CHAPTER 2
EVALUATION OF TEAM SITUATION AWARENESS CLASSROOM TRAINING

Mica R. Endsley, Ph.D.
SA Technologies
and
Michelle M. Robertson, Ph.D.
Institute of Systems and Safety Management, University of Southern California

2.1 OBJECTIVE

The objective of this effort was to provide an initial evaluation of the Team Situation Awareness (SA) Classroom Training Course[1,2] and to describe a methodology and instruments for conducting such evaluations in the future. The Team SA Training Course was developed based on an analysis of SA requirements and problems in aviation maintenance teams.[3,4] This analysis investigated situation awareness across multiple teams involved in aircraft maintenance. It identified several teams within the aviation maintenance setting, each of which involved leads and supervisors as well as line personnel: aviation maintenance technicians (AMT), stores, maintenance control, maintenance operations control, aircraft-on-ground, inspection, and planning. The analysis produced a delineation of situation awareness requirements for each of these groups and an understanding of the way in which each group interacts with the others to achieve SA pertinent to their specific goals. SA appears to be crucial to the ability of each group to perform tasks (as each task is interdependent on other tasks being performed by other team members), their ability to make correct assessments (e.g., whether a detected problem should be fixed now or later [placarded]), and their ability to correctly project into the future to make good decisions (e.g., time required to perform task, availability of parts, etc.) As a part of the analysis, certain shortcomings — both in the technologies employed and in the organizational/personnel system — were identified that may compromise team SA in this environment.

From the analysis, five major areas for improving SA in aviation maintenance were identified:

1. There were significant differences in the perceptions and understanding of situations between teams that were related to differences in the mental models held by these different teams. The same information would be interpreted quite differently by different teams leading to significant misunderstandings and system inefficiencies.

2. Not verbalizing the information that went into a given decision (the rationale and supporting situation information) was problematic. Only the decision would be communicated between teams. This contributed to sub-optimal decisions in many cases as good solutions often required the pooling of information across multiple teams.

3. A lack of feedback in the system also was present. The results of a given decision would not be shared back across teams to the team initiating an action. This contributed to the inability of people to develop robust mental models.

4. The importance of teamwork and the need to use shift meetings to establish both shared goals and a shared understanding of the situation was noted. The conduct of shift meetings for accomplishing these objectives was found to be highly variable in this environment.

5. Finally, several problems that can reduce situation awareness in individuals were noted in this domain, including task-related and other distractions, negative effects of noise and poor lighting, vigilance, and memory issues.

The Team SA Training Course[1,2] was developed to address the following five SA Training concepts:

1. Shared mental models
2. Verbalization of decisions
3. Better shift meetings and teamwork
4. Feedback
5. SA training

In addition, the course also provided a review of Maintenance Resource Management (MRM) principles which are considered to be prior knowledge requirements for the trainees. The Team SA Training Course was designed to be presented as an eight-hour classroom delivery course. The course was designed to be presented to personnel from across all maintenance operations departments (also called technical operations in some airlines). The course is best taught to a class composed of a mixed cross section from different maintenance operations organizations (e.g., stores, AMTs, inspectors, maintenance operations control, etc.) This is because the course focuses on helping to reduce the gaps and miscommunications that can occur between these different groups. It was anticipated that much of the course's benefit would come from the interaction that occurs when trainees share different viewpoints and information in going through the exercises.

An extensive set of Powerpoint® slides covering the Team SA Training principles, group exercises, maintenance examples, and case studies are included as part of the course to encourage active learning. The instructional strategy used for the course features adult inquiry and discovery learning. This allows a high level of interaction and participation amongst the trainees creating an experiential learning process. The Team SA Training Course strongly encourages participation in problem solving, discussion groups, and responding to open ended questions, thus promoting the acquisition and processing of information.

2.2 TRAINING EVALUATION METHOD

Two types of training evaluations were used in the Team SA training assessment: formative evaluation and summative evaluation. Formative evaluation occurs during the prototyping phase of the training implementation. Immediate feedback is gathered from the trainees about the effectiveness of the course. Specific questions were asked about the usefulness of the course and what could be done to improve the course. This information in turn will be used to modify and edit the existing course. Summative evaluation takes place after the prototyping of the course occurs and looks at overall effectiveness of the training course, changes in work performance attitudes, behaviors and knowledge, and the impact it has on organizational performance. Data collected from the Team SA Evaluation Assessment Instruments will be used to determine which areas of the training course will need to be revised or modified and to determine the effectiveness of the course.

2.2.1 Implementation of the Training

The Team SA Training Course was delivered by a major airline at four of its large maintenance bases. Most of the technical operations personnel in this airline had already received MRM training which is considered to be a precursor to the Team SA Training Course. The course was delivered over a two-day period by this airline. (It was expanded from the original eight-hour course design by this airline to allow for more group exercises, interaction and case studies.)

The Team SA Training Course was delivered in a classroom that was arranged to support group exercises and interactions, as well as multimedia presentations. Several tables were arranged in the room with four to five participants at each table forming a small group for the group exercises. A flip chart was provided to each group for the exercises. A break area was also provided, allowing for an atmosphere of teamwork and casual interaction. Participants used this area for informal discussions about the training material.

The course was delivered by one facilitator from the airline's Human Factors Group. The facilitator created and produced a participant handbook that included copies of the Powerpoint® slides, group exercises, and case studies. Informational and resource material regarding internal departments within the airline was provided. This material could be used to address issues regarding procedures, workcards, health and safety issues, and maintenance policies. Outside references related to human factors and risk management were also included in the handbook. This handbook was designed as a future reference and reinforcement tool for the newly acquired Team SA skills.

The instructional delivery methods were varied and multimedia oriented. There was an effective mix of the instructional technologies including slides, videos, and 35 mm slides. The pace of the course was kept at a reasonably high level. In group exercises, each small group of trainees met to analyze a case study or identify a particular set of problems and solutions. After each group exercise their results were scripted on a flip chart and one representative from the group presented their findings to the main group. All of these flip charts were then posted around the room for future reference. At the end of the day the facilitator used them to reinforce the key learning accomplishments of the day and how the Team SA skills applied in the training activities.

2.2.2 Course Participants

Seventy-two people from nine different maintenance locations attended the training sessions at which the present evaluation took place. Participation in the course was voluntary and participation in the course evaluation was also voluntary and confidential. Participants were present from a full cross-section of shifts, as shown in Figure 2.1. The majority of the participants were male (86%), however, 14% of the participants were female. The participants came from a wide range of technical operations departments and job titles, as shown in Figure 2.2. The most frequent job title was that of line mechanic (AMT), followed by leads and supervisors. A good cross section of other organizations within the Technical Operations Group were also represented, including inspection, planning, and documentation support personnel. Attendees were very experienced at their jobs and within the organization and had a fair amount of education as shown in Table 2.1.

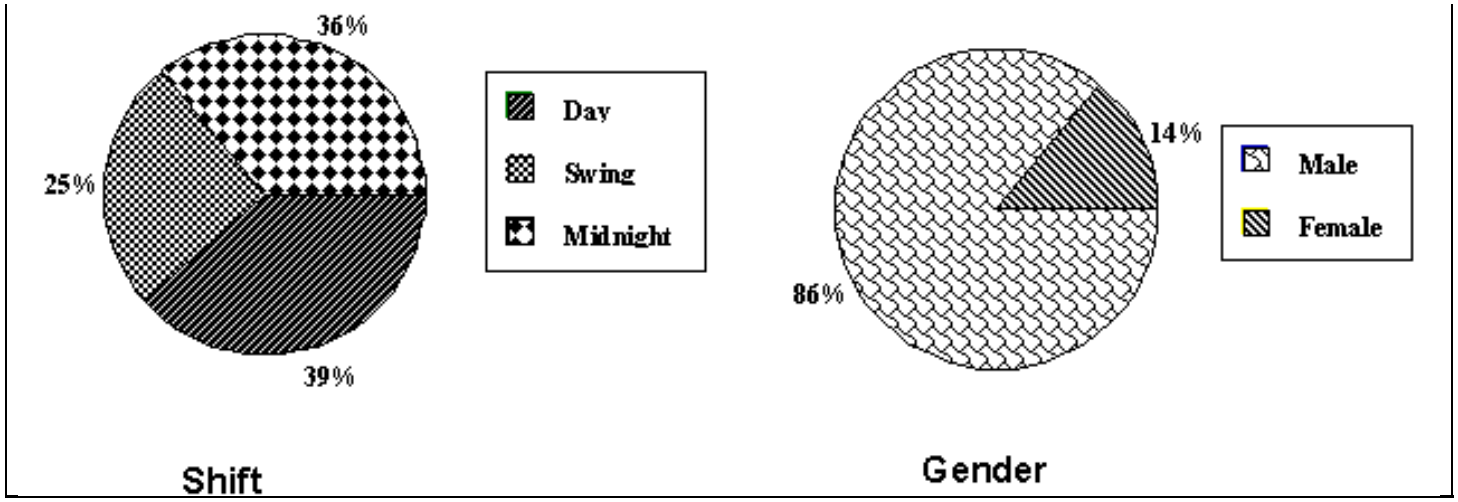


Figure 2.1. Participants' Work Shift and Gender

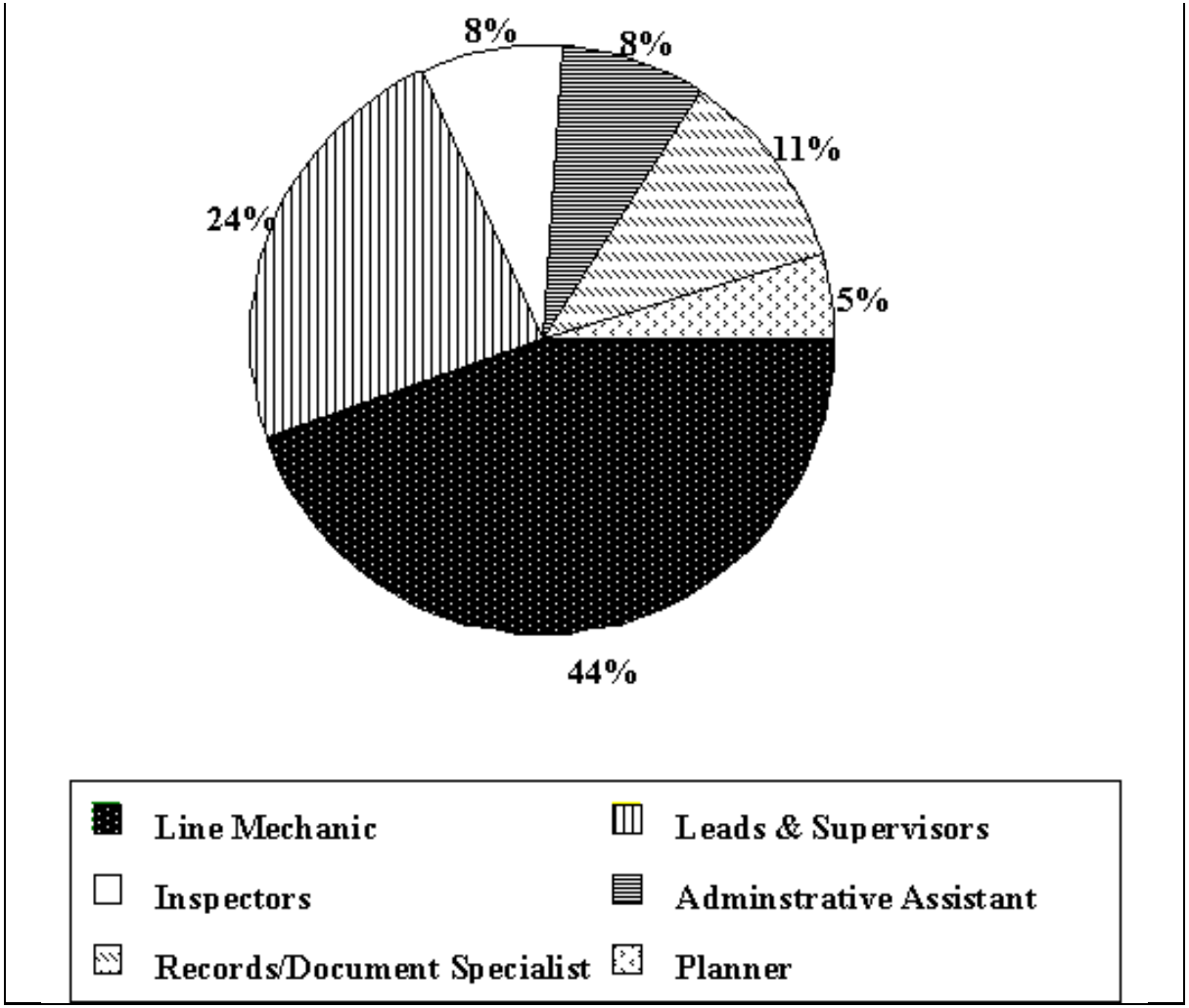


Figure 2.2. Participants' Job Titles

Table 2.1. Participants' Age, Education and Experience

Demographic	Mean Years	Standard Deviation
Years in Position	10.14	14.04
Years at Airline	12.16	5.37
Military Experience	4.71	2.66

Trade School	2.28	0.87
College	2.33	0.76
Age	40.11	7.5

2.2.3 Course Evaluation Measures

The Team SA training evaluation process consisted of three levels:

1. value and usefulness of the training
2. pre/post training measures
3. changes in behavior on the job.

