PREDICTION OF ATTITUDE CHANGE FOLLOWING AN AVIATION MAINTENANCE RESOURCE MANAGEMENT TRAINING PROGRAM

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Doctor of Philosophy

By

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PREDICTION OF ATTITUDE CHANGE FOLLOWING AN AVIATION

MAINTENANCE RESOURCE MANAGEMENT TRAINING PROGRAM

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CHAPTER I

Introduction

Despite increasing air traffic, the airline industry has seen decline in aviation accident rates throughout its history, though the slope of that decline has grown smaller in recent decades (Boeing accident rate history figure, n.d.). The decline has been mostly a consequence of technological advances in aviation that have produced safer and more reliable aircraft, as well as better standard technical practices for maintenance and flight crew professionals. As with most industries, initial improvements have occurred from a strong focus on research and development of the technical system. Building safer and more reliable aircraft has traditionally taken priority over human factors in the ongoing pursuit of reducing accident rates. However, in recent decades attention to issues of communication and human factors has increased, and the contribution of these factors is being addressed.

Despite the established ability of technological advances to reduce aviation accidents, a point has been reached at which such advances have not reduced accidents beyond the ability of the social organizational system utilizing the technology. As a consequence, a shift in focus must occur in order to maintain decreases in accident rates. The human component of the organizational system must then be more intently examined to minimize what theorists refer to as "normal accidents" (Perrow, 1998).

The airline industry has been entering this developmental stage since the 1980s, when accident investigations revealed that communication and other types of human error were comprising a very significant proportion of aviation accident

causes (NTSB website). The signature initiative of this shift to a human factors focus is "aviation resource management," an industry-wide program and set of principles implemented to target attitudes, opinions, and behaviors of individuals as critical components of the aviation system. Concerned with increased personal and situational awareness, as well as enhanced communication and trust among mechanics, pilots, and aviation management, the training programs attempt to reduce errors and accidents by teaching communication and awareness skills to aviation mechanics.

Noe (1986) acknowledged the importance of well designed training programs, but also asserts that "trainee attitudes, interests, values and expectations may attenuate or increase training effectiveness". Beyond just knowing whether an initiative is having impact at the organizational level, companies can benefit greatly from information about the impact of training for individuals of varying backgrounds and experience. The current research considers the disparate impact training programs can have on organizational subgroups of varying experience, and examines how such experience can interact with individual attitude change occurring as a result of an aviation maintenance human factors program. Further, this investigation attempts to identify trainee experience variables that predict training impact.

Identifying trainee attributes associated with changes in attitudes and reported behaviors will provide training facilitators and implementers with information about who is benefiting from the curriculum and how the training might be modified to reach diverse populations within the airline industry. This study may also contribute to existing literature on the interaction of trainee characteristics and training impact.

Because the dependent measures used are attitudes and intentions, and not tests of learning or observed behavior change, no inferences will be or should be made regarding the learning ability of training participants. The results are a tool to MRM program decision-makers and implementers for improvement of the program itself. If the program is speaking to different individuals in different ways, MRM programs will benefit from knowing the nature of these differences for program modification.

In pursuit of these goals, evaluation data were examined from a training program designed to address maintenance-related human error in aviation. The program was targeted at changing attitudes, opinions, and general safety awareness of aviation mechanics. The program, as well as the evaluation process designed to improve the program and identify training effects, will be described. Finally, training effects are more closely examined by determining the life experience characteristics of trainees that best predict training outcomes.

Background

In Pursuit of the Reduction of Normal Accidents

Normal Accident Theory is a view of complex high-risk systems that postulates diminishing returns on adding procedural checks and double-checks to reduce system error (Langewiesche, 1998; Perrow, 1998). According to the theory, an over-abundance of procedural complexity without regard for effects on the social system increases rather than diminishes the likelihood of a catastrophic accident. Both normal accident theory and the impetus for Maintenance Resource Management training programs are rooted in principles of Socio-Technical Systems Theory (Cherns, 1976; Ropohl, 1999; Taylor, 1991). The ultimate conclusion is that

increasing safety in high-risk systems must be accomplished through attention to influencing individual behavior and awareness within the system.

Patankar (2002) distinguished between organizational and individual contributing factors to maintenance error. Organizational factors are systemic and include such as policies, procedures and regulations, and might be regarded theoretically as falling into the technical system. By contrast, individual factors are specific to the person and situation at hand, and would be most closely associated with the social side of the socio-technical system. As many can likely attest, most crucial decision-making hinges on influences categorized in the latter set of factors. Components of the system such as communication and individual awareness of factors that contribute to error determine how much the technical aspects of the system are able to function as intended. Additionally, developments in system policies and procedures must be implemented with an eye to their effects on system participants.

The aviation mechanic has traditionally been viewed as a technical part of the aviation system (Shepard, Johnson, Druray, Taylor, & Berninger, 1991). Work cards from which the aviation mechanic receives instruction have been written as clearly and precisely as possible so that an individual can pick up the card and perform each stage of the task with minimal help or backup from other team members. Traditionally, when problems have manifested in the aviation system, changes to these work cards or stricter disciplinary policy have been often used measures to correct the system. A recent refocus on the aviation professional as part of the social system has changed the way maintenance error is being approached in aviation. The

underpinnings of normal accidents are now seen more as a human factors problem of poor teamwork, low trust, individual fatigue, high stress, or poor communication.

Wolf and Berniker (n.d.) validated normal accident theory with an analysis of archival data from government agencies regarding accidents in a petroleum refinery. A sample of 36 petroleum refineries located in the western United States was examined over a five-year period. A formula for the calculation of organizational complexity was derived based on five theoretical contributors to complexity, and an "index of complexity" was derived for each of the 36 refineries. As dependent measures, numbers of hazardous chemical accidents, as well as catastrophic "normal accidents," were also recorded. A relationship was found between index of complexity and chemical accidents. When the sole means of error avoidance lies in the technical system procedure, and not the individual communication and awareness of individuals occupying the system, errors become more rather than less likely.

In sum, normal accident theory and socio-technical systems were the theoretical justification for the beginning of attention to human components of aviation safety in the cockpit, and ultimately in the maintenance hangar. Analysis of aviation accident investigations indicates that a great percentage of aviation accidents are caused by human error, whether by flight or maintenance crews (National Transportation Safety Board, 2002). The conclusion is that the technical advances that once continued to improve aviation safety may have exhausted themselves. This unsettling realization sparked attention to principles of socio-technical systems in aviation, and an interest by applied psychologists and the aviation industry in tending

to non-technical aspects of the system (Shepard et al, 1991). Aviation resource management programs represent the emerging and ever-developing tool by which professionals intend to minimize human sources of "normal accidents."

Resource Management Training Programs in Aviation

Maintenance Resource Management (MRM) training programs are an initiative supported by the Federal Aviation Administration and the airline industry to reduce airline maintenance error and ultimately maintenance-related aviation accidents by addressing human factors that contribute to such errors. The program teaches mechanics the importance of greater awareness of themselves and their situation, as well as clear and appropriately assertive communications skills.

Crew resource management: The origins of MRM. Implementation of resource management originated in the cockpit with Crew Resource Management training programs. These programs, henceforth referred to as CRM, originated in the 1980's when investigations of airline accidents revealed that a great many aviation accidents were caused by a breakdown in communication among flight crew members in the cockpit. An example related on the National Transportation Safety Board website is that of a United Airlines DC-8 in a holding pattern over Portland that crashed because of low fuel. The first officer knew this but did not assertively communicate his observation to the captain. The conclusions of this and other investigations mark the birth of a greater industry focus on the aviation pilot and mechanic as a human rather than technical component of the system. Aviation professionals and academicians realized that a purely technical approach to error

reduction was no longer sufficient to maintain the decrease in aviation accidents that had been occurring previously.

The evolution of MRM programs. Taylor and Patankar (2001) described the evolution of resource management programs from communication skills training in the cockpit to the "integrated, behavior-based MRM programs" implemented today. Goglia, Patankar and Taylor (2002) pointed out that "MRM programs were not intended to be limited to classroom training . . however, industry's efforts in this area have been dominated by awareness training programs". These programs attempt to facilitate aviation cultures of open communication and high trust by teaching structured communication processes. As an example, the Concept Alignment Process (CAP) is a structured communication process whereby concepts regarding work processes and safety are clearly stated by any member of the work team, challenges to that concept are invited or asserted by any member of the work team, and judgements about further action are determined based on a team decision and contextual circumstance. The process provides a method by which the ordinarily reserved aviation employee can speak up and support good decision-making, or thwart bad decision-making. Further, employees who already possess these communication skills and call them "common sense" or "standard professional practice" will benefit from having a structured model by which to better understand their own behavior, and teach it to others.

Other communications processes offered in today's MRM programs are structured Maintenance Error Investigation (MEI) tools that management can use with mechanics after an error is committed. One such tool is the Maintenance Error

Decision Aid (MEDA), a form that categorizes factors that contribute to maintenance error. If a mechanic commits an error, that person can avoid punitive measures by sitting with management and identifying the factors that contributed to this error. The MEDA process increases trust in management by allowing maintenance employees to learn from the incident and avoid punishment, which ultimately leads to silence and more errors. The importance of top-level support is addressed by processes such as CAP and MEDA in today's MRM programs, as past attempts at implementation have been stunted by a management system that isn't fully trusted with information regarding error. In some companies, separate training programs are offered to managers that emphasize the importance of creating a maintenance culture of high trust.

