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Teamwork Training in Organizations: The Case of Training Resource Management

Capacitación para el Trabajo en Equipo en las Organizaciones: El Caso de la Capacitación en Manejo de Recursos

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As organizations increasingly rely on teams to accomplish operational and strategic goals, attention has centered on both the identification and training of requisite team skills. The structured approach to team training known as Crew Resource Management (CRM) training offers a highly effective paradigm that can be adapted to the specific needs of many organizations. The major highlights of this paper are: (a) a discussion of the requirements for training teams to work together effectively, (b) a presentation of five case studies that demonstrate how CRM training designed for aviation environments can be adapted to meet the unique conditions of other organizations, and (c) recommended guidelines for CRM implementation in non-aviation settings. Finally, the authors recommend extending CRM training, which is applicable to high-impact work organizations, to include the types of teams more frequently found in organizations.

Las organizaciones confían cada vez más en los equipos para lograr las metas operacionales y estrategias, y por lo tanto la atención se ha centrado en la identificación y capacitación de las habilidades del trabajo en conjunto. Un método para la capacitación de equipos conocido como Crew Resource Management (CRM) aporta un paradigma muy eficaz que puede adaptarse a las necesidades específicas de muchas organizaciones. Los principales componentes de este artículo son: a) una discusión de los requisitos para entrenar a los equipos para trabajar juntos eficazmente, b) una presentación de cinco casos que demuestran como la capacitación CRM diseñada para los ambientes de la aviación puede adaptarse para aplicarse a las condiciones únicas de otras organizaciones y c) recomendaciones para la aplicación de CRM en otros ambientes organizacionales.

Teamwork Training in Organizations: The Case of Training Resource Management

Government agencies and business organizations are increasingly relying on teams (e.g., project, R&D, development, brainstorming, and process-improvement teams) to accomplish organizational goals (Salas & Cannon-Bowers, 2000). Consequently, greater attention is being focused on the identification and training of teamwork skills. What is a team and why are teamwork skills important? We define a team as an entity comprising two or more individuals with specialized roles and responsibilities who interact dynamically, adaptively, and interdependently; who receive information from multiple sources; and who share common goals or purposes (see Salas, Dickinson, Tannenbaum, & Converse, 1992). Teamwork skills are important because optimal team performance depends on the ability of team members both to perform their individual tasks effectively, as well as exhibit a constellation of teamwork skills (e.g., communication, coordination, and performance monitoring) that promotes intra-team interactions.

In this article, we propose that a highly effective team-training strategy known as Crew Resource Management (CRM) training, which originated in the aviation industry, can be adapted to training teams in other industries. First, we review general team-focused instructional approaches. Next, we review how CRM training evolved to its present use in aviation settings. After summarizing the CRM training methodology, we present five case studies that demonstrate how effective CRM training can be when modified for use in non-aviation (i.e., offshore oil platforms, medical operating rooms) and

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extended aviation settings (i.e., commuter aviation, aircraft maintenance, and naval aviation). Each of the five applications is contrasted with the current aviation CRM paradigm. Finally, we describe general and domain-specific recommendations for implementing CRM training.

Team Training

In the past twenty years, researchers have expended considerable effort to identify the knowledge, skills, and attitudes (KSAs) that most impact successful team performance (see Salas & Cannon-Bowers, 2000). Once identified, the KSAs became the cornerstone of team-training programs. Team training is defined as a set of research-based instructional strategies that serve to improve team processes and their outcomes (Salas & Cannon-Bowers, 1997, 2000). The design and delivery of team training consists of content (i.e., competencies), tools (e.g., simulation, exercises), and delivery methods (e.g., guided practice) that are integrated to form these strategies. In team training, team members learn and practice the requisite team competencies (i.e., KSAs) and receive feedback on their performance. Recently, Salas and Cannon-Bowers (1997) described the components for the design of team training (see Figure 1). According to them, effective team training is a function of optimally combining tools, delivery methods, content, and strategies.

