Instructor variables[a]				
Objective[b] **Crew variables**	Introduction	Questions	Encourage	Content	Videos
Percent participation	-.19	.34	.57 *	.33	-.38
Words per Response	-.11	.27	.31	.39	.12
Self-initiated words	-.29	.11	.36	.09	-.23
Analyzing utterances	-.28	.38	.58 **	.43	-.20
Proactive questions	.00	-.16	-.01	-.24	-.26

[a] See Debriefing Assessment Battery (Appendix B)

[b] See Appendix C

*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$.

Next, correlations were calculated between subjective and objective crew variables to determine whether the two types of variables measure similar characteristics of crew participation. The correlations of the subjective measure of crew activity with the objective measures of percent participation ($\underline{r}$ = .86), number of words per response ($\underline{r}$ = .63), self-initiated statements ($\underline{r}$ = .65), and analyzing utterances per hour ($\underline{r}$ = .80) are all high and statistically significant (see Table 6). The correlations of the subjective measure of crew content with percent participation ($\underline{r}$ = .71), number of words per response ($\underline{r}$ = .65), and analyzing utterances per hour ($\underline{r}$ = .71) are moderately high and are also statistically significant.

Table 6

Correlations Between Subjective and Objective Crew Variables

	Objective variables[a]				
Subjective variables[b]	Percent participation	# of words per response	Self-initiated words	Analyzing utterances	Proactive questions
Activity	.86 ***	.63 **	.65 **	.80 ***	.08
Content	.71 ***	.65 **	.45	.71 ***	-.08

[a] See Appendix C

[b] See Debriefing Assessment Battery (Appendix B)

*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$.

Finally, correlations were calculated between subjective and objective IP measures to determine whether they measure similar components of IP facilitation. The three subjective IP measures of questions, encouragement, and content were found to have statistically significant correlations with three objective IP measures (see Table 7). The subjective measure of questions is moderately correlated with the objective measures of number of directed questions IPs ask per hour ($\underline{r}$ = .62) and the total number of questions IPs ask per hour ($\underline{r}$ = .57). IP encouragement is moderately correlated with percent of IP participation ($\underline{r}$ = -.58), number of directed questions asked per hour ($\underline{r}$ = .50), and total number of questions per hour ($\underline{r}$ = .47). IP content is correlated with number of directed questions asked per hour ($\underline{r}$ = .55).

Table 7

Correlations Between Subjective and Objective IP Variables

	Objective variables[a]				
Subjective variables[b]	Percent participation	# of words performance	Directed questions	Non-direct questions	Total questions
Introduction	.18	-.08	.66 **	-.27	.58 *
Questions	-.34	.09	.62 **	-.18	.57 *
Encourage	-.58 **	.04	.50 *	-.12	.47 *
Content	-.34	.21	.55 *	-.28	.45
Video	.38	.38	.25	.01	.26

[a] See Appendix C

[b] See Debriefing Assessment Battery (Appendix B)

*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$.

5. Conclusions and Recommendations

The results of this study indicate that the ratings assigned to IPs on the measures of questions, encouragement, and content on the Debriefing Assessment Battery can be used to predict the degree and depth of crew participation. In this section the relationships that exist between IP and crew measures will be discussed, followed by the patterns of IP and crew scores obtained from the battery. Finally, basic recommendations for the development and implementation of future training programs will be presented.

Of the five IP categories in the Debriefing Assessment Battery, three are highly and significantly related to the crew measures of activity and content. The measure of content of crew discussion is highly correlated with the IP measures of content, encouragement, and questions. This indicates that the depth to which crew members analyze the LOFT situation and evaluate their performance is directly related to the degree to which the IP facilitates and encourages them to do so. The fact that crew content is highly related to IP content also suggests that this component of IP performance on the Debriefing Assessment Battery does target techniques that tend to evoke in-depth analysis and evaluation by crews.

The IP technique which best predicts crew activity is encouragement, followed by content and questions. This indicates that crew activity is directly related to the degree to which IPs refrain from instructing to the crew and encourage the crews to participate fully and initiate discussion. The fact that these IP measures can predict crew activity also suggests that the IP measures do capture techniques helpful in evoking active crew participation.