Most MRM training programs are 2 full days in length. The number of facilitators varies from one to two. In some cases, the facilitator(s) are individuals who have worked recently as mechanics, and in other cases the facilitator(s) are professional trainers. Most programs include case studies and examples for analysis by the group, as well as exercises intended to reinforce training concepts. Some programs place management and mechanics into the same training session, and others have separate training for management. Management training generally involves more attention to systems principles and implementation issues, though it's arguable that MRM programs would benefit from exposing these concepts more heavily to the mechanic population. The programs are usually required of all maintenance department members, and participants are compensated for attendance.

The program used in the sample under study generally adheres to the criteria just described. The program occurs over two days, and is facilitated by an external professional trainer. Participants travel to an offsite training facility at the company's expense, and are compensated for their time at training. At the beginning of the 2-day training session, participants are asked to complete the MRM/TOQ and return in to the course facilitator. Participation in the survey is optional. The post-training survey is administered in the same way at the end of the second day.

The objectives of the course employed by our current sample, as stated in the training manual, are to: (a) describe the role of human factors in aircraft maintenance, (b) identify common human factors that contribute to errors in aircraft maintenance, (c) using the MEDA error investigation tool, analyze the role of these factors in aircraft incidents, (d) identify specific strategies to reduce errors due to these factors, and (e) build a plan to reduce maintenance errors at your work site. The course begins with a case study that demonstrates the role of miscommunication and human error on an aviation incident, followed by statistics suggesting that aviation accidents caused by human error are on the rise.

A model is then provided for understanding the nature and types of contributing factors that lead to accidents. Specifically, the concept of *chain of events* is described, whereby small, seemingly irrelevant circumstances can compound to produce disastrous results. The Maintenance Error Decision Aid (MEDA) is also introduced here as a means of showing categorized contributing factors. Inclusion of this tool in the program serves two purposes: (a) to convey the spectrum of possible causes and types of causes that can lead to error, and (b) to provide a decision aid by

which management and maintenance can dialogue after an incident about what the contributing factors were. The goal is to create an aviation culture geared to higher trust and learning rather than punishment and ignorance toward future avoidance. After presenting the tool, a class exercise with a case study is conducted to demonstrate its intended use.

Following this part of the program, issues of individual awareness are discussed with participants. This included personal factors that contribute to errors such as stress, fatigue or general distraction. Communication is next discussed, stressing the importance of clarity in writing, tips for avoiding conflict, and finally, speaking up about policies or procedures that might be contributing, or have the potential to contribute, to maintenance error.

The course ends with participants filling out a *personal work site plan.* Trainees are asked to identify a contributing factor operating in their workplace, describe how that factor is contributing to error, and then outline a plan to attenuate this factor's contribution to error. The course facilitator collects these plans, and mails them to participants 2 months later, asking them to reflect on the implementation of their plan.

The two final steps in the course are the instructor evaluation, and the post-training MRM/TOQ. Participants are dismissed as they complete these optional tasks.

Evaluation of MRM Programs

Action research. Coghlan and Brannick (2001, p.3) defined action research as "an approach to research that is based on a collaborative problem solving relationship between researcher and client which aims at both solving a problem and generating

new knowledge." The evaluation program associated with this research has conformed to this definition by providing measurement and analysis to those responsible for MRM design in ways that help to answer their questions based on experience with implementation. Lewin (1946) first articulated the function and position of research within planning and social action. His cyclical model of action research involves *planning, executing,* and *fact-finding/research.* Social planning and action continues indefinitely through these steps as efforts to move programs in desired direction at desired rates. As planning and execution evolve, so do the research questions associated with these steps. The research here is part of an action research cycle geared to the development and improvement of MRM programs. Also guiding the current research program is the Kirkpatrick model, a framework for program evaluation that highlights the depth of measurement criteria in terms of the closeness to the bottom line function of the entity under investigation.

The Kirkpatrick Model. Kirkpatrick (1998) identified three reasons for conducting evaluation: (a) To justify the existence of the training department by showing how it contributes to the organization's objectives and goals, (b) to decide whether to continue or discontinue training programs, and (c) to gain information on how to improve future training. The data employed in the proposed study have been used primarily to address Kirkpatrick's' third impetus. Individual factors in training impact are examined in this study to assist those associated with MRM in improving the training, and maximizing impact on organizational attitude change. Shrock and Geis (1999, p. 185) call evaluation the part of Human Performance Technology that provides information about worth or value or meaning. The aim of my research is to

contribute to the enhancement of worth, value and meaning of MRM programs. The primary model used in the construction of the currently proposed evaluation criteria was the Kirkpatrick model.

The Kirkpatrick model specifies four levels of training evaluation criteria or outcomes, each increasing in relevance to bottom-line organizational goals. The four levels are reactions, learning, behavior and results. Reactions are simply the opinions of training participants about the training. Such data is easily measured and collected, but has a theoretically and practically weak relationship to ultimate organizational goals. The second level of evaluation, learning, carries a bit more weight toward bottom-line training objectives. An evaluator targeting this level of criteria is interested in principles, facts, and attitudes that were gained or changed as a result of training. Behavior is the third level of evaluation and entails more direct observation of work practices. An evaluator at this level is looking for actual behavior change related to job performance. The final, deepest and most critical level of evaluation criteria, according to Kirkpatrick, is results. At this level, training effects are related to organizational objectives. If an evaluator can demonstrate that this level of criteria is affected by a training initiative, then that evaluator has data that are able to make meaningful statements about the success of the program.

The data used in the present study were collected with the Kirkpatrick concepts as a model, and with primary attention to the second and third levels of evaluation criteria (learning and behavior). Kirkpatrick warns that fourth level evaluation is generally difficult and many times impossible. Attempts have been made to link MRM training to organizational results (e.g., ground damage incidents,

lost time injuries), but relationships in this regard are weaker than those between MRM training and attitude change (Taylor, 2000). Hence, the currently proposed study will use only second and third level evaluation measures to gain insight into the impact of trainee experience. The next section describes evaluation methodology for CRM programs, which have influenced the procedures used in MRM training evaluation.

CRM evaluation. Among the earliest and most influential endeavors to evaluate CRM was Helmreich (1984). He developed the Cockpit Management Attitudes questionnaire, which was first introduced and administered to 245 line pilots serving as captains and first officers. The instrument was initially designed to stimulate group discussion about cockpit resource management and to generate a database on prevailing attitudes. The instrument has evolved into a measure of changes in attitude toward safety and communication as an effect of participation in CRM training modules.

Gregorich, Helmreich and Wilhelm (1990) used exploratory factor analysis of data from three commercial airlines to establish consistent internal structure of the instrument, and reported pre- and post-training differences in attitudes from the samples. Results revealed three stable factors across the three samples that resemble those that have emerged in Maintenance Resource Management research to be reviewed later (Taylor & Thomas, 2001). The first factors were Communication and Coordination, Command Responsibility, and Recognition of Stressor Effects. The emergence of these three factors as measures of pilot attitudes established the reliability and validity of the CMAQ, and acted as a strong step toward linking CRM

implementation to desirable organizational outcomes. However, the article by Gregorich et al. (1990) concluded with a plea for further research linking such attitude measures to performance measures such as error-reduction, a conclusion consistent with the four levels established in the Kirkpatrick model.

Development of the MRM/TOQ. With the success of resource management programs in the cockpit came the desire to develop similar programs in the aviation hangar with maintenance crews. Accordingly, an evaluation methodology was desired for these programs as had been for CRM programs. Stelly and Taylor (1992) introduced the MRM/TOQ, an instrument modeled after the evaluation survey used by Helmereich to examine the impact of CRM training. More recently, Taylor and Thomas (2001) conducted factor analysis to determine on five company samples to determine the emerging factor structure. Four reliable and valid scales were developed measuring supervisor trust, coworker trust, assertiveness, and stress management. Each of these constructs are targets of the MRM training programs, though to lesser or greater extents depending on the individual company. Depending on organizational goals and needs assessments, each company tailors the thrusts of their training agenda to suit their objectives. In the following section, the aspects of the program that are measured by the Taylor and Thomas (2001) scales are described.

Evaluation Constructs for Maintenance Resource Management Programs in Aviation

The study proposed here uses training evaluation data collected to draw conclusions about the effectiveness of MRM, and provide feedback for developing the program. A thorough understanding of MRM content and principles is critical to constructing and understanding the evaluation methodology. Those principles will be

outlined and discussed here as a vehicle to describing the evaluation methodology and data employed for purposes of the study.

As with CRM programs, MRM is practiced in many different companies in almost as many different ways. As such, developing both uniform and specific evaluation methodology is a challenge. However, the differences in training content and style across all participating companies can be reduced to a set of principles held critical by most of aviation maintenance that directly address the industry focus on human-related error. These are briefly discussed in the following sections.

Trust. Following directly from the need for open communication in the pursuit of error-reduction is the concept of trust. In their integrative model of organizational trust, Mayer, Davis and Schoorman (1995) define trust as " the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (p. 712).