2.2.3.1 Value and Usefulness of the Training

There were a number of questions that were asked of the participants to gage their reactions to the training: how they liked it and how useful they felt that it was for their jobs. Shown in Appendix 2-A, this Training Evaluation addressed the following questions:

- Did the trainees find the training concepts important to their jobs?
- Will they be able to use the training concepts and skills in their jobs?
- What were the particularly good aspects of the training?
- Does this training have the potential to increase aviation safety and Team SA effectiveness?
- What improvements can be made to the training?

2.2.3.2 Pre/Post Training Measures

The amount of learning in attitudes and behaviors related to SA was also measured. Shown in Appendix 2-B, this evaluation was provided immediately prior to the training to assess knowledge and behaviors of the trainees related to SA. It was administered again immediately following the course to measure changes in attitudes and self-reported intentions to change behavior as a result of the training. It addressed the following aspects of the training:

- The trainees' current knowledge of factors related to Team SA.
- Self-reported behaviors related to Team SA.
- The current level of the trainees' perceived importance regarding the training concepts.

- The intended behaviors of the trainees--How will they use the training on their jobs?

2.2.3.3 Changes in Behavior on the Job

Shown in Appendix 2-C, the same pre/post training evaluation measure was administered again one month later to determine actual changes in SA related performance behaviors on the job as a result of the training course. In addition, open-ended questions were provided as a follow-up. It addressed the following issues:

- How have the trainees used the Team SA concepts in their jobs?
- What self-reported behavior changes have occurred?
- What were useful aspects of the training?
- What improvements could be made to the training?

2.3 ANALYSIS METHOD

The feedback from the course was tabulated and analyzed to determine the trainees' perceptions towards the Team SA Training Course. The course evaluation form was analyzed to determine descriptive statistics regarding the participants' opinions regarding the course material and content. These evaluations were compared to participant demographics using analysis of variance to ascertain any meaningful differences between the participants. A .05 level of significance was used for all statistical analyses.

The SA behavior evaluation forms were analyzed to determine changes in SA behaviors and knowledge for each participant based on the three administrations of the form (pre-training, post-training, and one month after training). A factor analysis was applied to the questionnaire to determine whether subsets of the form were appropriate. A Wilcoxon non-parametric analysis was then applied to determine which factors on the questionnaire were affected by the Team SA Training Course, comparing each item on the pre-test to the same item on the post-test. The same statistical analysis was conducted to determine whether these measures changed after one month on the job following training or remained stable by comparing each item on the post-test to the corresponding item on the one-month questionnaire. A .05 level of significance was used for all statistical analyses.

2.4 RESULTS OF TRAINING EVALUATION

2.4.1 Value and Usefulness of the Training

The post-training course evaluation was used to measure the level of usefulness and perceived value of the course. Course participants scored each subsection of the course on a five-point scale which ranged from 1 (waste of time) to 5 (extremely useful). As shown in Figure 2.3, they rated the MRM review topics very highly. On average, they rated these topics as very useful (mean scores between 3.5 to 4.4). The discussion of chains of events leading to accidents and "link-busters," techniques for breaking the chain of events, were rated among the highest in the MRM section. There were very few ratings in the low end of the scale on any of the MRM training content topics.

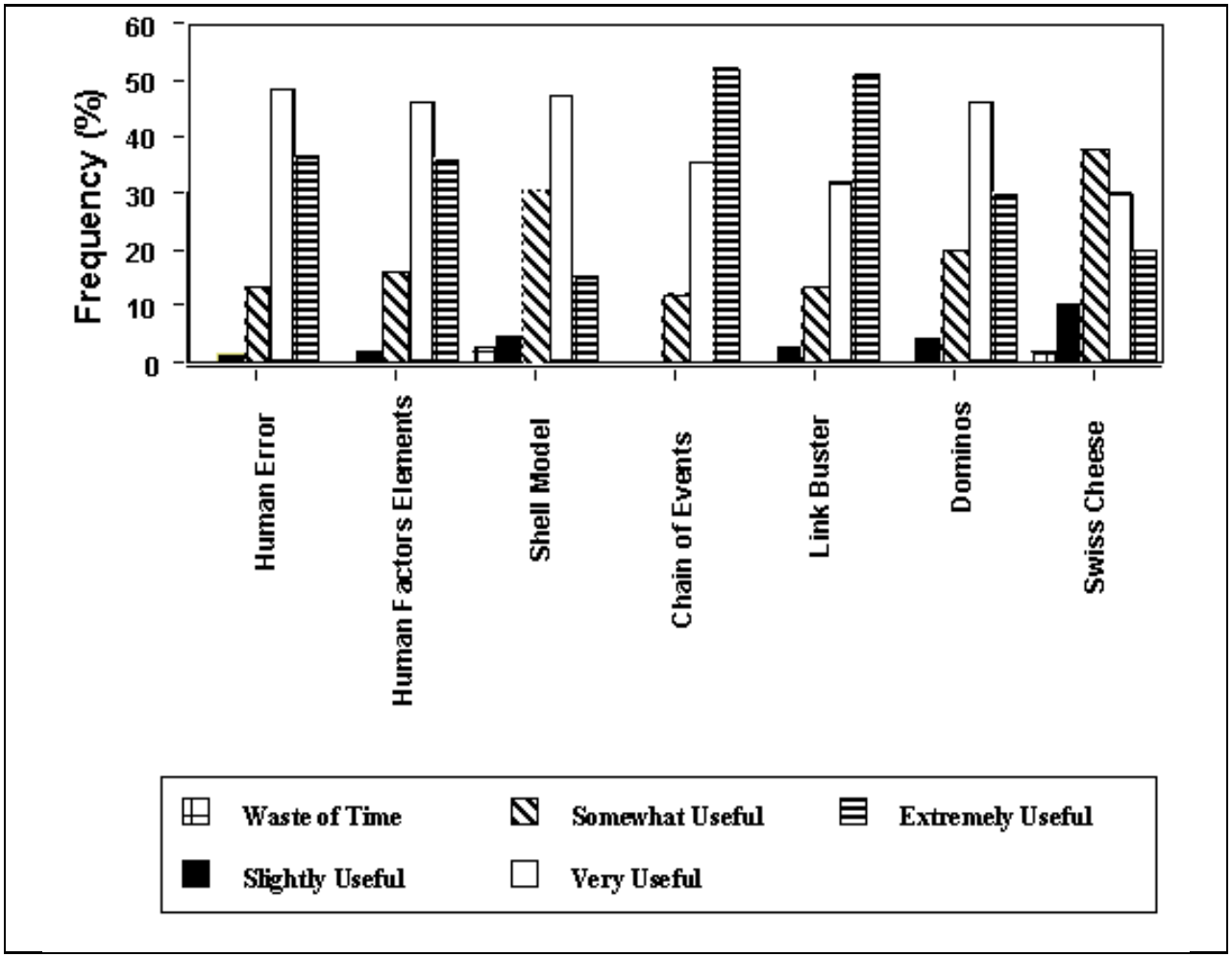


Figure 2.3. Evaluation of Course Module: MRM Review

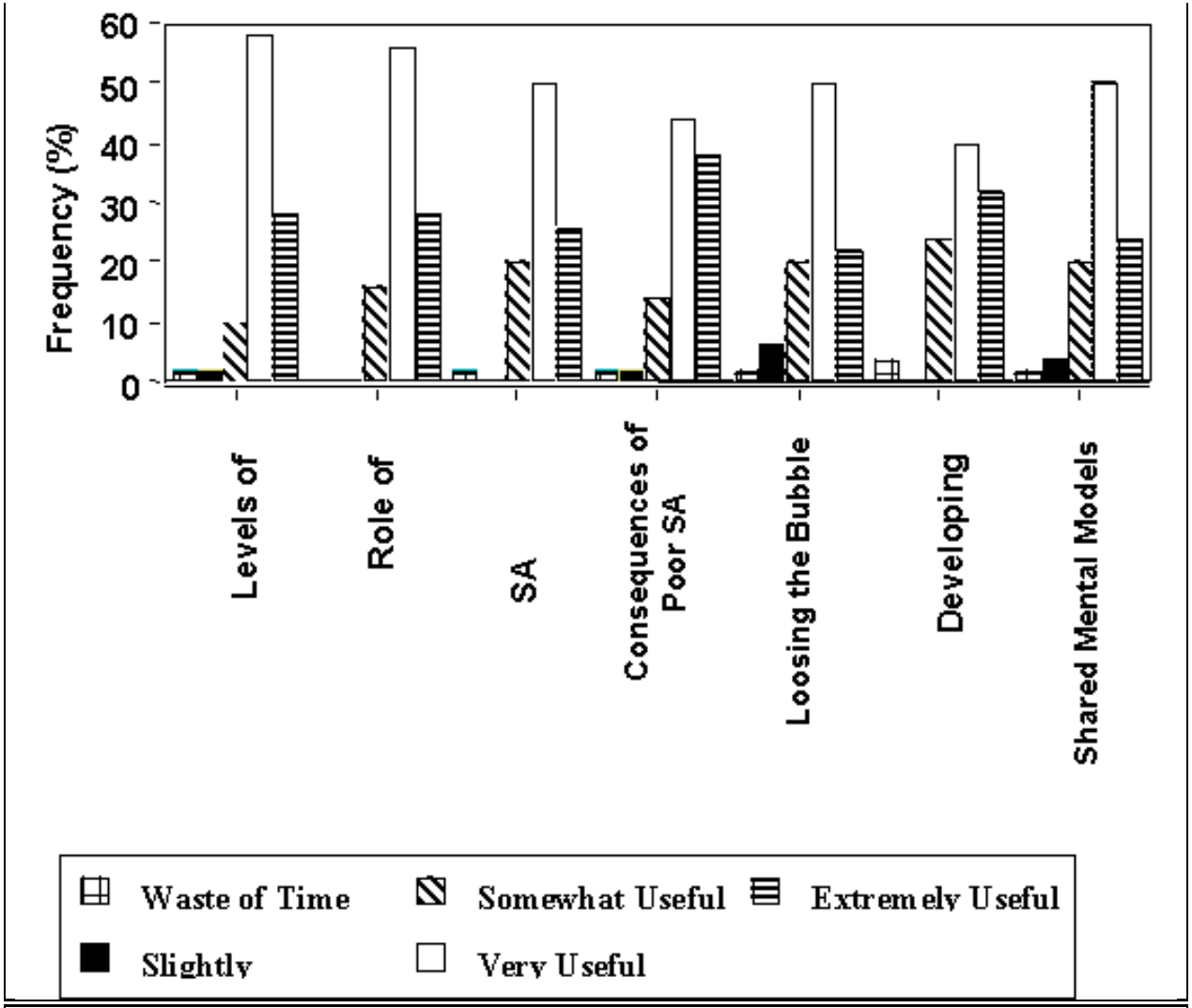


Figure 2.4. Evaluation of Course Module: SA Topics

Figure 2.4 shows the ratings for the components of the course that presented and discussed situation awareness principles directly. Again, these topics were rated very highly with most participants (72% to 86%) evaluating the training material as very useful or highly useful. Mean scores on these SA topics ranged between 3.8 and 4.1.