On each of the above measures crew content is more highly related to the IP variables than is crew activity. Part of the reason crew activity is not as easily predicted by IP techniques as crew content may be that crews have their own distinct personalities. They tend to enter the sessions with varying propensities to talk. In some instances, no matter how hard the IP works to facilitate discussion the crew will not cooperate. At the other extreme, some crews may participate actively regardless of what the IP does or doesn't do to facilitate their participation.

We cannot currently judge whether introductions can predict crew activity and content because not enough IPs gave introductions. While it is clearly possible to facilitate effectively without providing an introduction, theories of adult learning assert that introductions can enhance the quality of crew participation substantially because adults perform better when they know what is expected of them. It is therefore expected that if IPs begin giving thorough introductions in which they make it clear that they are facilitators and the crews are expected to analyze their own performance, crews will give more in-depth and thoughtful self-analyses.

While videos are an important element of the debriefing because they provide the crew with the ability to view their performance objectively, the current measure of video usage is not a good

predictor of either crew content or activity. While videos might not be expected to predict crew activity, the learning literature assumes that video usage should enhance content of discussion. The problem may be that our measure is not sensitive enough to factors that could predict content. Our measure focuses simply on the effectiveness of IP use of the equipment and utilization of segments to introduce topics for discussion, and does not probe deeper aspects such as the content of the videos. Perhaps a more sensitive measure can be developed to better predict content.

The fact that the subjective scores assigned on the Debriefing Assessment Battery are highly and significantly correlated with several objective measures of IP facilitation and crew participation suggests that the subjective rating scale is measuring valid aspects of IP and crew performance. To the extent they are not correlated the findings suggest that the subjective and objective measures are measuring differences as well as similarities. It is our belief that the subjective measures are identifying aspects of IP and crew performance that go beyond those captured by objective measures alone. The goal of developing the battery was to provide a tool for assessing IP facilitation skills and aspects of crew participation that are too subtle to be measured objectively.

The frequencies of individual scores assigned on the Debriefing Assessment Battery indicate that on all of the categories except introductions IPs are doing a relatively good job of promoting crew participation, although there is still room for improvement. With instruction and practice IPs should be able to develop techniques to maximize active and in-depth evaluation and analysis by the crews The majority of IPs did an inadequate job of introducing the debriefing session and setting expectations for how the session would be conducted. Since the preponderance of adult learning literature asserts that it is essential to set such expectations, this is an area that needs improvement. Instructors should be made aware of the importance of providing an introduction and given examples of what constitutes an effective introduction.

The purpose of the larger study of which the present study is a part is to determine what techniques IPs should use to most effectively facilitate crews in leading their own debriefings. In the present study it was found that ratings of crew participation can be predicted from ratings of IP facilitation. This indicates that what the IPs do has a significant impact on how well crews achieve the goal of active participation and in-depth analysis and evaluation of their LOFT performance; the more IPs work to encourage crew participation and probe for in-depth analysis, the higher crews rate on these measures. Thus, the above findings make a strong argument for the importance of providing IPs with clear guidelines and examples of good facilitation, and of providing training to IPs so they can develop their facilitation skills. Facilitation is not a skill that comes naturally; it must be practiced and developed to be implemented effectively. Currently, IPs are told that their objective is to facilitate crew self-analysis, but they are not given clear training or guidance on

how to do this. Therefore, the author recommends that the airlines develop and implement train-the-trainer programs to provide IPs with the skills and practice necessary to become effective facilitators.

Some of the key elements that should be included in airline industry train-the-trainer programs can be derived from Wexley and Latham's (1991) training guidelines. They include (a) how to establish and communicate training objectives, (b) basic principles of how adults learn, so IPs can develop an understanding of what factors facilitate and interfere with learning, (c) how to communicate more effectively and use the LOFT videotape as a tool for facilitation, and (d) how to pose questions in a way that elicits active crew participation and discussion, including how to draw out quiet members.

The final step in the development of any effective training program is to evaluate its effectiveness. Unfortunately it is currently impractical to track crews who participate in LOFT training to see if what they learn transfers to the line due to the strict standard of anonymity. As in the current study, the identities of all crew members, IPs, and airlines must remain confidential in order to preserve the learning capability of the LOFT. However, in order to determine the true effectiveness of the LOFT and facilitation techniques used for debriefing, longitudinal studies that track the progress and line performance of participants are needed (Gregorich & Wilhelm, 1993).