The model and definition proposed by these authors speak directly to the issues of trust targeted by MRM programs. Specifically, organizational trust as defined here is critical to error and accident reduction because it creates a safe environment for organizational members to speak out about issues they are concerned about, errors they see others making, or coming forward with their own errors. Efforts have been made in organizational research to link organizational trust to business performance and productivity (Sako, 1998; Fukuyama, 1995). Hosmer and Reid (1995), in a literature review examining organizational trust from an ethical perspective, calls on researchers to "show empirically that there is a connection –

through trust – between the moral duty of managers and the output performance of organizations . ." (p. 400). MRM programs attempt to show this link through its training programs, as well as evaluative research using case analysis, survey and other organizational assessment methods.

Trust between management and subordinates. Particularly critical to the implementation of MRM, and ultimately the reduction of aviation error, is trust between aviation management and the maintenance crew. Organizational research has attempted to understand trust in such relationships. Studies of managerial and subordinate trust have shown the mutual interdependence of trust between these groups (Butler, 1983), have identified specific factors that influence levels of trust between superiors and subordinates (Butler, 1984), and have developed instruments to measure such factors (Butler, 1991). More recent examinations into constructs such as organizational cynicism have provided groundwork for organizations to learn about ways to increase trust and reduce cynicism in the workforce (Dean, Brandes & Dharwadkar, 1998; Thompson, Joseph, Bailey, Worley & Williams, 2000). When organizational members perceive that they can expect a fair reaction from management and coworkers, the kind of open communication necessary to preventing and learning about maintenance error can occur. To foster this kind of organizational trust, concrete processes have been devised by industry experts and academicians to give organizational members a firm contract of what to expect when they speak out. These processes are discussed in training in an effort to increase trust among mechanics and management.

Communication. Communication in various forms is critical to aviation safety. As such, a centerpiece of all aviation resource management programs is the transfer of concepts and skills toward clear and effective communication. Communication has fundamental importance during all aviation maintenance operations, but written and verbal interactions that occur at shift turnovers represent the highest level of criticality. Taylor and Thomas (2001) examined shift turnover by looking at changes in the completion of work turnover cards coincident with the onset and termination of MRM programs in a major airline company. Improvements were found in both attitudes about the importance of written turnover, and the legibility and detail of the written turnover itself before and after MRM training, with a relapse occurring after several months without training. Surprisingly, this work represents one of the few examinations of written turnover in aviation, despite it's widely held importance to error-reduction. Other targets of communicative change in MRM programs are skills and strategies that bring potential errors to light before they become accidents. Specifically, cockpit and maintenance crew members at all levels are encouraged to speak out assertively when something doesn't seem right. The willingness by maintenance employees to do this is measured by one of the Taylor and Thomas (2001) scales. In some industries this may not seem a difficult change endeavor, but aviation draws heavily from military backgrounds, where hierarchical command is often expected to be accepted and unchallenged.

Stress Management. Another objective of MRM and CRM programs is to help cockpit and maintenance crews with awareness of individual factors that contribute to one's own propensity for committing errors. Sleep deprivation, personal

issues, and general stress are examples of factors of which training participants are told to be wary. When maintenance crew members find themselves affected by one or more of these factors, MRM principles dictate that they should communicate their condition assertively to let others know that their performance may be impaired. Many accident investigations have uncovered individual stress factors as one link in a chain of contributors.

Experience as Predictors of Attitude Change

The constructs just described are important because they have been identified as contributors to maintenance error. For this reason, finding predictors of changes in attitude toward these constructs is a valuable method of facilitating program improvement. If characteristics of the program content, the method of delivery, or even characteristics of the training participants can be shown to have a relationship to changes in these attitudes, training can be improved utilizing the knowledge of these relationships.

For the present study, trainee experience variables were used as the independent variables in an attempt to predict changes in attitude. Specifically, age, years in the company, years with another airline, years in the military, years in trade school, and years in college were used. The variables were selected because the data were collected and readily accessible, and because the background and experience of the individual within the organization was thought to have logical implications for that person's attitudinal response to the program. Thus, these *experience* measures were employed as the exploratory first step toward understanding factors that are related to changes in attitudes targeted by MRM training.

The background related here was designed to give readers an understanding of current issues in aviation human factors, describe the MRM programs designed to address those issues, and finally detail the measurable criteria used for the current analysis. A critical component to success of a training initiative is a carefully planned evaluation methodology that shows what effects have been achieved, the size and nature of those effects, participant reaction to the training, and the longevity of any changes in attitudes, opinions or behaviors. The research conducted here was interested in identifying predictors of changes in training participant attitudes. This is important to program development because it will assist those who design and teach MRM training courses in understanding the role of individual differences in reaction to the course. A comparable study by Workinger (1994) examined key elements contributing to organizational resistance of employees in creating a high involvement organization. Specifically, he examined demographic and occupational influences on level of resistance to the program. The current study had similar purpose: to evaluate the life experience and occupational relationships to the magnitude of training effects as measured through the MRM/TOQ questionnaire (Taylor, 1998; Taylor et al., 2001). Such analysis was designed to create awareness among MRM trainers and implementers regarding differences in impact on organizational members of differing types of experience. Identifying trainee attributes associated with changes in attitudes and reported behaviors provides training facilitators and implementers with information about who is benefiting from the curriculum and how the training might be modified to reach diverse populations within the airline industry.

Summary and Hypotheses

MRM programs seek to reduce errors in the aviation system through attention to what accident investigation reports have referred to as "human factors". Because attention to such factors is relatively new in aviation, attitudes regarding the program principles are expected to vary among members of the culture. As a means of learning more about the way MRM programs are impacting various groups within the aviation culture, the current study is interested in the relationship, if any, between individual background and experience, and attitudes regarding MRM training principles communication, trust and individual awareness.

The following research question will be addressed by this study: To what extent do experience characteristics of trainees (age, years in the company, experience with another airline, years in the military, years in trade school, years in college) have a relationship to the amount of pre-post attitude change or on the amount of post-training enthusiasm? In operational terms, the following hypothesis will be evaluated for the currently proposed study: Independent variables of age, years in the company, experience with another airline, years in the military, years in trade school and years in college, enthusiasm and intentions to change behavior will be significant predictors of the magnitude of pre-post attitude change as measured by the MRM/TOQ.

CHAPTER II

Method

Participants

Sample participants are 978 airline mechanics, managers, and various other job roles from an airline company that has implemented an MRM training program. Trainees were required to attend training. Response to the survey was optional, but almost all trainees participated. Table 1 and Figures 1 and 2 show the composition of the sample employed in the current study as compared to a large population of surveyed trainees from 15 airline companies and maintenance facilities throughout the U.S. aviation industry.

The sample used was about 88% male, a statistic consistent with the greater industry. The current sample has less time with the company, more military experience, similar educational experience and slightly more years in different airline companies. The sample make-up is suggestive of an aviation culture with more external experience. The relative lack of team experience could have implications for trust and communication. The proportion of management, mechanics and other job roles in the current sample is consistent with the industry.

Table 1

Sample Composition Compared to Total Surveyed Population

	Sample n	M	Population N	μ
Years with Current Company	956	8.85	16,033	11.98
Years with Current Company	956	8.85	16,033	11.98
Years in Military	774	4.35	15,704	2.57
Years in Trade School	771	1.01	14,763	1.16
Years of College	760	1.48	15,110	1.35
Years with Other Airline	759	3.50	15,256	2.50
Age	952	43.05	16,837	46.08

Note. M = sample mean, μ = population mean

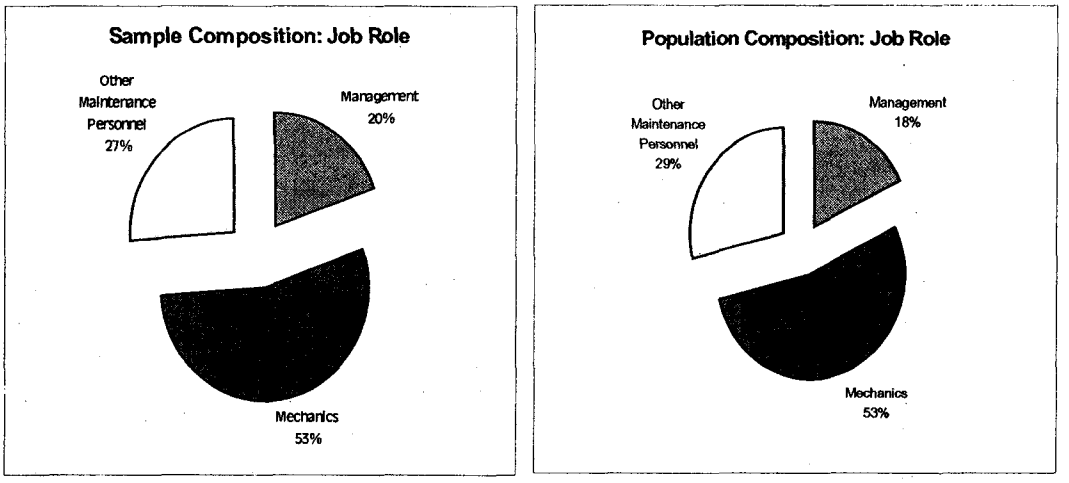

Figure 1. Percentage of Management, Mechanics and Other Job Roles

Instrument

The survey instrument employed in the current analysis is the Maintenance Resource Management/Technical Operations Questionnaire (MRM/TOQ), a questionnaire designed to measure attitudes and opinions on a range of constructs related to safer airline maintenance (see Appendix A). The instrument was based on the work of Gregorich, Helmreich and Wilhelm (1990), who began Resource Management training programs with airline crews in the cockpit during the 1980's and developed a survey to measure training impacts on participant attitudes.