Training evaluation ratings related to the three final training objectives--communicating decisions, teamwork and shift turnovers, and feedback--are shown in Figure 2.5. Ratings on these training objectives were very good as well. Mean ratings varied between 4.3 and 4.7. Between 88% and 96% of the participants rated this information as very useful or highly useful.

As the course was designed to encourage a great deal of participation and interaction on the part of the trainees, it utilized appropriate instructional techniques, including aviation maintenance videos, case studies, and group exercises to reinforce the concepts taught in the course. Twelve different maintenance case studies were included in the course. The mean rating for these case studies was 4.2, as shown in Figure 2.6, corresponding to a rating slightly over very useful. Mean ratings for each individual case study varied from 4.0 to 4.4. All of the case studies were viewed very positively by the participants. Similarly, the maintenance video used in the course received a mean rating of 4.2, indicating it was also viewed as very useful. The six group exercises included in the course each received a mean rating of between 4.0 and 4.3, averaging to a mean rating of 4.2. Again this material was viewed very positively by the course participants.

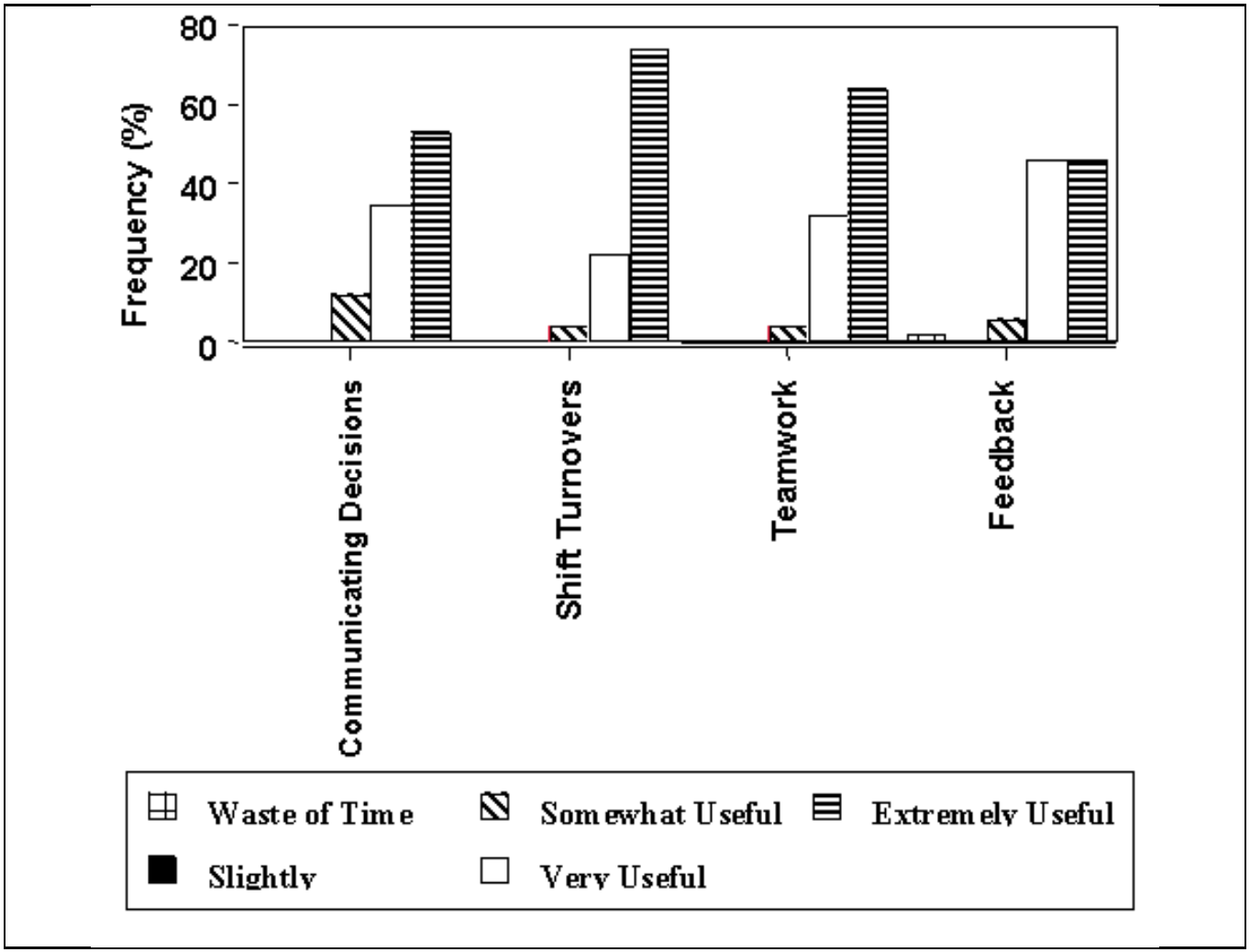


Figure 2.5. Evaluation of Course Module: Communications Topics

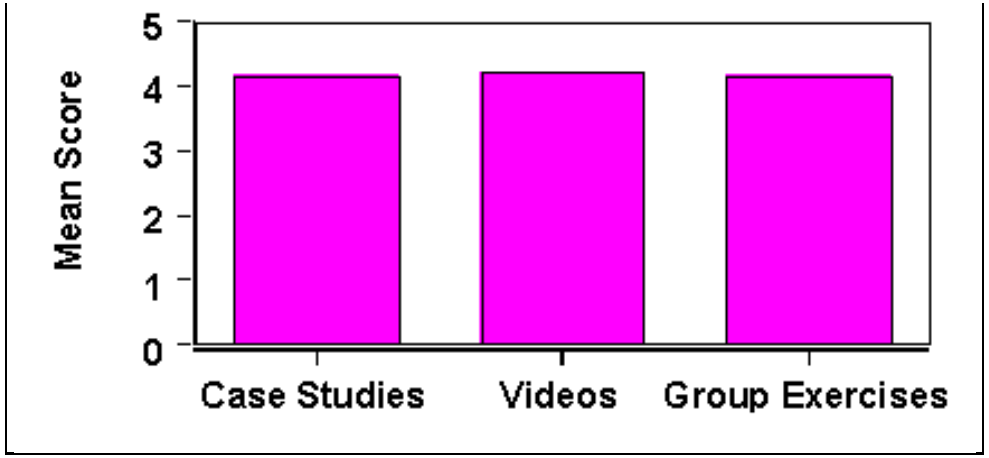


Figure 2.6. Evaluation of Course Training Methods & Media

In addition to rating topics in the course, participants also answered several questions related to the course as a whole, shown in Figure 2.7. The mean rating for the course overall was 4.3, corresponding to better than very useful. A whopping 89% of the participants viewed the course as either very useful or extremely useful, representing a high level of enthusiasm for the course. There were no low ratings of the course as a whole. Over 94% of the participants felt the course was either very useful or extremely useful for increasing aviation safety and teamwork effectiveness (mean rating of 4.4). Over 89% felt the course would be either very or extremely useful to others (mean rating of 4.3). When asked to what degree the course would affect their behavior on the job, 83% felt they would make a moderate change or a large change, as shown in Figure 2.8.

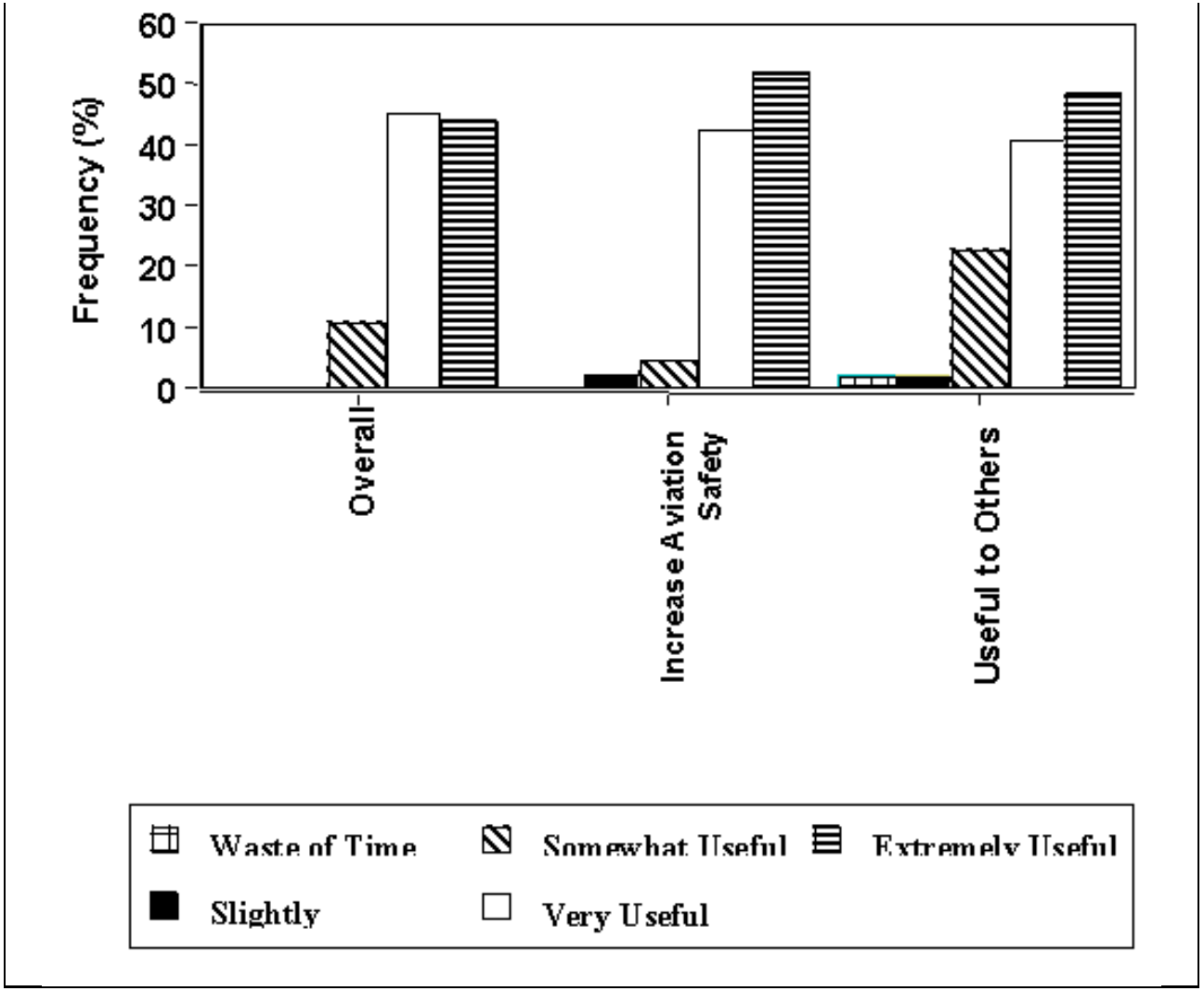


Figure 2.7. Overall Course Evaluation

Trainees also provided written comments on the course regarding how they would use the material. Over 95% of the course participants provided written comments. These comments were content coded and categorized into groups. As shown in Figure 2.9, participants stated they would use the training on the job to: become more aware and improve SA on the job (39%); increase open, positive communication including written communications (26%); and to try to learn more about other departments and improve SA between departments (21%). They also mentioned having better shift turnovers (14%), improving job flow and following procedures (11%), and breaking the chain of events to improve safety (12%).