Tools

For team training to be effective, instructional designers must consider not only the trainee's characteristics but also the characteristics of the learning environment, competencies, and tasks (Goldstein, 1993; Salas & Cannon-Bowers, 1997, 2000). Therefore, instructional designers must

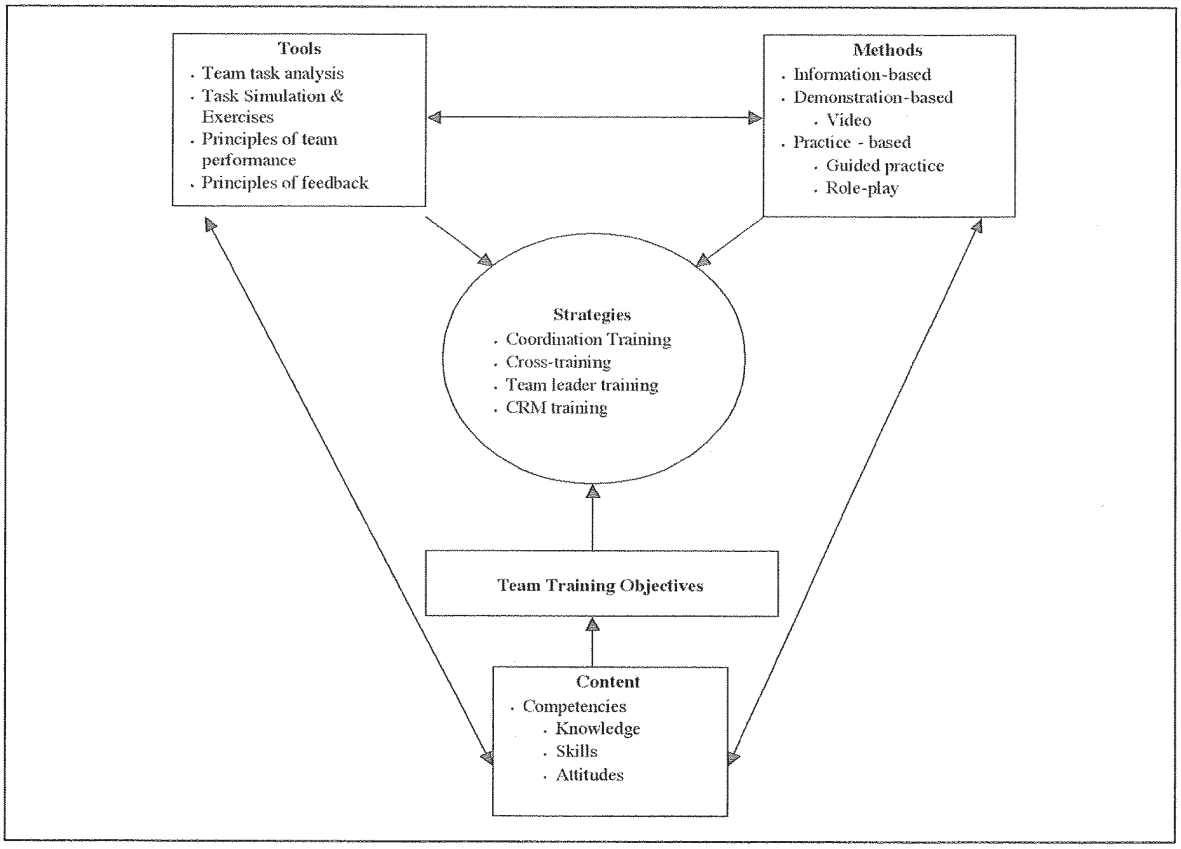

Figure 1. The elements of team training.
Note: Adapted from "Methods, tools, and strategies for team training" by E. Salas & J. A. Cannon-Bowers, (1997), in M. A. Quinoñes & A. Ehrenstein (Eds.), *Training for a rapidly changing workplace: Applications in psychological research* (pp. 249-279). Washington, DC: APA Press.

choose training-design tools that will provide requisite information and task conditions for developing, practicing, and assessing teamwork properly. The four representative tools available to designers are presented in Figure 1. First, team task analysis is used to determine the learning objectives, required KSAs, events, communication flows, and coordination needs needed for effective teamwork and training. Next, the use of task simulations and exercises provides a systematic means by which to construct practice scenarios that are based on the objectives of the training. Third, principles of team performance (derived from the literature) guide the what, when, how, and why of team training design and delivery that will maximize team performance. Finally, principles of feedback direct trainers to use the information gathered during performance assessment to deliver feedback that is accurate, timely, and detailed.