The measures used in the current study were part of the MRM/TOQ. The data were collected from a large U.S. airline that recently implemented an MRM training program. Measures were taken immediately prior to training (pre-training), and immediately after training (post-training). In addition to participant responses to survey items, demographic and background data were collected regarding experience, job title, education, military experience and other such information. These measures

serve the primary goal of the current study: to examine how trainee experience is related to these variables. Scales derived from the MRM/TOQ are described below.

Survey Scales

The following scales were developed and validated through factor analysis using the MRM/TOQ (see Taylor & Thomas, 2001), and are the dependent measures. The calculations of the scales are shown in Appendix B, following the questionnaire from which they were derived.

Trust supervisor's safety practices. This scale reflects the quality of the relationship between the respondent and her/his supervisors or managers on safety related matters. Survey questions that comprise this scale probe for how much the respondent feels she/he can approach management without fear of punishment, backlash or inaction (especially with safety issues and suggestions).

Communication and Trust in coworkers. This scale, also a trust measure, indicates the importance of trust and quality communication among the respondent's coworkers. The general importance and feeling of open communication, debriefing and shift meetings are measured by this scale.

Assertiveness. A critical component of good communication in aviation maintenance that is stressed in MRM training is the ability to speak and listen assertively when doubt arises or a situation seems unclear. This scale measures the respondent's comfort in disagreeing with or speaking out against the opinions of others in maintenance.

Understand effects of stress. This scale measures the respondent's awareness of the impact and importance of individual stress factors to her/his performance. The

degree to which the respondent believes that fatigue and personal problems degrade safe performance is measured with this scale, as well as self-perceived ability to separate personal problems from work.

Enthusiasm for the training. Post-training enthusiasm measures are taken to assess trainee motivations to transfer training concepts to the work environment. Enthusiasm is measured only for post training, and is comprised of three statements for which respondents are to rate their level of agreement: (a) This training can increase safety and teamwork, (b) This training will be useful to others and, (c) This training will change my behavior.

Intention to change behavior. Additionally, the post-training survey instrument asks participants about their intentions to change behavior on the job. Specifically, participants were asked "How will you use this training on the job?" Coded response rates among various sub-groups were examined regarding this question to see the relationship between having an intention to change one's behavior and attitude and attitude change.

Procedure

The MRM/TOQ was administered to training participants at the beginning and end of the two-day training courses. It should be noted here that the data was collected on different dates across forty-two separate training sessions, so the description of procedures for completing the survey by the facilitator are subject to slight variance. However, all sessions were conducted with the same course facilitator and approximately twenty participants per session, so considerable consistency can be expected.

For the pre-training administration, the course facilitator explained that the data would be sent to Santa Clara University for analysis to help him and others better understand the training impact. This introduction was informal and likely to vary somewhat among facilitators and programs. Participants were given all the time they needed (this was generally no more than 10 minutes) to complete the instrument and return it to the course facilitator, who later mailed the surveys to the research lab at Santa Clara University.

Post-training survey administration occurred in much the same way. Slightly more time was needed for this survey, as the open-response questions take more time. Completion of the post-training survey marked the final task in the training, and participants were thanked as they returned their surveys.

CHAPTER III

Results

The present study was designed to assess the utility of trainee experience variables in predicting attitude change among airline maintenance personnel following an MRM training program. In other words, a relationship was sought between certain demographic characteristics of training participants, and their reaction to the training. Multivariate statistical procedures were selected as the best statistical approach, if the collected data were found suitable for such analysis. Multivariate analysis carries the advantage over univariate procedures of reducing the likelihood of type I error (erroneous significant findings). To test the appropriateness of the data for multivariate tests, preliminary analyses were conducted to assess conformity to necessary assumptions articulated in multivariate statistical theory (Licht, 1995; Stevens, 1995; Wienfort, 1995; Yarnold & Grimm, 2000). These assumptions, and the corresponding analysis to assess conformity, are detailed in the next section.

Preliminary Analysis: Examination of Data Conformity to Multivariate Assumptions

The primary assumptions of repeated measures multiple analysis of variance, the statistical test used here to establish pre-post change across dependent measures, are detailed by Weinfort, 2000 as follows: First, variables under consideration must have shown reasonably normal distributions. Second, covariance matrices of the dependent variables should be the same for all levels of the between subjects variables, and variables should be correlated. In other words, any groups that are compared must have comparable variance. A third necessary condition for

multivariate analysis is that the dependent measures must bear moderate relationship to one another (Stevens, 1995; Wienfort, 1995; Yarnold & Grimm, 2000). Finally, the observations must be independent of one another. That is, each observation used in the analysis must be derived from separate individuals, whose responses have not been influenced by one another. If the responses of individuals are influenced by those around them, and not the program or intervention, then obvious difficulty arises in determining how much of the individual change is attributable to the program itself. Although attitudes of individual trainees were likely influenced by others in the program, the violation was disregarded for the current analyses. In the current context, attitude change following the training is considered practically important regardless of whether it occurred partly from trainee interaction. Hence, partial violation of this final condition is noted, and results are interpreted in light of the impact on the meaning of statistical significance.

Examination of Multivariate Normality

Regarding the first assumption, normality was examined for each of the four dependent measures. All variables, with two exceptions, were normally distributed. *Communication and Coworker Trust* and *Enthusiasm* showed slight "J" distributions, which are shown in Figure 2. These types of distributions occur when responses are skewed to the positive end of the distribution. The "ceiling effect" reduces variance and makes problems for interpretation of results. When this happens, transformations of data are sometimes employed as a correction. However, Howell (2002) warned against making unwarranted transformations (i.e., when variables are more or less

symmetrical and have a few outliers). Because the normality violation only occurred in two of the five measures, multivariate analysis proceeded without transformation, and with caution about the nature of the two violating variables. Data also conformed to the two assumptions of equal covariance matrices and independence of observations.

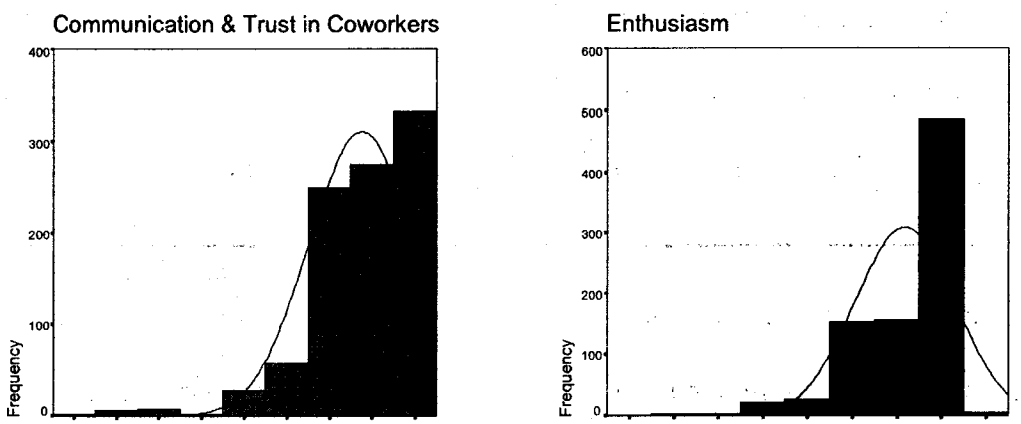

Figure 2. Skewed Distributions for Communication and Trust in Coworkers and Enthusiasm Scales

Correlations among dependent variables. Another necessary condition for multivariate analysis concerns the relationship among dependent measures. The multivariate analysis of variance (MANOVA) is appropriately used when dependent variables are correlated (Stevens, 1995; Wienfort, 1995). As shown in Table 3, moderate correlations were found among the dependent measures. With conformity to the assumptions of MANOVA established, the analysis was conducted to test pre-post attitude changes and is described in the next section.

Overall Attitude Change from Pre-Training to Post-Training

The prediction of pre-post change on the criterion measures, of course, requires that such changes exist. Such change is measured by gain scores, which are

calculated by subtracting pre-training from post-training scores, and thus show the magnitude of difference between pre- and post-training attitude measures. To establish the existence of pre-post attitude gain, a repeated measures MANOVA was conducted with pre- and post- attitudes as dependent measures. An overall within-subjects multivariate effect was obtained $F(4,789)=116.18)$, $p<.001$. To test which scales contributed to the multivariate effect, post-hoc paired samples ANOVAs were conducted between pre- and post- measurements on each of the four survey scales. Results are given in Table 2. All of the four scales being employed as dependent measures show a significant change from pre- to post-training. However, attitudes about communication become significantly less assertive after training, while the two trust scales and the awareness of stress effects scale increase. Results established a significant change in attitude before and after training, and justify analyses regarding predictors of such change.

Table 2

Pre-Post Differences in Attitude Scales (n= 793)

Scale	Mean Difference	*SD*	*F (1,792)*
Supervisor Trust and Safety	.16	.67	56.53
Communication and Trust in Coworkers	.14	.60	44.73
Assertiveness	-.22	1.00	34.11
Effects of My Stress	.52	.79	346.11

Note. All *F*'s were significant at $p<.0001$.