Aspects of the course which participants particularly liked are shown in Figure 2.10. These comprised group involvement and discussion including interaction between different departments (55%), understanding how to communicate better (28%), and the case studies (22%). Also listed were SA as a whole (12%), chain of events and link busters (10%), videos (10%), and all of it (12%). Ten percent stated that they felt all AMTs needed this training.

Recommended improvements to the course are shown in Figure 2.11. Participants suggested providing even more examples, case studies, exercises, and discussion (26%), keeping a mix of trainees from different departments in the course (13%), and providing follow-up training (13%). Approximately 17% of the participants said no improvements were needed.

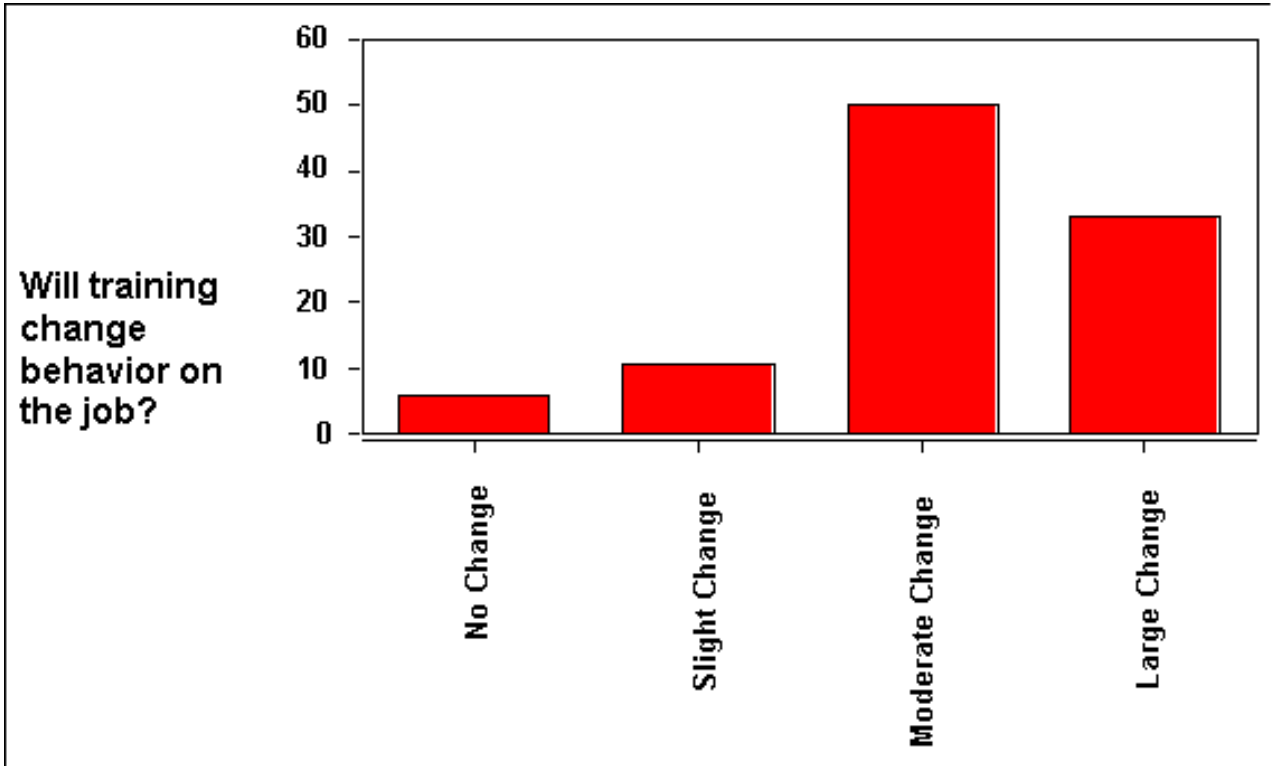


Figure 2.8. Perceived Affect of Course on Behavior

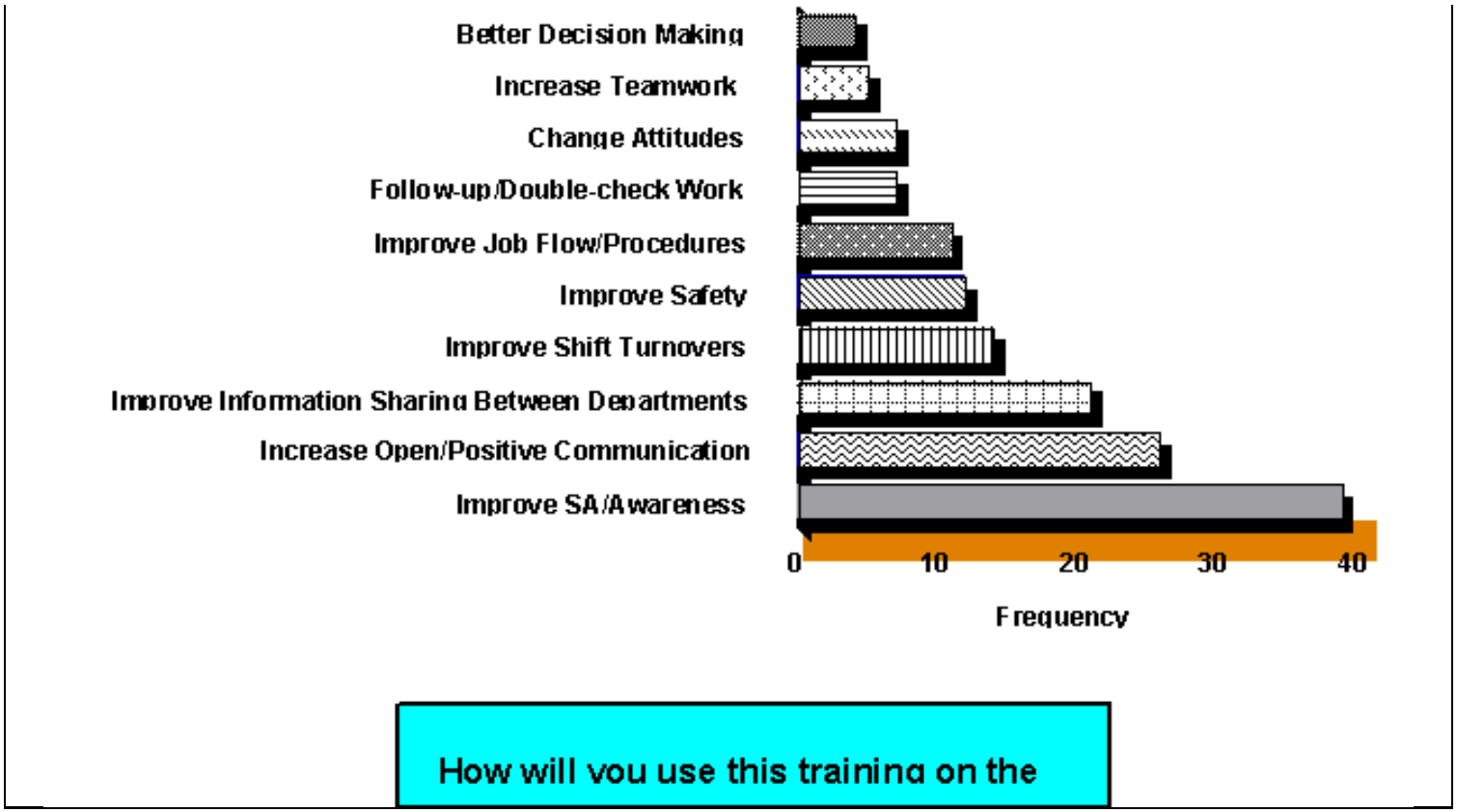


Figure 2.9. Participant's Use of Training on the Job

Overall, the evaluation that participants provided after taking the SA Team Training Course was overwhelmingly positive. Trainees felt the course was very useful and were complimentary about almost all aspects of the course. In particular they felt the amount of participation and job relevance provided by the examples, case studies and exercises were particularly important and wanted even more.