Methods

The methods used to deliver team training are shaped by the products of the tools discussed above (Salas & Cannon-Bowers, 1997). The three main methods presented in Figure 1 are information-based, demonstration-based, and practice-based. Information-based methods, which facilitate the presentation of knowledge, facts, concepts, or theories, include lectures and slide presentations. Cost effective and easy to use, these methods are the most commonly used in training. Next, demonstration-based methods serve to illustrate actions, behaviors or strategies to trainees. Although the trainee passively observes the presentation of information, this method effectively presents dynamic and complex information and facilitates the building of shared expectations among team members. Finally, practice-based methods allow trainees to receive hands-on experience as well as valuable feedback on their performance. To be effective, this method requires that the practice be guided by training objectives. Role-playing exercises and computer-based simulations are two of the most frequently used practice methods.

Strategies

Up to this point, we have discussed the tools that support instruction and the medium by which they are delivered. Now we will discuss the final element of the training strategy: the competencies that comprise the content (Salas & Cannon-Bowers, 1997). Each training strategy is associated with particular tools, methods, and competencies. Four examples of team-training strategies are presented in Figure 1: coordination training (i.e., training team members to work together as a team), cross training (i.e., creating expectations about other team members roles and tasks), team leadership training (i.e., training the skills needed to be an effective team leader), and crew resource management training (i.e., training crews to use all of the resources available to them). These are only a few examples of team-training strategies that organizations may employ.

Team Competencies

The content section of the figure presented above includes the specific competencies–knowledge, skills, and attitudes (KSAs)–that underlie effective team interactions (see Bowers, Jentsch, & Salas, 2000; Cannon-Bowers, Salas, Tannenbaum, & Mathieu, 1995). After thoroughly reviewing the literature on team performance, Salas and Cannon-Bowers (2000) identified a set of core competencies that contribute to every team's performance. Knowledge-based competencies, or cognitions (i.e., what team members think), refer to the compatible knowledge structure (i.e., mental models) that team members must share to perform team tasks effectively. The shared knowledge structure creates expectations about the roles and tasks of teammates, as well as the situations that may be encountered, that allow team members to predict how the other members of the team will behave in a given situation. In Table 1, we describe the knowledge that each team member must possess in order to contribute to the effective functioning of the team.

In addition to knowledge-based competencies, a set of teamwork skill-based competencies also has been identified by Salas and Cannon-Bowers (2000). Skill-based competencies are the behavioral skills that team members must perform appropriately to accomplish the team's objectives. In Table 2, we describe the competencies and the typical behaviors associated with each.

In addition to team-based knowledge and skills, team members must also demonstrate certain attitudes. Attitude-based competencies refer to how team members feel about the other team members and about the tasks being performed (Salas & Cannon-Bowers, 2000). These competencies include

Table 1
Knowledge-Based Team Competencies

Cue-strategy associations	The association of cues in the environment to appropriate coordination strategies.	Team members must • know how and when to change coordination strategies
Task-specific teammate characteristics	Task-related competencies, preferences, tendencies, strengths, and weaknesses of teammates.	• understand team role interaction patterns • understand task-specific role responsibilities
Shared task models	Shared models of the situation and appropriate strategies for coping with task demands.	• hold shared interpretation of task information and demands
Team mission, objectives, norms, and resources	These are meaningful only for dealing with a specific team and task–when one changes, knowledge must be adjusted to incorporate new team members and task demands.	• hold common understanding of mission, objectives, norms, and resources
Task sequencing	Integrating task inputs according to team and task demands.	• know how to organize tasks
Accurate task models	Team members must interpret task information and demands in a similar manner.	• adjust task strategies so that they are optimal with respect to teammates' expected performance
Accurate problem models	Correct understanding of a problem including goals, information cues, strategies, and member roles.	• recognize and integrate task contingencies • provide the knowledge foundation necessary for successful team performance
Team role interaction patterns	How teams communicate and arrive at decisions.	• know who talks to whom • understand the number of communication channels
Teamwork skills	Ability to comprehend the required skills and behaviors necessary for successful team performance.	• understand what needs to be done in order of the team to perform effectively
Boundary-spanning roles	Knowledge of how a team manages its interactions with other units and non-team-members.	• obtain resources and information • provide output to others
Team orientation	Process by which information relevant to task accomplishment is generated and disseminated to team members.	• hold knowledge of team goals, mission, norms, and resources