Examination of Data for Conformity to Multivariate Regression Assumptions

With the establishment of significant pre-post gains in attitude measures in the previous section, it was considered appropriate to proceed with analyses concerning the prediction of change using trainee experience variables, thus testing the hypothesis of this study. The statistical procedure deemed appropriate to test the predictive relationship among these variables was multiple regression. However, as with MANOVA, there are necessary data conditions that must be satisfied before this procedure can be performed. These assumptions were therefore examined and addressed.

Correlations among predictor variables. When several predictors are employed in a regression analysis, the use of multiple regression techniques assumes significant associations among the independent (predictor) variables. As shown in Table 2, that assumption is met with moderately significant correlation among trainee experience variables.

Multicollinearity. This term refers to the degree of intercorrelation among predictor variables in a regression analysis. Excessive multicollinearity results when predictor variables are highly correlated. Licht (1995, p.45) stated that, "in general, the greater the multicollinearity, the more problems exist in terms of technical aspects of multiple regression analysis." The data for the current study, though correlated, do not exhibit this problem with the predictor variables used here.

Table 3

Correlations Among Experience Variables, Scale Gain Scores and Scales at Pre-Training

Variable	2	3	4	5	6	7	8	9	10	11	12	13	14[a]
1. Years with the Current Company	-.067 750	-.234** 765	-.085* 751	.092* 762	-.023 811	.050 822	-.026 830	-.021 819	-.028 939	-.005 945	.076* 950	.050 945	-.007 835
2. Years with Another Airline	-	.006 741	-.031 725	.017 737	.008 653	-.028 659	.049 665	-.078* 659	.039 747	.081* 752	.020 755	.013 753	.012 667
3. Years in Military		-	-.003 742	-.147** 749	-.051 664	-.068 673	.028 678	-.026 671	-.105** 761	.056 767	-.010 770	.081* 767	-.004 680
4. Years of College			-	-.119** 741	.000 652	.011 661	.087* 664	-.011 659	.024 749	.046 756	.058 756	-.122 754	.041 665
5. Years in Trade School				-	.020 663	-.017 672	.001 676	-.065 669	-.061 758	-.012 765	-.016 767	.021 764	-.006 676
6. Supervisor Trust and Safety[b]					-	.166** 815	-.147** 816	-.048 810	-.323** 825	-.064 826	.138** 830	.035 823	.131** 809
7 Communication and Trust in Coworkers[b]						-	-.074* 827	.116** 820	-.079* 818	-.485** 836	.055 834	.005 826	.126** 820
8. Assertiveness[b]							-	.102** 825	.020 820	.010 831	-.418** 844	-.032 829	.018 829
9. Awareness of Stress Effects[b]								-	.124** 818	-.055 830	.023 836	-.495** 834	.094** 818
10. Supervisor Trust and Safety[c]									-	.318* 1025	-.202* 1028	-.119* 1028	.191* 835
11 Communication and Trust in Coworkers[c]										-	-.083* 1033	.047 1032	.296* 839
12. Assertiveness[c]											-	.151* 1037	-.161* 843
13. Awareness of Stress Effects[c]												-	.049 840

*$p<.05$ **$p<.01$ [a]14 = Post-Training Enthusiasm [b]Pre-Post Gain Score [c]Pre-Training Score

Correlation among experience variables and attitude change. Another precursor to multiple regression analysis is correlation among independent (experience variables) and dependent (attitude) variables. The regression model is based on the concept of correlation, and without such correlation, regression analysis of these variables lacks purpose. However, as depicted in Table 3, practically no relationship exists between the type of experience of the trainee, and the amount of change that results from MRM training. The past experience of aviation employees appears to bear no relationship to their potential to increase trust and improve communication and personal awareness. This suggests that training participants of varying individual experience are not being impacted differentially by the program. Although this lack of correlation casts doubt on the probability of finding a predictive relationship between experience and attitude change, multiple regression analysis was conducted with hope of finding at least partial support for the current hypothesis.

Test of Hypothesis

Multiple Regression: Prediction of Change in Attitude

The main goal of this study was to arrive at a predictive model for the relationship between trainee experience and changes in measured attitude. The experience variables included in the regression analysis were years in the military, years of college, years in trade school, years with another airline, years with the company, job role (manager or mechanic), shift (day, afternoon, night), age and gender. Criterion measures included pre-post gain scores for the five MRM/TOQ scales (Supervisor Trust and Safety, Communication and Trust in Coworkers, Assertiveness and Awareness of Stress Effects). No significant predictive

relationship was found between experience measures and changes in attitude before and after training. In the present sample, the amount of attitude change as a result of MRM training was not affected by characteristics of the trainee.

Although data did not support the hypothesis of a predictive link between trainee experience and changes in attitude, the *ancillary analyses* section describes further tests conducted to examine other variables (e.g., stated intention to change behavior, pre-training attitudes) that might predict such change. Also, analyses were conducted to test the relationship between experience variables and *baseline* attitudes (those measured only prior to training). Finally, other analyses are conducted that are considered useful toward the goals of MRM program improvement.

Ancillary Analyses

The ancillary analyses described here further examine relationships among trainee characteristics and attitude change, and goes further to examine relationships to baseline attitudes. The section also takes a closer look at the impact of job role on maintenance attitudes, as analyses show the variable to be unique in its ability to predict attitudes prior to training.

Further Attempts to Predict Attitude Change

Post-training intentions as predictors. Thus far, I examined the predictive associations between experience variables and changes in measured attitudes. Because data regarding intentions to change behavior was collected on the MRM/TOQ, and insight about individuals who have no intention to change can be valuable to shaping MRM programs, another set of analyses was conducted examining differences in attitude and experience based on whether respondents

intended to change behavior after training. Participants were coded into two groups based on their responses to the post-training survey question "How will you use this training on the job?" Specifically, respondents who said that (a) they intended to make some kind of change in work behavior related to the training principles (*N= 579)*, and (b) they "don't know," don't think any change is necessary, or somehow implied that they would not be making any change in behavior (*N= 214),* were compared on attitude measures. This analysis was conducted to shed light on the small proportion of MRM trainees who appear unmotivated to implement training principles in some way.

For the analysis, responses were re-coded into a dichotomous variable separating respondents who intended to change, and those who said the "didn't know" or indicated that they had no plans to change. A repeated measures MANOVA was conducted with two time levels (pre- and post-) and with intention to change ("no intention" and "don't know" or "no change needed") as the independent variable. The dependent variables were gain scores (calculated by subtracting pre-training from post-training scores) for the four survey attitude measures (*Supervisor Trust, Value Communication and Coworker Trust, Assertiveness, Awareness of Stress Effects).*

The interaction of time (pre-post) and group was significant only for *Supervisor Trust*, $F(1,791)= 4.85$, $p<.05$. Inspection of Figure 3 shows that individuals with a subsequent post-training intention to change not only had more trust in their supervisors initially, but also improved their trust to a greater degree than the group without subsequent intention to change behavior.

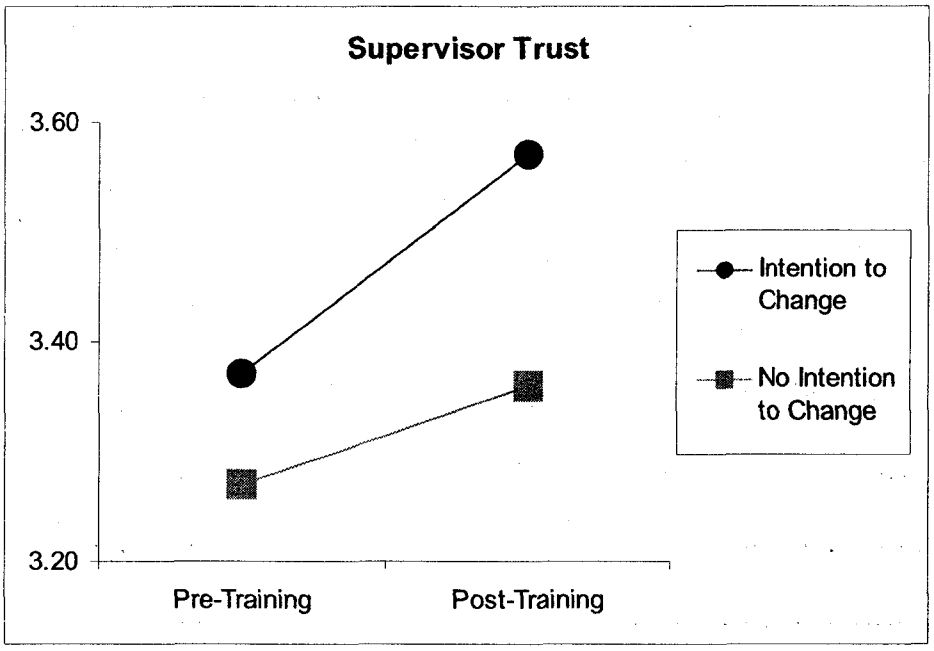

Figure 3. Interaction of Behavioral Intention with Time for Supervisor Trust

In addition, a significant multivariate main effect of time was found, $F(4,788)= 89.88, p<.001$, affirming the preliminary finding that attitude change occurred from pre- to post-training on each scale. Table 4 presents scale gain scores for intention to change and no intention to change groups.