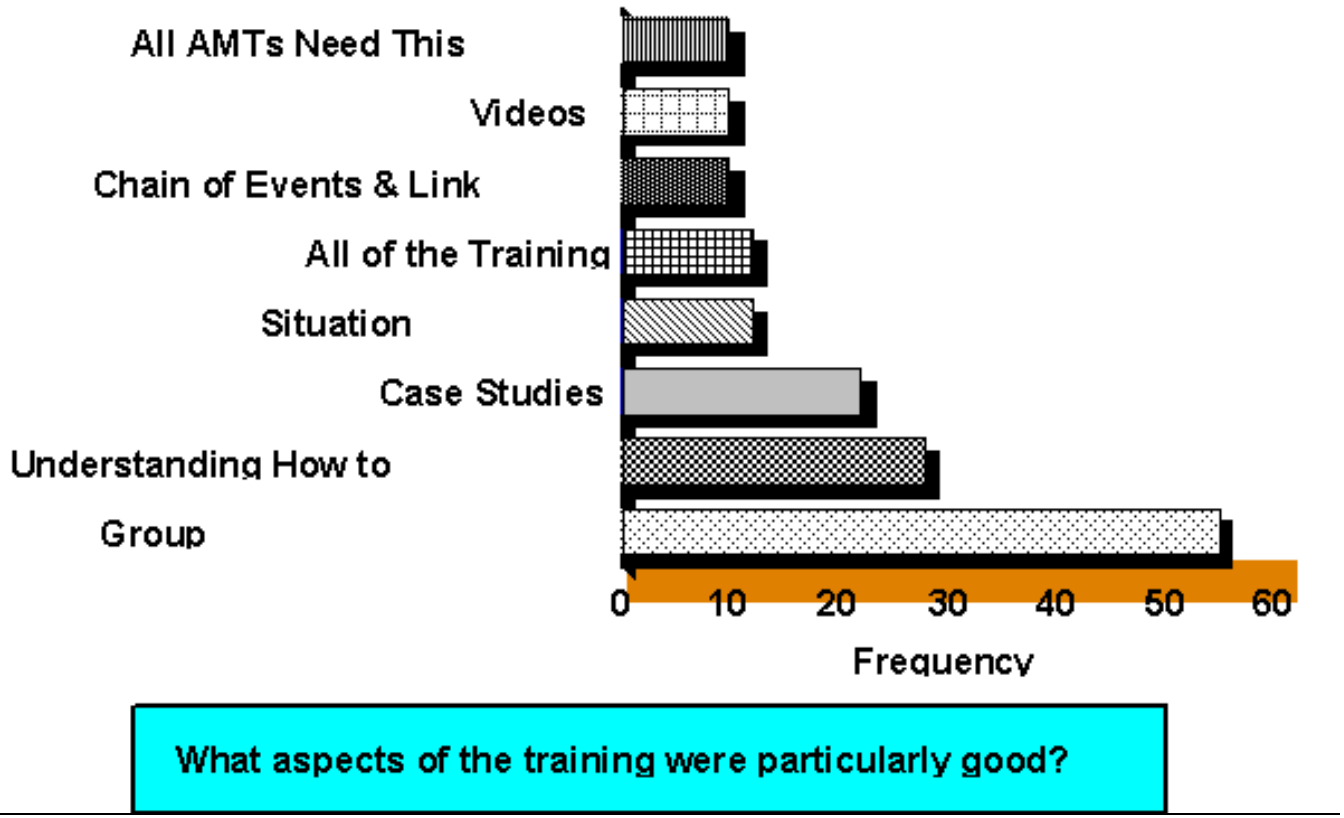


Figure 2.10. Preferred Aspects of the Training

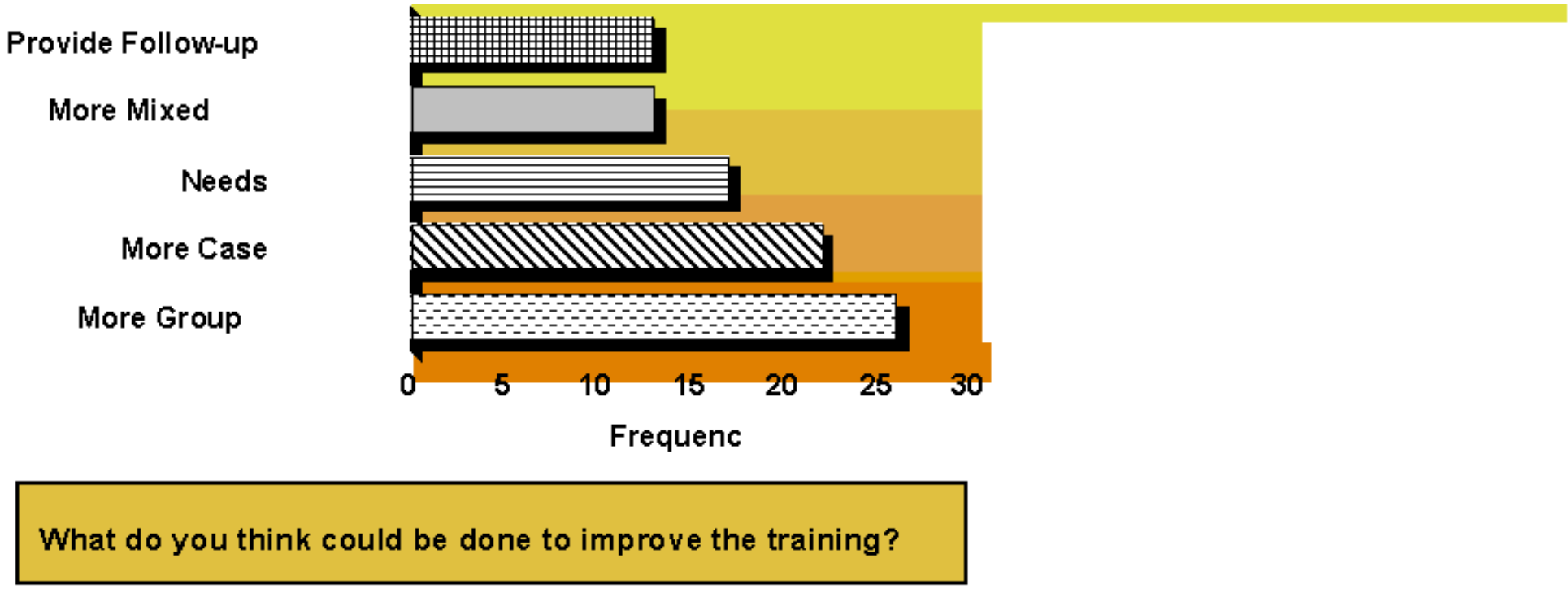


Figure 2.11. Recommended Course Modifications

2.4.2 Pre/Post Training Measures

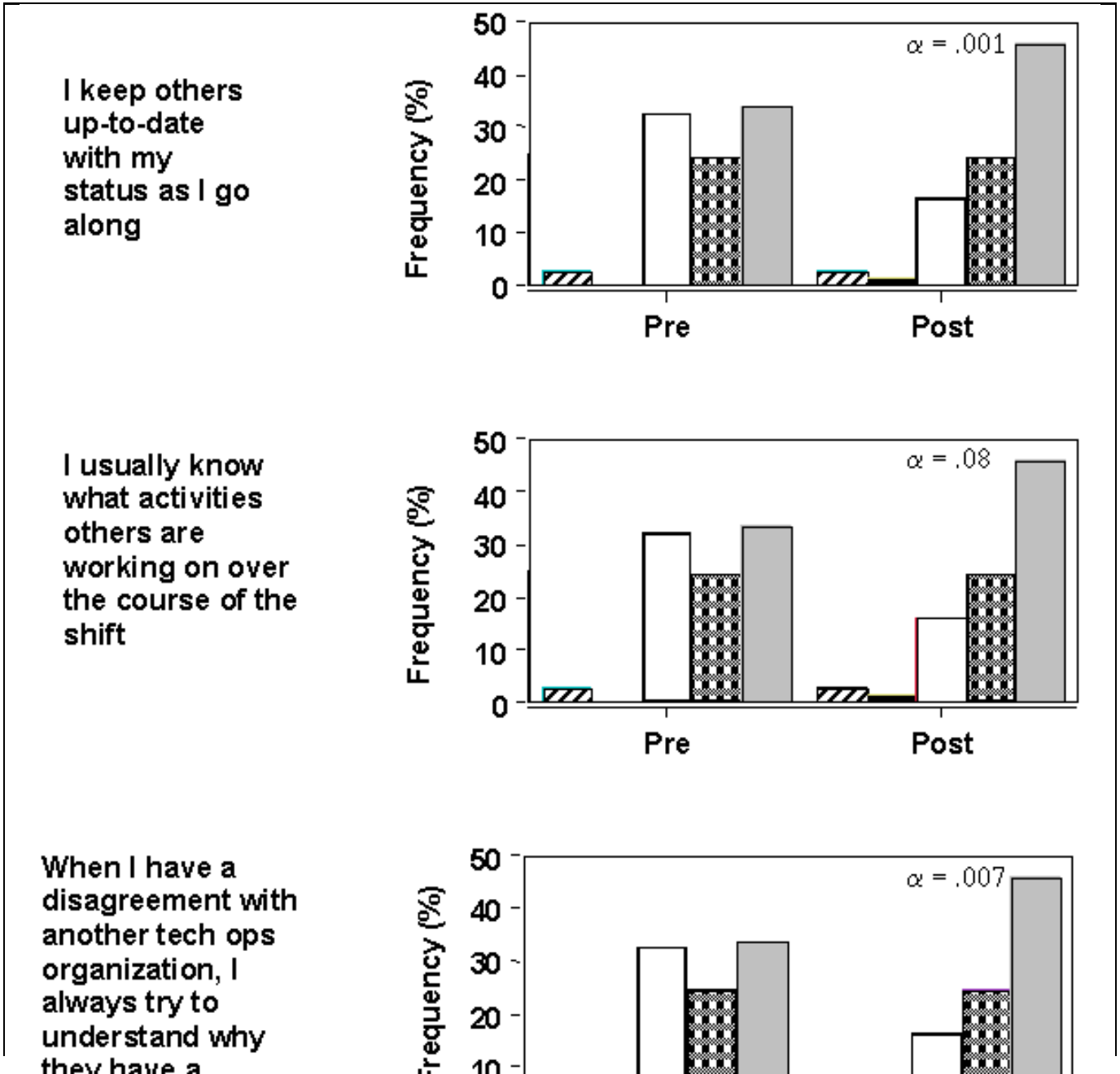
The mean change in the post-test compared to the pre-test on each behavior (described in the pre/post self-reported SA behavioral measure form Appendix 2-B) was also assessed. A factor analysis on the questionnaire revealed a moderate degree of homogeneity. That is, responses on the items were somewhat interrelated; however, no large groupings of related factors were revealed to explain a large portion of the variance. Only one factor accounted for more than 10% of the variance, with most accounting for less than 5%. The questionnaire was, therefore, treated as a set of independent items. Changes on each item were compared for each subject using a paired comparison analysis (pre-test to post-test).

The Wilcoxon non-parametric statistical analysis revealed that attitudes and self-reported behaviors changed significantly on seven of the 33 items. These are shown in Figures 2.12 and 2.13. Participants reported after the training they would be more likely to keep others up-to-date with their status as they perform their jobs (an increase of 15%). They also were slightly more likely to report that they would try to keep up with what activities others were working on over the course of the shift (an increase of 10%). Both of these items relate to improved situation awareness across the team.

Participants reported they would be more likely to try to understand others' viewpoints when engaged in a disagreement with other departments (an increase of 15%). This relates to an effort to develop better shared mental models regarding other departments. In addition, participants reported changes in several behaviors related to improved communications and teamwork. They were more likely to report improved written communication when sending an aircraft with a minimum equipment list (MEL) to another station (an increase of 21%). Participants were more likely to report that they would make sure to pass on information about an aircraft and work status to the next station (an increase of 13%).

They were also more likely to report making sure all problems and activities are discussed during shift meetings (an increase of 11%), and encouraging others to speak up during shift meetings to voice concerns or problems (an increase of 12%).

These differences between the pre-test and post-test measures on SA related behaviors and attitudes indicates that in addition to participants responding positively to the course, they reported actual changes in behaviors they would make on the job as a result of the course, thus improving SA on the job both between and within maintenance teams.