Note. From "The anatomy of team training," By E. Salas & J. A. Cannon-Bowers, 2000, in S. Tobias & J. D. Fletcher (Eds.), *Training and retraining: A handbook for business, industry, government, and the military* (p. 316). New York: Macmillan Reference.

Table 2
Skill-Based Team Competencies

Type of Skill	Definition	Descriptors
Adaptability	Process by which team members use information from task environment to adjust strategies through flexibility, compensatory behavior and the dynamic reallocation of functions.	Team members exhibit • flexibility • capacity for closure • mutual adjustment • backing-up behavior • providing/asking for assistance
Shared situational awareness	Process by which team members develop compatible models (shared understanding) of teams' internal and external task environment.	Team members perform • shared situations • integrated task models of the environment
Mutual performance monitoring	Process by which team members give, seek, and receive task-clarifying feedback.	Team members perform • performance feedback • planning review • monitor and cross-check • strategy development
Motivating team members/team leadership	Process by which team members direct and coordinate activities of and motivate other team members, assess team performance, and establish a positive atmosphere.	Team members • establish priorities • resource management • leadership control • goal setting
Mission analysis	Process by which team resources, activities, and responses are organized to ensure integrated and synchronized completion of tasks.	Team members exhibit • coordinated task sequence • technical coordination • response coordination
Communication	Process by which information is clearly and accurately exchanged between two or more team members.	Team members • share information • volunteer/request information
Decision making	Process by which team members gather and integrate information, use sound judgment, identify alternatives, select the best solution, and evaluate the consequences.	Team members exhibit • situation assessment • problem solving • planning • metacognitive behavior
Assertiveness	The willingness of team members to communicate ideas and observations in a manner that is persuasive to other team members.	Team members • provide performance feedback • address ambiguities • state and maintain opinions
Interpersonal relations	Process by which team members optimize the quality of team members' interactions through resolution of dissent, utilization of cooperative behaviors, or use of motivational reinforcing statements.	Team members exhibit • cooperation • conflict-resolution behaviors • exchange of relevant information
Conflict resolution	The willingness to resolve conflicts in a way that minimizes harm done to both parties, seeking win-win situations.	Team members • seek win-win solutions • exhibit cooperative behavior

Note. From "The anatomy of team training," By E. Salas & J. A. Cannon-Bowers, 2000, in S. Tobias & J. D. Fletcher (Eds.), *Training and retraining: A handbook for business, industry, government, and the military* (p. 317). New York: Macmillan Reference.

Table 3
Attitude-Based Team Competencies

Type of Skill	Definition	Descriptors
Motivation	Process by which team objectives are defined and the team is energized to achieve the objectives.	Team members • resolve conflicts • reinforce each other • develop norms
Collective efficacy/ potency	Belief that the team can perform effectively as a unit when given specific task demands.	Team members hold • perceptions of the collective successes of the group • hold judgments regarding team leadership, power base, cohesiveness, and structure
Shared vision	Commonly held attitude regarding the direction, goals, and mission of a team.	Team members • agree on direction and goals of the team
Team cohesion	Total field of forces that act on members to remain in the group; an attraction to the team as a means of task accomplishment.	Team members • develop and maintain interpersonal relationships within the team • achieve team goals through commitment
Mutual trust	An attitude held by team members regarding the aura, mood, or climate of the team's internal environment.	Team members • allow opinions of team members to emerge • respect each other • reward innovative, proactive behavior
Collective orientation	Belief that team approach is better than individual one.	Team members • ask for input • take the behaviors of others into account
Importance of teamwork	The attitudes that the team members have toward working as a team.	Team members have • the need to coordinate and communicate with each other • mutual belief in importance of team

Note. From "The anatomy of team training," By E. Salas & J. A. Cannon-Bowers, 2000, in S. Tobias & J. D. Fletcher (Eds.), *Training and retraining: A handbook for business, industry, government, and the military* (p. 318). New York: Macmillan Reference.

motivation, collective efficacy, shared vision, team cohesion, mutual trust, collective orientation, and the importance of teamwork that contributes to the success of the team. In Table 3, each of the competencies is defined and examples of appropriate behaviors are provided for each.