Also, a significant between subjects multivariate effect of change occurred, $F(4,788)= 4.701, p=.001$, indicating overall higher attitude ratings for the group in which participants reported an intended behavior change. Post hoc analysis indicated that *Supervisor Trust* $F(1,791)= 6.154, p=.013$, *Value Communication and Coworker Trust* $F(1,791)= 9.318, p=.002$ and *Awareness of Stress Effects* $F(1,791)= 7.673, p=.006$ were greater overall with trainees that had subsequent post-training intentions to change than when such intentions were absent. Assertiveness, though impacted by training, was not different for respondents who reported an intention to change. Table 5 is the corresponding ANOVA table for the difference among means.

Table 4

Gain Scores for Intention and No Intention Groups

Scale	*Intention to Change*	*SD*	*No Intention to Change*	*SD*
Supervisor Trust and Safety	.20	.72	.02	.52
Communication and Trust in Coworkers	.15	.61	.13	.56
Assertiveness	-.24	1.07	-.15	1.00
Effects of My Stress	.51	.81	.54	.74

Table 5

Analysis of Variance for Intentions to Change and Attitude Gain

Source	*SS*	*df*	*MS*	*F*	*p*
		Supervisor Trust			
Between Subjects					
Intention	6.154	1	7.417	6.154	.013
Error	953.326	791	1.205		
Within Subjects					
Time	6.993	1	6.993	32.235	.000
Intention x Time	1.051	1	1.051	4.847	.028
Error	171.606	791	.217		
		Value Coworker Trust and Communication			
Between Subjects					
Intention	5.287	1	5.287	9.318	.002
Error	448.78	791	.567		
Within Subjects					
Time	6.154	1	6.154	33.32	.000
Intention x Time	.023	1	.023	.124	.725
Error	146.085	791	.185		
		Assertiveness			
Between Subjects					
Intention	.082	1	.082	.048	.827
Error	1355.063	791	1.713		
Within Subjects					
Time	12.092	1	12.092	22.242	.000
Intention x Time	.564	1	.564	1.038	.309
Error	430.016	791	.544		
		Awareness of Stress Effects			
Between Subjects					
Intention	7.379	1	7.379	7.673	.006
Error	760.675	791	.962		
Within Subjects					
Time	86.494	1	86.494	283.517	.000
Intention x Time	.154	1	.564	.504	.478
Error	241.315	791	.305		

Intention to Change Behavior as a Function of Experience. A follow up analysis was conducted to examine differences in experience for those who responded with intentions to change and those who did not. A 2-way MANOVA was selected as the appropriate test, and multivariate significance was obtained, $F(6,676)= 2.72$, $p<.05$. Tests of between subjects effects revealed the only significant difference in experience was years of college, $F(1,681)= 12.22$, $p<.001$. Those with a stated intention to change were significantly more educated than those without (Stated Intention $M= 1.7$ years, No Stated Intention $M= 1.5$ years). One might surmise that a written stated intention becomes more likely with enhanced writing skills developed in college. Alternatively, making the link from training principles to behavior might be a product of analytical skills sharpened in education.

Prediction of Pre-Training Attitudes

As an alternative to examining relationships with changes in attitude, the following analyses examine relationships to pre-training attitudes. Such analysis is a departure from examination of training impact, as measurement of pre-training attitudes represents measurements as they naturally exist before exposure to training. Prediction of baseline attitudes was attempted with experience measures as independent variables. Such information can still be useful for development and delivery of MRM training, as it provides insight into attitudes regarding trust, communication and individual awareness prior to the program. Because correlation between experience variables and baseline attitudes is a precondition for regression analysis, the reader is referred back to Table 3, which shows that life experience variables are moderately correlated to pre-training attitude measures, providing

reasonable justification to continue with multiple regression using these measures. Specifically, independent measures of *age, years in the company, experience with another airline, years in the military, years in trade school,* and *years in college* were employed as predictors of the dependent measures *Supervisor Trust* Communication *and Coworker Trust,* Assertiveness and *Awareness of Stress Effects.*

Experience variables as predictors of baseline attitudes. Though not successful in predicting pre-post changes in attitude, one of the experience variables was able to predict baseline attitudes. For the two trust measures, job role was the only predictor contributing to the overall significance of the regression: *Supervisor trust* ($\beta = -.230$, $p<.001$), *Value Communication and Coworker Trust* ($\beta = -.177$, $p<.001$). *Awareness of Stress Effects* was significantly predicted by job role ($\beta = -.159$, $p=.001$) and years of college ($\beta = .127$, $p=.005$). The most effective predictor of baseline attitudes was whether the training participant was in management, or a regular maintenance technician.

Relationship between Post-Training Intentions to Change Behavior and Baseline Attitudes

Recalling that differences were found between those who had intentions to change and those who did not in the gain scores on all of the dependent measures except Assertiveness, a follow-up analysis was conducted to examine differences in baseline attitude measures between trainees with intentions to change behavior and those without such intentions. Findings were deemed important for MRM program development, as knowledge of prior attitude impact on later behavior is critical to understanding participant motivation to change behavior.

Multivariate analysis was conducted with Supervisor Trust, Value Communication and Coworker Trust, Assertiveness, Awareness of Stress Effects and post-training enthusiasm as dependent measures, and *intention to change (no intention x intention)* as the independent factor. An overall multivariate effect was obtained $F(5,811)= 5.21$, $p<.001$. Contributing to the multivariate difference were Value Communication and Coworker Trust, Awareness of Stress Effects, and Post-Training Enthusiasm. Table 6 shows baseline means for *intention to change* and *no intention to change* groups. Table 7 is the ANOVA source table for the analysis. No difference in Supervisor Trust or Assertiveness was revealed between the Intention to Change and No Intention to Change groups. Generally, those who reported an intention to change behavior as a result of the program had more favorable attitudes regarding the important components of the program. While this may seem unsurprising, it underscores the need for more systemic program development that attempts to influence attitudes even before traditional classroom training begins. The lack of difference regarding *Supervisor Trust* and *Assertiveness* has no apparent or simple explanation.

Table 6

Baseline Scores for Intention and No Intention Groups

Scale	*Intention to Change*	*No Intention to Change*
Supervisor Trust and Safety	3.37	3.27
*Communication and Trust in Coworkers	4.42	4.29
Assertiveness	3.20	3.17
**Effects of My Stress	3.13	2.91
**Enthusiasm	4.13	3.97

*$p<.05$, **$p<=.01$

Table 7

Analysis of Variance for Intentions to Change and Baseline Attitude

Source	*SS*	*df*	*MS*	*F*	*p*
			Supervisor Trust		
Intention	1.669	1	1.669	2.506	.114
Error	542.736	815	.666		
			Value Coworker Trust and Communication		
Intention	2.306	1	2.306	6.166	.013
Error	304.764	815	.374		
			Assertiveness		
Intention	.150	1	.150	.147	.702
Error	834.943	815	1.024		
			Awareness of Stress Effects		
Intention	7.007	1	7.007	10.715	.001
Error	532.945	815	.654		
			Post-Training Enthusiasm		
Intention	3.930	1	3.930	12.805	.000
Error	250.158	815	.307		

Further Comparisons of Job Role

Because job role proved to be the sole predictor of most of baseline attitude measures and post-training enthusiasm, further analysis was conducted to examine the nature of the differences between managers and mechanics on attitudes and attitude change. The relationship between management and maintenance crews appears to have important implications for MRM program success, and deserves a closer look. Specifically, management and maintenance were compared to examine the nature of their differences regarding attitudes and behavioral intentions.

A mixed MANOVA was conducted with pre- and post- levels of each of the four survey scales as repeated dependent measures, and job role (management or maintenance) as the between subjects independent factor. The pre-post by job role interaction was significant, $F(4,586)= 4.53$, $p= .001$. Interaction effects were nearly significant for *Understanding of Stress Effects,* $F(1,589)= 3.79$, $p= .052$, and reached significance for *Value Communication and Coworker Trust,* $F(1,589)= 4.65$, $p= .031$, and *Assertiveness,* $F(1,589)= 10.834$, $p=.001$. These results suggest significant differences in how the two groups are responding to training.

Job role main effects (overall difference between managers and maintenance) were significant for every scale except *Awareness of Stress Effects,* $F(1,589)= 23.94$, $p<.001$. Results for each dependent measure are displayed in Figure 4.

Because of the differences found in attitudes between management and maintenance, one might expect similar differences between these groups regarding intended behavior change after the training. To examine the relationship between job role and behavioral intentions to change, a 2X2 chi-square was conducted between

these variables. The test was not significant, $\chi^2(1)= 1.25$, $p= .263$, indicating no relationship between hierarchical status and having a stated goal toward acting differently on the job.