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8. Appendices

A. Methods for Study by Dismukes et al. (1995)

B. Debriefing Assessment Battery

C. Objective Measures

Appendix A

Methods for Study by Dismukes et al. (1995)

This study, which began in the summer of 1994, is based on observations at a cross-section of major U.S. airlines. We have to date visited six companies. Our basic technique is to sit in on five to ten debriefings from a cross-section of the fleets at each company. For the most part we observe one debriefing per instructor and crew, though for about 20% of the instructors we have observed debriefing of a second crew for the purpose of comparison. For context, we interview managers in the CRM departments and review the written scenarios for each LOFT. We observe at least one LOFT simulation of each type in each fleet, but do not observe all of the LOFTs flown by all of the crews.

We obtain permission from each instructor and each crew member to attend the debriefing and to audiotape the session. We provide assurance that all data collected will be completely de-identified to assure anonymity for subjects. After the debriefing, we interview the instructor, ask him or her to rate the crew's CRM performance and their technical proficiency on a 5 point Likert scale, and ask for comments about the debriefing process.

The audio recordings of the debriefings are later transcribed into text in their entirety and all references to individuals and organizations are deleted. Each utterance is coded for each of the factors in Table 1. We also record how many video segments from the LOFT were played, how long each lasted, and how each segment is discussed in the debriefing.

Table 1. Coding of Utterance Factors	
Utterance length:	number of words
Speaker:	Instructor (IP), Captain (CA), First Officer (FO), or Flight Engineer (FE)
Target of Question (if directed to a particular crew member):	Instructor (IP), Captain (CA), First Officer (FO), or Flight Engineer (FE)
Utterance type:	Question, Command, Response, or Statement (S1 for statements self-initiated by crew)
Topic type:	CRM, Technical, Mixed, or Non-Specific
Topic category:	Introduction or Summary, Scenario, Static (general knowledge), crew performance (categorized as Positive, Negative, how to Improve, or Neutral description)
CRM subtopic:	e.g., workload, communication, team building
Technical subtopic:	e.g., abnormal procedures, aircraft systems, weather

Appendix B

DEBRIEFING ASSESSMENT BATTERY

INSTRUCTOR PROFILE

The Instructor Profile is a summary of the strategies and techniques IP's use to guide the debriefing session. The two main goals of the debriefing session are to 1) get the crew to perform an in-depth analysis of the situation that confronted them, how they understood and managed the situation, the outcome, and ways to improve, and 2) get the crew to participate in a proactive, rather than reactive, manner in which they initiate discussion and elaborate beyond the minimal.

Directions:

Use the scale below to rate the instructors on each of the following elements, then total the scores to get the overall rating for each category

Poor	Marginal	Needs Improvement	Adequate	Good	Very Good	Outstanding
1	2	3	4	5	6	7

INTRODUCTION

One purpose of the introduction is to let the crew know that participation and self-evaluation are expected of them, and why it is important.

_____Makes clear that his role is guide/facilitator and that crew should do most of the talking
_____Clearly conveys that crew should take an active role, initiating discussion rather than just responding to him
_____Clearly conveys that he wants crew to dig deep, critically analyzing the LOFT and their performance
_____Gives a persuasive rationale for the crew to participate actively and make their own analysis

_____**Overall rating of introduction**

QUESTIONS

The purpose of asking questions is to get the crew to participate, focus the discussion on important topics, and enlist the crew in discussing the topics in depth.

_____Asks an appropriate number of questions to get crew talking & lead them to issues
_____Avoids answering for the crew when they do not respond immediately or correctly and uses a pattern of questioning that keeps the focus on the crew
_____Uses probing and follow-up questions to get crew to analyze in depth and to go beyond yes/no and brief factual answers
_____Uses questioning techniques to encourage interaction and sharing of perspectives among crew members

_____**Overall rating of questions**

ENCOURAGEMENT

Encouragement refers to the degree to which the instructor encourages and enables the crew to actively and deeply participate in the debriefing.