Thus, to perform effectively in a team setting, each team member must possess a set of related competencies (cognitions, behaviors, and attitudes) that can be employed to optimize team performance (see Salas & Cannon-Bowers, 2000). Clearly, the importance of any particular competency will vary depending on the situation. For that reason, a thorough needs analysis is critical as the beginning step of designing a team-training system. Having established the importance of teamwork

competencies, we will now discuss how CRM training evolved as a specialized team-training paradigm in high-impact settings and describe the current CRM training methodology.

Crew Resource Management (CRM) Training

Crew Resource Management (CRM) training was originally developed to train aviation crews to work together as a team. CRM training, based on the premise that team members must be proficient in both individual task skills as well as in team skills, emphasized the need for intra-team communication, coordination, and use of all available resources (i.e., people, equipment, and information) (Wiener, Kanki, & Helmreich, 1993). Recently, CRM training was defined as a "family of instructional strategies designed to improve teamwork in the cockpit by applying well-tested training tools (e.g., performance measures, exercises, feedback mechanisms) and appropriate training methods (e.g., simulators, lectures, videos) targeted at specific content (i.e., teamwork knowledge, skills, and attitudes)" (Salas, Prince, Bowers, Stout, Oser, & Cannon-Bowers, 1999, p. 163). The key elements of this definition are the emphasis on multiple instructional strategies and the need for identifying and training specific teamwork competencies (Salas, Rhodenizer, & Bowers, 2000).

CRM training has been implemented in many airlines, including Lan Chile, for many years. Although the aviation community argues for the success of CRM training, a recent review of the literature suggests that the results may not be so clear. Salas, Burke, Bowers, and Wilson (2001) reviewed 58 studies that evaluated CRM training. The studies were organized using Kirkpatrick's (1976) multilevel typology (i.e., reactions, learning, behavior, organizational impact). The results of their evaluation do support the findings that CRM training does lead to positive attitudes, learning, and behaviors. However, it is unclear whether this success has resulted in improved safety (i.e., organizational impact) within the aviation community. One reason for this is that more than half of the studies reviewed evaluated training at only one level of evaluation, and only six of all studies reviewed evaluated training at the organizational level. In addition, taking into consideration other factors that have improved over the past two decades (e.g., aircraft reliability, technical skills training for pilots, and laws and regulations), it cannot be stated with certain that the improved safety record is due to CRM training alone.

We argue that the ambiguous results found in the previous review may be due to more than just inadequate evaluation of training, and may stem from a lack of theoretical guidance throughout the design and delivery as well. There is a science to training that organizations must exploit. However, many organizations (within the aviation community as well as outside it) implement training without relying on the resources available (e.g., scientific literature) to help guide them. Salas, Rhodenizer, and Bowers (2000) argue that there are seven resources that should be used.

First, organizations must have an understanding of the principles of practice and feedback. Research suggests that providing trainees with an opportunity to practice (e.g., role-playing) and providing constructive feedback regarding their performance results in enhanced learning and performance on the job. Next, organizations must take a systems view of training effectiveness. A systems view focuses on external factors from the training program that may affect training effectiveness (e.g., organizational support, trainee characteristics, situational characteristics). Third, organizations must take into consideration the principles of teams and teamwork. Reviewing the available literature on teams and teamwork will allow organizations to understand issues such as how to foster teamwork as well as how to analyze and observe team performance. Organizations must also use guidelines for training teamwork-related skills. Based on the literature available in this field, guidelines have been developed to help train these skills (see Salas & Cannon-Bowers, 2000; Swezey & Salas, 1992). A fifth resource to be used is the tools and approaches for measuring teamwork. As one of the greatest challenges faced by organizations may be measuring team performance, several researchers have developed frameworks that may help (see Cannon-Bowers & Salas, 1997; Dickenson & McIntyre, 1997; Johnston, Cannon-Bowers, & Smith-Jentsch, 1995). Next, scenario-based training is a resource that uses simulation and technology. This training approach provides trainees with an opportunity to learn, practice, and receive feedback on trained competencies necessary for a task (see Fowlkes, Dwyer, Oser, &