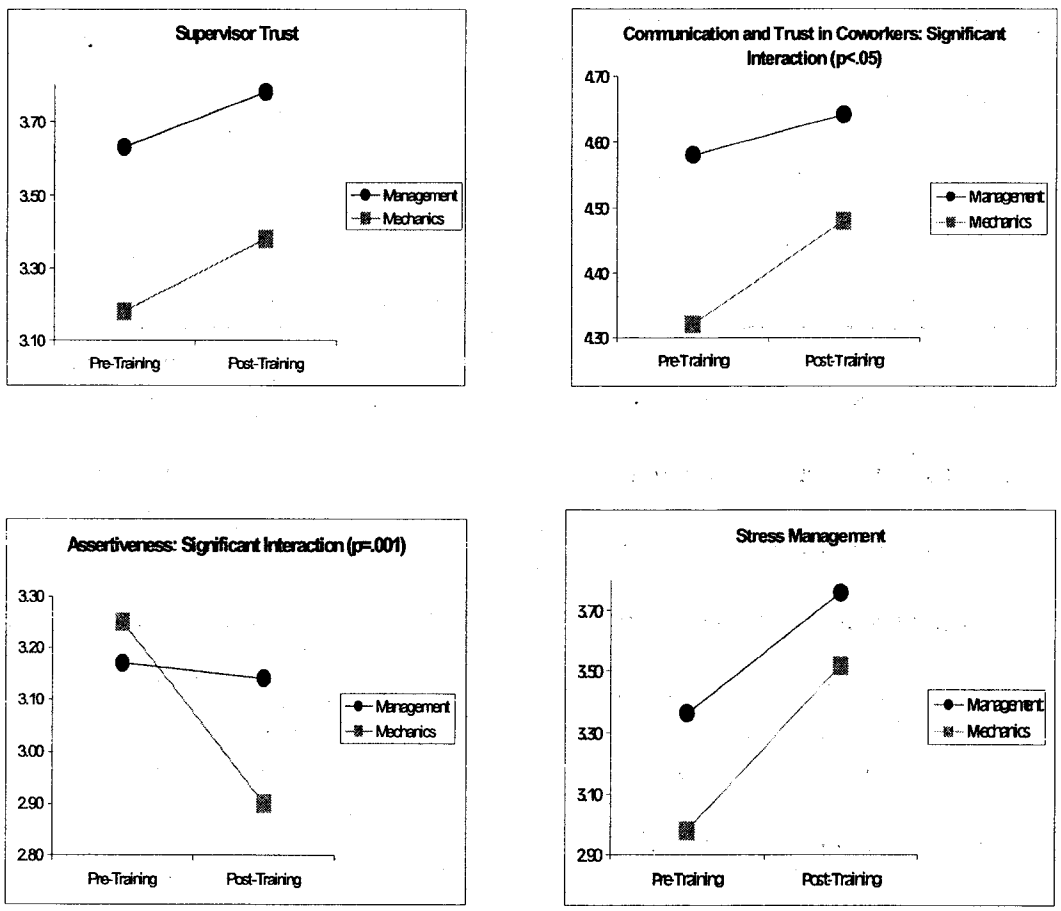

Figure 4. Pre-Post Change with Job Role as a Factor

CHAPTER IV

Discussion

The primary goal of this study was to examine factors that predict changes in attitude regarding trust, communication and personal awareness. More practically, the current study was an attempt to help those involved in Maintenance Resource Management Programs gain knowledge about the impact of the programs. By looking at trainee characteristics as factors in training impact, this study hoped to provide insight toward creating programs to meet the diverse needs and interests of training participants.

Support for Hypothesis

The hypothesis that changes in survey attitude scales (gain scores) could be predicted by trainee experience and demographic variables (years in company, years in military, years in college, years in trade school, years with another airline company, job role, shift, age, gender) was not supported through multiple regression analysis. The trainee characteristics used in this study were simply not related to the change in attitude observed before and after training. The implication for MRM program improvement is that the program should not be modified toward targeting groups of varying types of experience, because such experience is demonstrated here to have no relationship to training impact.

In fact, no variables employed throughout this study showed any relationship to changes in attitude from pre- to post- training. It is possible that these gains represent too short of a time interval for individual characteristics to have significant impact. Future research should focus on attitude change over longer time periods,

such as 2-, 6- or 12-month intervals. Such analysis is geared more toward program evaluation, in which change across a period of both training and attempted implementation is measured, rather than mere training evaluation that examines only the time interval from before and after training. The body of research on training evaluation and development indicates that the most critical aspect of training is the period during which knowledge, skills and abilities are being integrated in the workplace (Goldstein & Ford, 1997). This systemic view of training is the direction MRM programs strive to take and evaluation should pursue accordingly. Despite the inability to support the main hypothesis, or find any relationship to attitude change, further analyses revealed some findings that may assist curriculum and program development for aviation human factors initiatives.

Ancillary Analyses

The impetus for analysis beyond that which tested the main hypothesis was to look at the influence of variables other than experience on attitudes measures, and to examine attitude measures prior to training, before being impacted by MRM training. Specifically, the impact of intentions to change behavior was examined, followed by attempts to predict baseline (pre-training) attitudes using experience variables.

Intention to change behavior. It was first revealed that training participants with an articulated intention to change behavior in some way after training also have greater trust of their coworkers and better attention to personal factors that affect their own performance. Participants with a stated intention at post-training had higher pre-training attitude ratings for *Value Communication and Coworker Trust* and *Awareness of Stress Effects,* as well as higher post-training attitude ratings for

Enthusiasm. The finding establishes a link between general maintenance attitude and intention to behave differently.

Similarly striking is that those who made a behavioral commitment also made the most positive change toward trust their supervisor. As the job role analyses indicated, the relationship between maintenance crews and their supervisors seem to have the most significant implications for program implementation. This finding affirms the notion that trust between these two groups is critical to behavioral change.

Some MRM programs have made practice of having each participant write one or more concrete ways in which that person will act differently on the job as a consequence of the training. In fact, the program under study employs this method. These "contracts" are collected at the end of training, and then mailed to each participant several months later. Participants are then asked to reflect upon how they have lived up to their stated intentions since the training. In light of the relationship between stated intentions and desired attitudes established in the current study, such practice might be a model for industry-wide MRM programs.

Experience prediction of baseline attitude. After failing on all counts to find gain score predictors, further ancillary analysis was conducted to see if baseline, or pre-training attitudes could be predicted from trainee experience measures. Although experience variables were not generally significant predictors of baseline attitudes, beta coefficients revealed that job role was the only variable making a significant prediction. A predictive relationship was found between job role and the level of trust in coworkers, the degree of comfort with assertive communication, and awareness of personal factors that affect performance. This finding prompted further investigation

of attitude disparities between aviation management and maintenance crews as a factor with a history of implications for MRM implementation and development.

Manager-Subordinate Differences in Training Impact

The differences between management and maintenance are the strongest findings that occurred in this study, and likely have the most consequence for MRM program development. Firstly, comparative analysis of management and maintenance showed disparity on all five scales. That is, at pre- and post-training, management had significantly more favorable attitudes regarding trust, communication, personal awareness and enthusiasm. One might infer that the perspective these two groups have one the organizational environment produces varying levels of optimism regarding the program. We can rule out that these differences are caused by management's greater experience or background, as these variables have shown no impact on attitudes in the current study.

Despite management's overall higher attitude ratings, mechanics showed greater pre-post attitude change than management on two of the scales. This occurred with *Trust in Coworkers* and *Assertiveness*. In both cases, Management had more favorable ratings on these attitude scales, but the maintenance crew showed significantly more change before and after training. Curiously, this change worked in a *negative* direction for assertiveness. That is, maintenance staff actually responded with significantly less favorable ratings after training than before, and more so than management.

Such differences in post-training approaches to MRM principles are obstacles in successful implementation. Interestingly, both groups report intentions to change at

about the same rate, but results here support the notion that differences in attitudes will pose challenges to such change. Reports that detail observation of implementation throughout the industry have also noted the impact of different perspectives in the aviation hierarchy on successful implementation of the programs (Taylor, 2000).

Limitations

The current study examined factors that predict attitude change over a very short period of time. This shortcoming was alluded to previously in discussion of the lack of support for the main hypothesis. Missing from this analysis is the predictive value of experience variables on change over longer periods during which participants have met with the challenges of actual implementation. Measurement of attitudes on a delayed post-training schedule lends itself to a *program* evaluation model rather than *training* evaluation. The former captures the program's interaction with organizational life, while the latter only the reactionary impact of two days of instruction. On a delayed post-test, one might expect even greater differences between management and maintenance because time has passed for these parties to behaviorally negotiate their perspectives on the program in the work environment.

Another limitation regarding this study is the breadth of variables used as potential predictors of attitude. The variables were chosen firstly because they represented a potentially valuable basis for future research, and a potentially valuable basis for program improvement. However, these variables were also employed because the data had been collected, and the application of the data to the purpose of the present study was extremely practical. With an opportunity for further data

collection, a greater breadth of variables might be utilized with greater probability of significant results. Such variables might include data pertaining to individual learning styles or perceptions of management that would have implications for course design or management development.

Another caveat should be stated regarding the application of findings. The predictor variables used here were chosen because they are the first step in an attempt to determine individual factors that affect attitude change from MRM training. Because similar data has already been collected for thousands of training participants over a ten-year period, the proposed study was an opportunity to begin to look at how separate groups are differently impacted by MRM training programs. Because data here has been collected regarding a single training program in a single industry, difficulty arises in generalizing findings to other trainings in other industries. Though there is reason to believe that the impact of individual factors on attitude change in the airline industry might show a similar pattern in other contexts, the primary purpose here remains consistent with the action research model: to provide implementers of these important programs with a more detailed sense of how organizational members are being affected, so that findings can be used to improve the design and implementation of the program.

Despite the specificity of the present sample, findings here can provide insights for other high-risk industries and companies that seek to improve error management. Helmreich (2000) asserts that medicine is a field that can learn from the advances in aviation human factors. Researchers have already identified culture-driven forces in hospitals and operating rooms that suppress trust and increase silence

regarding error. There is every reason to believe that the current findings regarding management attitudes might be repeated in other high-risk settings such as medicine. Further, non-punitive incident reporting systems and structured communication processes that are developing in aviation certainly have relevance beyond this domain. In any context where proactive error mitigation might be inhibited by cultural factors or unsupportive management, the findings and conclusions herein can apply. However, that is not to say that these findings would be repeated in other organizational contexts. Further research is necessary to determine whether management systems in other high-risk industries show similar patterns.