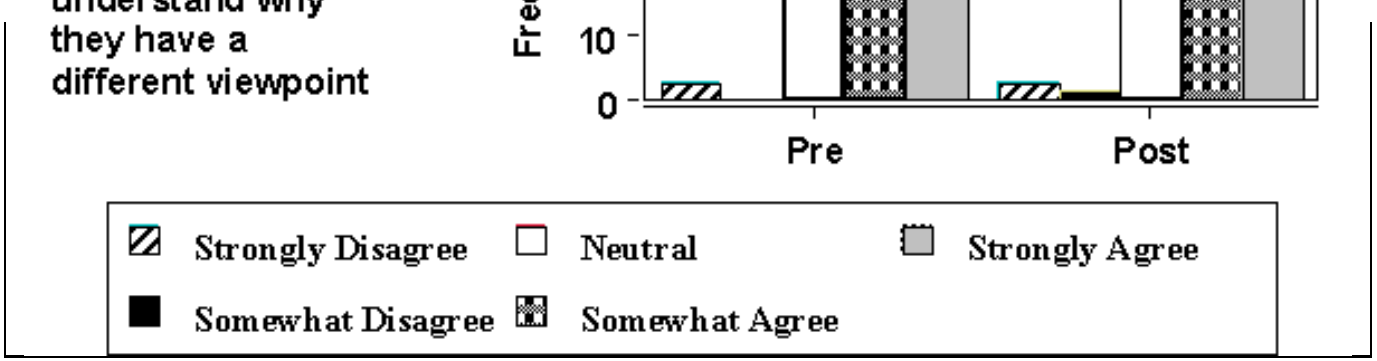
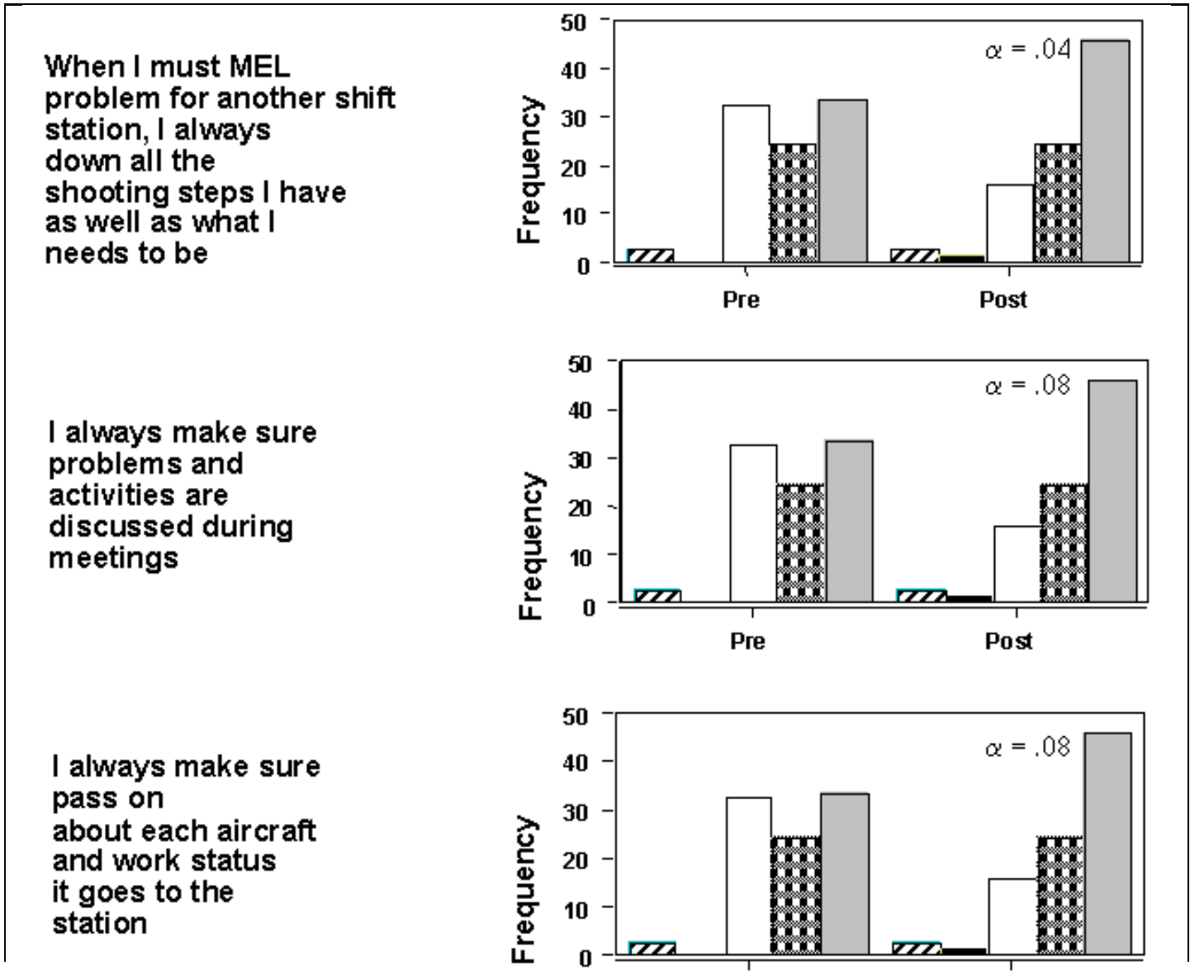


Figure 2.12. Reported Behavior Changes Resulting From Training



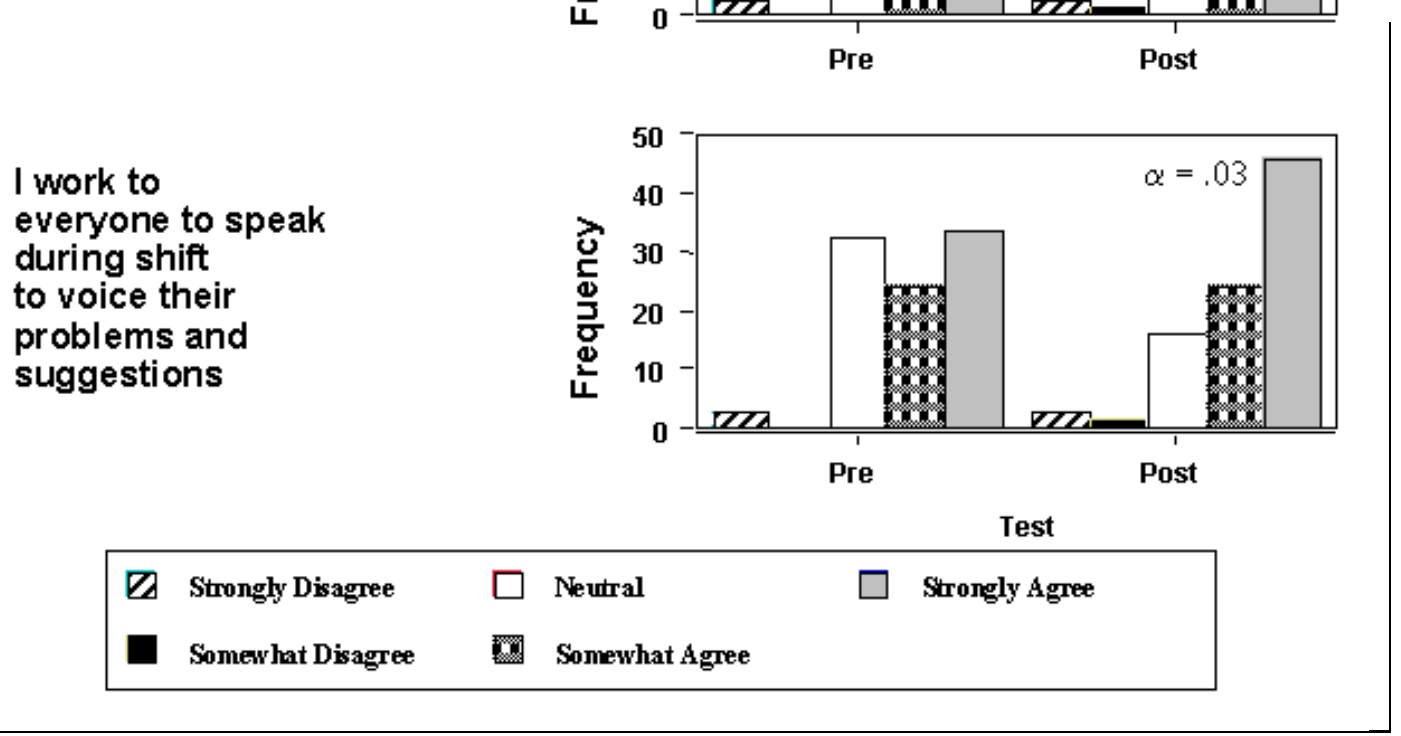


Figure 2.13. Reported Behavior Changes Resulting From Training

2.4.3 Changes in Behavior on the Job

In order to assess whether participants actually made the intended changes in their job behaviors following the course, the same form was again administered one month following the course. At the time of this analysis, the participants of only one course had been on the job for a full month

after the training session. Of these participants (17), six responses were available for this analysis (representing a return rate of 35% which is typical of mail-in questionnaires). A paired comparison of responses on each item between the post-test questionnaire and the one-month questionnaire was made using the Wilcoxon test. This analysis revealed no changes on any of the test items at a .05 level of significance. Therefore, it would appear that the behaviors participants reported they would engage in following the training were carried out in practice, at least for this small sample.

In addition, participants provided written comments to four questions. All returned forms included responses to these questions. These comments are summarized in Tables 2.2 and 2.3. As shown, these comments mirror the written comments provided immediately following the training.

Table 2.2. Comments on Training After 1 Month: Changes on Job

What changes have you made as a result of the Human Factors/MRM training?
Stop and think before charging through
Be more attentive to how Human Factors elements impact my work
Follow-up and double check all work
Provide better information for others
Spend more time learning other departments functions and point of view
More assertive, verbal and express concerns
How will you further use Human Factors/MRM **training in the coming months?**
Be a better team player
Teach others by example
Continue to be attentive and safety minded
Continue to pass on information to others
Be aware how my decisions affect others
Continue to spend time learning other departments function and viewpoints
Continue to work better with others

Table 2.3. Comments on Training After 1 Month: Evaluation

Looking back on it now, what aspects of the training were particularly good?
Group exercises
Being aware of when the slightest piece of the puzzle is missing can lead to severe consequences
Interaction in small groups with people from other departments (4)
What do you think could be done to improve Human Factors/MRM training?
Have management reinforce this training more actively
More case studies
More group exercises & interaction (2)
Discuss & practice more teamwork skills
More training

2.5 DISCUSSION OF FINDINGS

Overall, the SA Team Training Course was highly successful. The course content associated with all of the major training objectives was rated very highly with the vast majority of participants rating each area as very useful or extremely useful. The course was viewed overall as being between very useful and extremely useful for increasing aviation safety and in terms of usefulness to others. The course training methods and media (including the case studies, videos, and group exercises) were viewed as particularly successful and supportive in acquiring the learning objectives. In fact, the only suggestion many participants had for improvement was to use even more of these materials. Clearly an instructional strategy that emphasized experiential learning and participation was effective for achieving the training objectives and facilitating the learning process.

The course was administered to a fairly experienced aviation maintenance group who represented a wide range of departments and skill areas within the Technical Operations Department of the airline. The fact that the course included such a mix of participants also was viewed as a key ingredient in its success. The mixed group allowed people from different areas to better understand each other's viewpoints, contributing to the development of shared mental models and open communications for future decision making.

The majority of participants felt that the course would result in making changes in their behaviors on the job. The results of the follow-up questionnaire, administered one month after the training course, supported these intentions. The self-reported behavior follow-up questionnaire showed that participants were making the changes they had intended to make following the training.

These results are very similar to those achieved in previous evaluations of MRM training programs which have been shown to be highly successful in improving safety and performance in aviation maintenance. Figure 2.14 illustrates the enthusiastic support for Crew Resource Management (CRM) and MRM courses by flight operations and maintenance participants respectively as measured immediately following training.[5] This is compared to the response measured in this study to the Team SA Training Course. Nearly two-thirds of the flight operations groups reported that the CRM training was very useful or extremely useful.[6] Even though this response is very strong, the response of maintenance personnel to the MRM training was even stronger. Ninety percent of the maintenance personnel sampled at two different airlines felt the course was very useful or extremely useful.[7,8] The Team SA Training Course, evaluated in this study, drew a response that was comparable to that found for the highly successful MRM Training program that was conducted at the same airline.5 Based on this result, it can be concluded that the Team SA Training Course is viewed as highly useful at a rate that is favorably compared to previous courses in the MRM/CRM area.