_____Conveys sense of interest in crew views and works to get them to do most of the talking
_____Encourages continued discussion through active listening, strategic pauses, avoiding disruptive interruptions, and/or following up on crew-initiated topics
_____Encourages all members to participate fully, drawing out quiet members if necessary
_____Refrains from giving long soliloquies or giving his own analysis before crew has fully analyzed

_____**Overall rating of encouragement**

CONTENT OF DISCUSSION

The goal of the debriefing session is to get the crew to evaluate and analyze their own CRM performance so they will learn more deeply and can gain practice in debriefing themselves, a skill they can then begin to use on the line.

_____Encourages crew to analyze along CRM dimensions the situation that confronted them, what they did to manage the situation, and why they did it
_____Encourages crew to evaluate their performance and/or ways they might improve
_____Encourages crew to explore CRM issues and how they specifically affect LOFT performance and line operations
_____Encourages crew to analyze issues, factors, and outcomes in depth, going beyond simply describing what happened and what they did

_____**Overall rating of content of discussion**

VIDEOS

One stated purpose of showing videotaped segments of the LOFT is to enable the crew members to see how they performed from an objective viewpoint so they can better evaluate their performance. More realistically, perhaps, the video reminds the crew of the situation, aiding their memory and providing a focus for discussion.

_____Shows an appropriate number of videos of appropriate duration to illustrate/introduce topics
_____Uses video equipment efficiently: is able to find desired segment without wasting time and pauses the video if substantial talk begins while playing
_____Consistently discusses video segments, using them as a springboard for discussion of specific topics
_____Has a point to make and uses the video to make that point.

_____**Overall rating of video usage**

_____**Overall instructor rating**

CREW PROFILE

The crew profile measures the degree and depth of participation by the crew.

Directions:

Use the scale below to rate the crew on each of the following elements, then total the scores to get the overall rating for each category

Poor	Marginal	Needs Improvement	Adequate	Good	Very Good	Outstanding
1	2	3	4	5	6	7

CONTENT OF DISCUSSION

Content of analysis refers to the depth to which the crew members analyze the LOFT situation and their performance.

_____Analyze along CRM dimensions the situation that confronted them, what they did to manage the situation, and why they did it
_____Evaluate their performance and ways they might improve
_____Explore CRM issues and how they affect LOFT performance and line operations
_____Analyze issues, factors, and outcomes in depth, going beyond simply describing what happened and what they did

_____**Overall rating of content of discussion**

ACTIVITY

Activity refers to how actively, versus passively, the crew participates in and initiates discussion.

_____Go beyond minimal responses to IP questions
_____Participate deeply and thoughtfully
_____Initiate dialogue rather than just responding to questions, and/or interact with each other rather than only with the IP
_____Behave in a predominantly proactive rather than reactive manner, being actively involved rather than just passing through the training

_____**Overall rating of activity**

_____**Overall crew rating**

Appendix C

Objective Measures

OBJECTIVE IP VARIABLES

Percent Participation: percentage of total words during debriefing sessions spoken by IPs

Number Of Words Performance: average number of IP words relating to crew performance

Directed Questions: average number of questions IPs asked per hour that were directed to specific crew members

Non-Directed Questions: average number of questions IPs asked per hour that were not directed to specific crew members

Total Questions: average number of total questions asked by IPs per hour

OBJECTIVE CREW VARIABLES

Percent Participation: percentage of total words during debriefing sessions spoken by crew members

Number Of Words Per Response: average number of words per crew member response to IP questions

Self-Initiated: average number of words per hour initiated by crew members

Analyzing Utterances: average number of analyzing utterances per hour by crew members

Proactive Questions: average number of questions initiated by crew members that are not responsive to the IP or miscellaneous in content

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Based on theories of adult learning and airline industry guidelines for Crew Resource Management (CRM), the stated objective during Line Oriented Flight Training (LOFT) debriefings is for instructor pilots (IPs) to facilitate crew self-analysis of performance. This study reviews 19 LOFT debriefings from two major U.S. airlines to examine the relationship between IP efforts at facilitation and associated characteristics of crew participation. A subjective rating scale called the Debriefing Assessment Battery was developed and utilized to evaluate the effectiveness of IP facilitation and the quality of crew participation. The results indicate that IP content, encouragement, and questioning techniques are highly and significantly correlated with, and can therefore predict, the degree and depth of crew participation.

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