Implications and Future Directions

Failure to support the main hypothesis suggests that trainee characteristics such as age and experience have no relationship to attitude or attitude change. This leaves training implementers with no specific criteria related to experience for development of the programs for diverse training needs. However, it makes the general statement that maintenance employees of varying backgrounds are similarly impacted by the training, and begin training with similar attitudes regarding trust, communication and individual awareness.

The exception, job role, suggests that a critical determinant of implementation success is the resolution of disparate attitudes and approaches between maintenance management and the technicians. That job role proved to be such a strong predictor of attitudes and attitude change reflects the somewhat conflicting responsibilities each role has in the maintenance process. While both have utmost concern for safety, management carries an additional burden of production responsibility (i.e., plane

schedules, minimizing cost and man hours), while the floor mechanic is ultimately legally responsible for the work that person conducts and for which that person signs as completed. In cultures relatively low in trust and open communication, these differences are magnified and create significant impediments to integrating MRM principles. Aviation research has produced examples of the maintenance employee who embraces the program and it's principles, but is frustrated by an unsupportive management system (Taylor & Thomas, 2001). Future training will need to focus on the management system, and stress the importance of open maintenance cultures in which management opinions can be challenged, errors can be brought immediately to light, and the individual mechanic feels supported by her/his department and company. Tools such as the Concept Alignment Process and Maintenance Error Investigation are good starts as training modules, but evidence shows that implementation among aviation management is currently limited. (Goglia et al, 2002).

Efforts to link trainee characteristics to attitudes regarding trust, communication and personal awareness in the current study yielded no indication that further attempts would prove fruitful as these constructs pertain to MRM programs. Further research might attempt to find such a link in other samples and with different programs. The most promising ground for future exploration, however, appear to be in hierarchical disparities. Differences in optimism and attitudes between aviation mechanics and the aviation management system appear to be among the most critical barriers to successful implementation.

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APPENDIX A

Pre- and Post-Training Versions of the MRM/TOQ

MRM Program, Engineering School, Santa Clara University

Maintenance Resource Management/Technical Operations Questionnaire (Pre-training)

Your maintenance organization is interested in your comments regarding human factors and safety within the department. The success of this survey depends on your contribution, so it is important to answer as honestly and fairly as you can. All answers are confidential. There are no right or wrong answers. This survey is part of a FAA and NASA-sponsored study regarding maintenance safety throughout the USA. Additional comments are welcome throughout the survey.

I. BACKGROUND INFORMATION: Today's Date: ___/___/___

1. Job Title: _____
2. Years in Maintenance at this company: _____
3. City or Station: _____
4. Present Shift: _____
5. Gender Male Female
6. Year of birth: _____
7. Past Experience or Training: (# of years: fill in below)
   Military: _____ Trade School: _____ College: ____ Other Aviation: ____
   (Specify other company if "Other Aviation": _____)
8. Non-Contract Contract
9. Where do you work? Line Hangar QC Planning Shop
   Stores Engineering Appearance Other

II. TECHNICAL OPERATIONS ATTITUDE MEASUREMENT:

1	2	3	4	5
Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree

Using the scale above, please circle the number that best describes your opinion.

1 2 3 4 5	1.	Maintenance personnel should avoid disagreeing with one another.	1 2 3 4 5	10.	We should always provide both written and verbal turnover to the oncoming shift.
1 2 3 4 5	2.	Even when fatigued, I perform effectively during critical phases of work.	1 2 3 4 5	11.	Employees should make the effort to foster open, honest, and sincere communication.
1 2 3 4 5	3.	My suggestions about safety would be acted on if I expressed them to my lead or supervisor.	1 2 3 4 5	12.	My supervisor can be trusted.
1 2 3 4 5	4.	My supervisor protects confidential or sensitive information	1 2 3 4 5	13.	My work impacts passenger satisfaction/safety.
1 2 3 4 5	5.	It is important to avoid negative comments about the procedures and techniques of other team members.	1 2 3 4 5	14.	A debriefing and critique of procedures and decisions after a significant task is completed is an important part of developing and maintaining effective crew coordination
1 2 3 4 5	6.	Mechanics' ideas are carried up the line.	1 2 3 4 5	15.	Personal problems can adversely affect my performance.
1 2 3 4 5	7.	I know the proper channels to route questions regarding safety practices.	1 2 3 4 5	16.	My coworkers value consistency between words and actions.
1 2 3 4 5	8.	Having the trust and confidence of my coworkers is important.	1 2 3 4 5	17.	Start of shift crew meetings are important for safety and for effective crew management
1 2 3 4 5	9.	A truly professional team member can leave personal problems behind when working.	1 2 3 4 5		

THANK YOU FOR YOUR PARTICIPATION IN THIS SURVEY.

MRM Program, Engineering School, Santa Clara University

Maintenance Resource Management/Technical Operations Questionnaire (Post-training)

Your maintenance organization is interested in your comments regarding human factors and safety within the department. The success of this survey depends on your contribution, so it is important to answer as honestly and fairly as you can. All answers are confidential. There are no right or wrong answers. This survey is part of a FAA and NASA-sponsored study regarding maintenance safety throughout the USA. Additional comments are welcome throughout the survey.

I. BACKGROUND INFORMATION: Today's Date: ___/___/___

1. Job Title: _____
2. Years in Maintenance at this company: _____
3. City or Station:_____
4. Present Shift: _____
5. Gender Male Female
6. Year of birth:_____
7. Past Experience or Training: (# of years: fill in below)
   Military: _____ Trade School: _____ College: ____ Other Aviation: ____
   (Specify other company if "Other Aviation":_____)
8. Non-Contract Contract
9. Where do you work? Line Hangar QC Planning Shop
   Stores Engineering Appearance Other

II. TECHNICAL OPERATIONS ATTITUDE MEASUREMENT:

1	2	3	4	5
Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree

Using the scale above, please circle the number that best describes your opinion.

1 2 3 4 5	1.	Maintenance personnel should avoid disagreeing with one another.	1 2 3 4 5	10.	We should always provide both written and verbal turnover to the oncoming shift.
1 2 3 4 5	2.	Even when fatigued, I perform effectively during critical phases of work.	1 2 3 4 5	11.	Employees should make the effort to foster open, honest, and sincere communication.
1 2 3 4 5	3.	My suggestions about safety would be acted on if I expressed them to my lead or supervisor.	1 2 3 4 5	12.	My supervisor can be trusted.
1 2 3 4 5	4.	My supervisor protects confidential or sensitive information	1 2 3 4 5	13.	My work impacts passenger satisfaction/safety.
1 2 3 4 5	5.	It is important to avoid negative comments about the procedures and techniques of other team members.	1 2 3 4 5	14.	A debriefing and critique of procedures and decisions after a significant task is completed is an important part of developing and maintaining effective crew coordination
1 2 3 4 5	6.	Mechanics' ideas are carried up the line.	1 2 3 4 5	15.	Personal problems can adversely affect my performance.
1 2 3 4 5	7.	I know the proper channels to route questions regarding safety practices.	1 2 3 4 5	16.	My coworkers value consistency between words and actions.
1 2 3 4 5	8.	Having the trust and confidence of my coworkers is important.	1 2 3 4 5	17.	Start of shift crew meetings are important for safety and for effective crew management
1 2 3 4 5	9.	A truly professional team member can leave personal problems behind when working.	1 2 3 4 5		

Please go on to the other side-

1 Strongly Disagree	2 Slightly Disagree	3 Neutral	4 Slightly Agree	5 Strongly Agree

III. Human Factors Training QUESTIONS:
Using the scale above, please circle the number that best describes your opinion about each item.

1 2 3 4 5 1. This training has the potential to increase aviation safety and crew effectiveness.

1 2 3 4 5 2. This training will be useful for others.

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

No Change A Slight Change A Moderate Change A Large Change

4. How will you use the information from the Human Factors training on your job?

_____

_____

_____

5. What aspects of the Human Factors training were particularly good?

_____

_____

_____

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

_____

_____

_____

THANK YOU FOR YOUR PARTICIPATION IN THIS SURVEY.

APPENDIX B

Survey Items Comprising Each Dependent Scale

Supervisor Trust and Safety
My supervisor can be trusted
My suggestions about safety would be acted upon if I expressed them to my lead or supervisor
My supervisor protects confidential or sensitive information
I know the proper channels to route safety questions
Mechanics' ideas are carried up the line
Value Communication and Trust in Coworkers
Having the trust and confidence of my coworkers is important
A debriefing and critique of procedures and decisions after a significant task is completed is an important part of developing and maintaining effective crew coordination
Employees should make the effort to foster open, honest and sincere communication
Start of shift crew meetings are important for safety and for effective crew management
My coworkers value consistency between words and actions
Assertiveness
Maintenance personnel should avoid disagreeing with one another (Inverse)
It is important to avoid negative comments about the procedures and techniques of other team members (Inverse)
Understand Stress Effects
Even when fatigued, I perform effectively during critical phases of work (Inverse)
A truly professional team member can leave personal problems behind when working (Inverse)
Personal problems can adversely affect my performance
Enthusiasm
This training can increase safety and teamwork
This training will be useful to others
This training will change my behavior