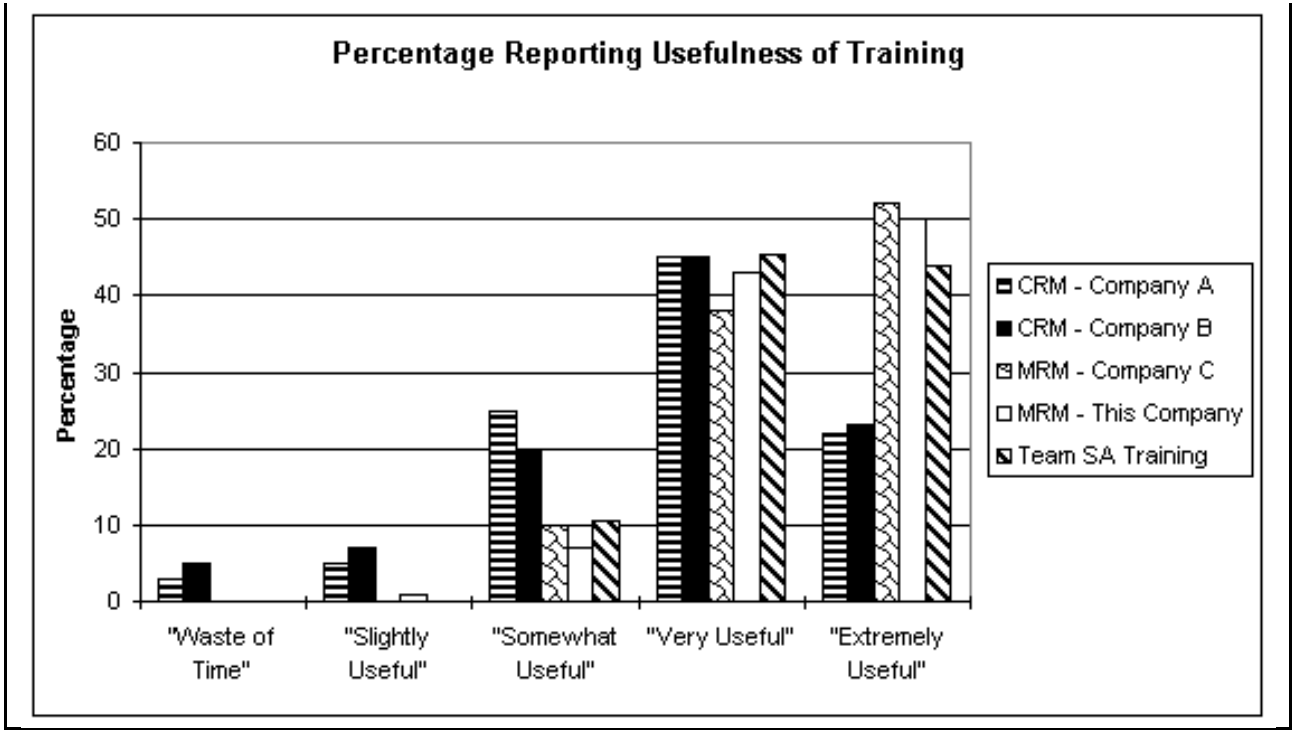


Figure 2.14. Comparison of Team SA Training Course Usefulness to CRM/MRM Courses

Figure 2.15 compares the post-training assessment of the degree to which trainees felt they would change their behavior as a result of the course to similar assessments from CRM and MRM programs.5 The comparison samples are from flight operations CRM courses9 and a maintenance operations MRM course conducted at the same airlines as the present study.5 Nearly 90% of the trainees in the MRM course felt they would make a moderate or large change as a result of the course, as compared to approximately 30% in the flight operations sample. In comparison, 86% of the trainees in the Team SA Training Course gave a similar response, again comparing favorably with previous MRM evaluations. The maintenance groups regard MRM and Team SA Training as having a strongly positive potential for impacting both job performance and safety.

2.6 RECOMMENDATIONS

As a result of this analysis, very few modifications to the course appear to be needed. Participants mainly wanted more of everything: more interaction, more case studies, more group exercises and more discussion. They particularly felt management support of the concepts (both in training and in practice) and the mixing of the departments was important. As the course already features a high level of all these elements, these findings can be taken to mean that the course is designed and developed effectively, supporting the achievement of the training objectives. These findings can serve to reinforce the value of the instructional design and the delivery of the course by the airline facilitator who provided many case studies and exercises in addition to those initially provided.

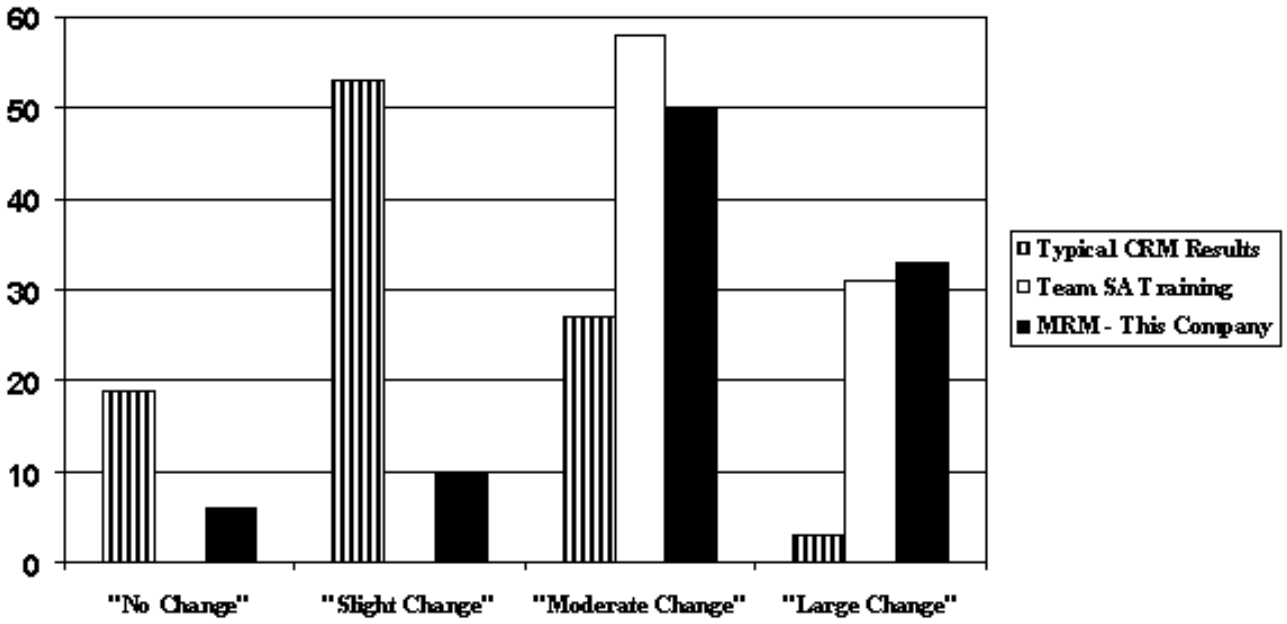


Figure 2.15. Comparison of Self-Reported Behavior Change with TeamA

This evaluation represents an initial evaluation of the Team SA Training Course in its prototype implementation phase. It was the first time the course had been offered to a group of technical operations personnel. The fact that it was viewed so positively as useful to maintenance operations is highly indicative of its success. It is strongly recommended that the airline continue to implement the course and that additional airlines consider adopting the course.

These findings are based on the responses of an initial group of course participants. To further validate these findings, this evaluation should be continued with succeeding groups of trainees in the course. In addition, more follow-up research is needed to validate the results of the on-the-job behavior changes. At the time of this analysis, very few course participants had been back on the job for one full month. Therefore, the sample size for this analysis was very small, probably too small for much confidence in the results. By following up with the remaining participants at the one month point (and again at longer durations), more reliable results can be obtained regarding the degree to which the training effected job behaviors related to SA.

Finally, it would be highly desirable to ascertain the degree to which the training impacts critical maintenance performance measures at the airline. The bottom-line objective is to reduce maintenance errors, improve aviation safety and improve performance. Since the course had been administered to so few participants (scattered over 9 cities), making any meaningful assessment of the effect of the training on performance outcomes was not feasible in this study. In the future, however, the effect of the training implementation on several key safety and performance measures should be assessed. These include:

- Safety performance measures: ground damage, occupational injury rates, loss days
- Dependability performance measures: departures times, head starts
- Efficiency performance measures: MELs, rotable and expendable parts, overtime.

A longitudinal trend analysis of these measures across departments and locations with personnel participating in the training would be highly beneficial. This must be done over a period of time in which large portions of the airline receive the Team SA Training program.

Overall, the value of the Team SA Training Program has been supported by this analysis and its future implementation within this airline and others is strongly encouraged.

2.7 REFERENCES

1. Endsley, M. R., & Robertson, M. M. (1997). Team Situation Awareness Training Program. In *Human Factors Issues in Aircraft Maintenance and Inspection '97 CD-ROM*. Atlanta, GA: Galaxy Scientific Corporation.

2. Robertson, M. M., & Endsley, M. R. (1997). Development of a situation awareness training program for aviation maintenance. In *Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting* (pp. 1163-1167). Santa Monica, CA: Human Factors and Ergonomics Society.

3. Endsley, M. R., & Robertson, M. M. (1996). *Team situation awareness in aircraft maintenance.* Lubbock, TX: Texas Tech University.

4. Endsley, M. R., & Robertson, M. M. (1996). Team situation awareness in aviation maintenance. In *Proceedings of the 40th Annual Meeting of the Human Factors and Ergonomics Society* (pp. 1077-1081). Santa Monica, CA: Human Factors and Ergonomics Society.

5. Taylor, J. C., & Robertson, M. M. (1995). *The effects of crew resource management (CRM training in airline maintenance: Results following three year's experience.* Moffett Field, CA: NASA Ames Research Center Office of Life and Microgravity Sciences and Applications.

6. Helmreich, R. L., Foushee, H. C., Benson, R., & Russini, W. (1987). Cockpit management attitudes: Exploring the attitude behavior linkage. *Aviation, Space and Environmental Medicine, 57,* 1198-1200.

7. Robertson, M. M., Taylor, J. C., Stelly, J. W., & Wagner, R. (1995). A systematic training evaluation model applied to measure the effectiveness of an aviation maintenance team training program. In *Proceedings of the Eighth International Symposium on Aviation Psychology* (pp. 631-636). Columbus, OH: The Ohio State University.

8. Taggart, W. (1990). Introducing CRM into maintenance training. In *Proceedings of the Third International Symposium on Human Factors in Aircraft Maintenance and Inspection.* Washington, DC: Federal Aviation Administration.

9. Helmreich, R. L., & Wilhelm, J. A. (1991). Outcomes of crew resource management training. *International Journal of Aviation Psychology, 1*(4), 287-300.

2.8 APPENDICES

2.8.1 APPENDIX 2-A: TRAINING ASSESSMENT FORM

MRM--II Team SA Training Experience and Evaluation

For each of the topic areas of training techniques listed below, please rate the value of this aspect of the training to you. Rate each item by choosing the number on the scale below which best describes your personal opinion and then write the number beside the item.

1 2 3 4 5

Waste of Time | Slightly Useful | Somewhat Useful | Very Useful | Extremely Useful

MRM **Review and Background**

____ Human Error

_____ Human Factors Elements

_____ SHELL

_____ Chain of events

_____ "Link Busters"

_____ Dominos

_____ Swiss Cheese

Situation Awareness (SA**)**

____ Levels of SA

____ Role of SA

____ SA Problems

____ Consequences of Poor SA

____ "Loosing the Bubble"

____ Developing SA

____ Shared mental models

1 2 3 4 5

Waste of Time | Slightly Useful | Somewhat Useful | Very Useful | Extremely Useful

Communication

_____ Communicating Decisions

_____ Shift Turnovers

_____ Teamwork

_____ Feedback

CASE STUDIES

____ American Airlines Flight #191

____ Aloha Airlines, Flight #243

____ Nationair, Flight #2120

____ British Airways, flight #5390

____ AMT trapped in MLG Doors

____ Eastern Airlines, Flight #855

____ Loss of Thrust Reverser on Landing

____ Inflight Separation of the Horizontal Leading Edge

____ Inadvertent Engine Start in Hangar

____ Maintenance Taxi- Collision with another Aircraft

____ Maintenance Taxi into Terminal #1

____ Maintenance Taxi into Terminal #2

1	2	3	4	5
Waste of Time	Slightly Useful	Somewhat Useful	Very Useful	Extremely Useful

VIDEOS:

_____ Maintenance Video

GROUP EXERCISES:

____ SA problems and solutions within Tech Ops

____ Gaps between Maintenance Operations groups

____ Written communication

____ Information “gaps” between maintenance operations groups

____ Teamwork Exercises

____ Feedback Exercise

____ **OVERALL,** how useful did you find the training

HUMAN FACTORS AND MRM **TRAINING**:

1. Human Factors/MRM training has the potential to increase aviation safety and teamwork effectiveness.

1 2 3 4 5

Waste of Time | Slightly Useful | Somewhat Useful | Very Useful | Extremely Useful

2. This Human Factors/MRM seminar will be useful to others.

1 2 3 4 5

Waste of Time | Slightly Useful | Somewhat Useful | Very Useful | Extremely Useful

3. Is the training going to change your behavior on the job? (circle one from list below)

No Change A Slight Change A Moderate Change A Large Change

4. How will you use this training on your job?

_____

_____

_____

5. What aspects of the training were particularly good?

_____

_____

_____

6. What do you think could be done to improve the training?

_____

_____

_____

PLEASE GO ON TO THE NEXT PAGE

BACKGROUND INFORMATION

JOB TITLE: _____

YEARS IN PRESENT POSITION with CAL: _____

TOTAL YEARS with CAL: _____

DEPARTMENT YOU WORK IN: _____

YOUR CITY NAME OR CODE: _____

SHIFT: _____

PAST EXPERIENCE or TRAINING (# OF YEARS: fill in below)

_____ MILITARY

_____ TRADE SCHOOL

_____ COLLEGE

_____ OTHER AIRLINE

(Specify _____)

YEAR of BIRTH: 19_____

MALE (**M**) or FEMALE (**F**): _____

2.8.2 APPENDIX 2-B: PRE/POST EVALUATION FORM

Pre-Training Last 4 digits of SS#_____

Session_____

MRM **II: Situation Awareness**

Rate the degree to which the following statements describe your **current** behavior in the workplace:

1 2 3 4 5

strongly somewhat neutral somewhat strongly
disagree disagree agree agree

_____ (1) It takes unneeded effort to find the information I need on workcards, logs and the computer.

_____ (2) When performing my tasks, I am often distracted by other tasks that need my attention.

_____ (3) I often already know what is wrong with a system, even before I take it apart because I have worked on aircraft for so long.

_____ (4) When performing my tasks, I am often distracted by the conversations and activities of others around me.

_____ (5) I try to develop a better understanding of how systems work by learning from each job.

_____ (6) I keep others up-to-date with the status of my tasks as I go along.

_____ (7) I usually know what activities others are working on over the course of the shift.

_____ (8) I make sure to pass on to the next shift the status of all ongoing activities and tasks.

_____ (9) I actively work with people from the prior shift to find out what tasks have been done and what tasks still need to be done.

_____ (10) I am extra vigilant in making sure that I read information correctly when working in poorly lit environments.

_____ (11) At the end of the shift I always make sure to double check for loose parts and tools.

_____ (12) During walk arounds, I am extra careful to check for loose parts and tools.

_____ (13) I am always careful to follow the workcards exactly on every step.

_____ (14) When I have made a difficult repair, I follow up down the line to make sure the repair worked to solve the problem.

_____ (15) I never assume that someone else has performed a task or step; I always check to insure that it has been done.

_____ (16) I fully understand the tasks and goals of other tech ops organizations.

_____ (17) When I have a disagreement with another tech ops organization, I always try to understand why they have a different viewpoint.

_____ (18) When working with others, I always tell them what I think needs to be done.

_____ (19) I always explain the reasons for my decisions when I am telling others what needs to be done.

_____ (20) When I must MEL a problem for another shift or station, I always write down all the trouble shooting steps I have taken as well as what I think needs to be fixed.

_____ (21) When I am having a disagreement with someone, I always try to understand why they are making a different recommendation or decision.

_____ (22) I always make sure all problems and ongoing activities are discussed during shift meetings.

_____ (23) I always make sure to pass on information about each aircraft and work status when it goes to the next station.

_____ (24) When I am involved in a difficult joint trouble shooting problem, try to be very explicit with others about what has been done and what I think needs to be done.

_____ (25) I always document everything I do very carefully and fully in the log.

_____ (26) During a shift meeting I make sure that I pass on known information on aircraft status and special problems.

_____ (27) During a shift meeting I work to create a shared understanding of what is going on across the whole team.

_____ (28) I make the goals of the maintenance team as a whole explicit during the shift meeting.

_____ (29) During a shift meeting I work to insure that each person understands their individual tasks and how their tasks may have an impact on or by impacted by the tasks of others.

_____ (30) People on my team work to help each other with their tasks.

_____ (31) People on my team usually understand what tasks others on the team are doing.

_____ (32) People on my team work to keep each other up-to-date on the status of their activities over the course of the shift.

_____ (33) I work to encourage everyone to speak up during shift meetings to voice their concerns, problems and suggestions.

Post-Training Last 4 digits of SS#_____

Session_____

MRM **II: Situation Awareness**

Rate the degree to which the following statements describe your **intended** behavior in the workplace:

1 2 3 4 5

strongly disagree somewhat disagree neutral somewhat agree strongly agree

_____ (1) It takes unneeded effort to find the information I need on workcards, logs and the computer.

_____ (2) When performing my tasks, I am often distracted by other tasks that need my attention.

_____ (3) I often already know what is wrong with a system, even before I take it apart because I have worked on aircraft for so long.

_____ (4) When performing my tasks, I am often distracted by the conversations and activities of others around me.

_____ (5) I try to develop a better understanding of how systems work by learning from each job.

_____ (6) I keep others up-to-date with the status of my tasks as I go along.

_____ (7) I usually know what activities others are working on over the course of the shift.

_____ (8) I make sure to pass on to the next shift the status of all ongoing activities and tasks.

_____ (9) I actively work with people from the prior shift to find out what tasks have been done and what tasks still need to be done.

_____ (10) I am extra vigilant in making sure that I read information correctly when working in poorly lit environments.

_____ (11) At the end of the shift I always make sure to double check for loose parts and tools.

_____ (12) During walk arounds, I am extra careful to check for loose parts and tools.

_____ (13) I am always careful to follow the workcards exactly on every step.

_____ (14) When I have made a difficult repair, I follow up down the line to make sure the repair worked to solve the problem.

_____ (15) I never assume that someone else has performed a task or step; I always check to insure that it has been done.

_____ (16) I fully understand the tasks and goals of other tech ops organizations.

_____ (17) When I have a disagreement with another tech ops organization, I always try to understand why they have a different viewpoint.

_____ (18) When working with others, I always tell them what I think needs to be done.

_____ (19) I always explain the reasons for my decisions when I am telling others what needs to be done.

_____ (20) When I must MEL a problem for another shift or station, I always write down all the trouble shooting steps I have taken as well as what I think needs to be fixed.

_____ (21) When I am having a disagreement with someone, I always try to understand why they are making a different recommendation or decision.

_____ (22) I always make sure all problems and ongoing activities are discussed during shift meetings.

_____ (23) I always make sure to pass on information about each aircraft and work status when it goes to the next station.

_____ (24) When I am involved in a difficult joint trouble shooting problem, try to be very explicit with others about what has been done and what I think needs to be done.

_____ (25) I always document everything I do very carefully and fully in the log.

_____ (26) During a shift meeting I make sure that I pass on known information on aircraft status and special problems.

_____ (27) During a shift meeting I work to create a shared understanding of what is going on across the whole team.

_____ (28) I make the goals of the maintenance team as a whole explicit during the shift meeting.

_____ (29) During a shift meeting I work to insure that each person understands their individual tasks and how their tasks may have an impact on or by impacted by the tasks of others.

_____ (30) People on my team work to help each other with their tasks.

_____ (31) People on my team usually understand what tasks others on the team are doing.

_____ (32) People on my team work to keep each other up-to-date on the status of their activities over the course of the shift.

_____ (33) I work to encourage everyone to speak up during shift meetings to voice their concerns, problems and suggestions.

2.8.3 APPENDIX 2-C: EVALUATION OF CHANGES ON JOB

Post-Training: 1 month followup Last 4 digits of SS#_____

Session_____

MRM **II: Situation Awareness**

Rate the degree to which the following statements describe your **current** behavior in the workplace:

1	2	3	4	5
strongly disagree	somewhat disagree	neutral	somewhat agree	strongly agree

_____ (1) It takes unneeded effort to find the information I need on workcards, logs and the computer.

_____ (2) When performing my tasks, I am often distracted by other tasks that need my attention.

_____ (3) I often already know what is wrong with a system, even before I take it apart because I have worked on aircraft for so long.

_____ (4) When performing my tasks, I am often distracted by the conversations and activities of others around me.

_____ (5) I try to develop a better understanding of how systems work by learning from each job.

_____ (6) I keep others up-to-date with the status of my tasks as I go along.

_____ (7) I usually know what activities others are working on over the course of the shift.

_____ (8) I make sure to pass on to the next shift the status of all ongoing activities and tasks.

_____ (9) I actively work with people from the prior shift to find out what tasks have been done and what tasks still need to be done.

_____ (10) I am extra vigilant in making sure that I read information correctly when working in poorly lit environments.

_____ (11) At the end of the shift I always make sure to double check for loose parts and tools.

_____ (12) During walk arounds, I am extra careful to check for loose parts and tools.

_____ (13) I am always careful to follow the workcards exactly on every step.

_____ (14) When I have made a difficult repair, I follow up down the line to make sure the repair worked to solve the problem.

_____ (15) I never assume that someone else has performed a task or step; I always check to insure that it has been done.

_____ (16) I fully understand the tasks and goals of other tech ops organizations.

_____ (17) When I have a disagreement with another tech ops organization, I always try to understand why they have a different viewpoint.

_____ (18) When working with others, I always tell them what I think needs to be done.

_____ (19) I always explain the reasons for my decisions when I am telling others what needs to be done.

_____ (20) When I must MEL a problem for another shift or station, I always write down all the trouble shooting steps I have taken as well as what I think needs to be fixed.

_____ (21) When I am having a disagreement with someone, I always try to understand why they are making a different recommendation or decision.

_____ (22) I always make sure all problems and ongoing activities are discussed during shift meetings.

_____ (23) I always make sure to pass on information about each aircraft and work status when it goes to the next station.

_____ (24) When I am involved in a difficult joint trouble shooting problem, try to be very explicit with others about what has been done and what I think needs to be done.

_____ (25) I always document everything I do very carefully and fully in the log.

_____ (26) During a shift meeting I make sure that I pass on known information on aircraft status and special problems.

_____ (27) During a shift meeting I work to create a shared understanding of what is going on across the whole team.

_____ (28) I make the goals of the maintenance team as a whole explicit during the shift meeting.

_____ (29) During a shift meeting I work to insure that each person understands their individual tasks and how their tasks may have an impact on or by impacted by the tasks of others.

_____ (30) People on my team work to help each other with their tasks.

_____ (31) People on my team usually understand what tasks others on the team are doing.

_____ (32) People on my team work to keep each other up-to-date on the status of their activities over the course of the shift.

_____ (33) I work to encourage everyone to speak up during shift meetings to voice their concerns, problems and suggestions.

1. What changes have you made as a result of the Human Factors/MRM training?

_____

_____

_____

_____

2. How will you further use the Human Factors/MRM training in the coming months?

_____

_____

_____

_____

3. Looking back on it now, what aspects of the training were particularly good?

_____

_____

_____

_____

4. What do you think could be done to improve Human Factors/MRM training?

_____

_____

_____

_____

BACKGROUND INFORMATION

JOB TITLE: _____

YEARS IN PRESENT POSITION with CAL: _____

TOTAL YEARS with CAL: _____

DEPARTMENT YOU WORK IN: _____

YOUR CITY NAME OR CODE: _____

SHIFT: _____

PAST EXPERIENCE or TRAINING (# OF YEARS: fill in below)

_____ MILITARY

_____ TRADE SCHOOL

_____ COLLEGE

_____ OTHER AIRLINE
(Specify _____)

YEAR of BIRTH: 19_____
MALE (**M**) or FEMALE (**F**): _____