Salas, 1998). The final resource argued by Salas and colleagues (2000) as being important is evaluating CRM training. It is suggested that organizations evaluate training programs at multiple levels (i.e., reactions, learning, behavior, organizational results) to properly ensure training effectiveness (see Kirkpatrick, 1976). For additional information regarding the resources presented above, see Salas et al. (2000).

CRM training began as an aviation intervention, however it is now being used within other domains. While the data supporting the success of CRM training are encouraging, the results are still inconclusive about its impact on safety. Nevertheless, its success in producing positive attitudes and behaviors in the aviation domain has led to its implementation in other settings in which error control/minimization is of paramount concern (e.g., medical, offshore oil). We will discuss specific examples of the use of CRM training in non-aviation settings later in this article. First, we will present a brief overview of the history of CRM training.

History of CRM Training

The first instance of CRM training occurred over twenty years ago. Since then, CRM training has progressed through five generations of changes (Helmreich & Foushee, 1993). Originally, before the inception of CRM, aviation training focused only on the technical elements of flying. Then in the late 1970's, the National Aeronautics and Space Administration (NASA) released a report designating human error as a factor in the majority of airline crashes (Helmreich, Wilhelm, Klinect, & Merritt, 2001). Specifically, over 70% of the worst airline accidents that occurred during the 30-year period between 1959 and 1989 were attributable in some degree to human error (Guzzo & Dickson, 1996). Furthermore, NASA indicated that most of the errors were not due to technical problems, but rather to human error such as poor communication, poor teamwork and poor decision-making. These findings spurred the development of a comprehensive training program, once known as cockpit resource management and now more widely known as crew resource management, that is based on the premise that successful high-performance aircraft teams require team members to possess and use both task knowledge as well as knowledge about team interaction (Helmreich, 1997).

Evolution of Crew Resource Management (CRM) Training

Originally, the purpose of CRM training was to change pilot culture. Pilots' strong pride in their profession contributed to a lack of teamwork in the cockpit (Helmreich, 1997). Also, pilots tended to feel a sense of personal invulnerability, which manifested itself as an unwillingness to acknowledge that stress and fatigue could slow their response times (Helmreich, 2000). CRM training was intended to teach aircraft pilots and crews to rely less on the pilot as an independent decision maker and become more aware of the value of teamwork as a way to temper and avoid mistakes caused by fatigue, high stress, and work overload (Flin, 1995; Helmreich, 1997).

As CRM training progressed through several generations, its focus expanded to include training on group dynamics, the inclusion of crew members outside of the cockpit (e.g., cabin and maintenance crews), and proceduralization and integration with technical training through the use of line-oriented flight training (LOFT) (Helmreich & Foushee, 1993; Helmreich, Merritt, & Wilhelm, 1999; Maurino, 1999).

Today, CRM training is considered to be in its fifth generation (Davies, 2001). The major focus of current CRM training systems is still to teach crews the interpersonal and communication skills that help them work together more effectively as a team and the factors that limit human performance during periods of stress, as described earlier in this article. However, its focus also encompasses error management (Helmreich & Merritt, 1996; Helmreich et al., 1999). The premise behind this fifth generation of CRM training is that because human error is inevitable, it cannot be ignored, but must be managed. To that end, CRM training is moving beyond error avoidance to teach the teamwork skills required for early error detection as well as the mitigation of error consequences.

Furthermore, CRM training is being expanded beyond the scope of the extended crew to embrace the culture of the organization. Another emerging feature of CRM training is an emphasis on the need for a strong organizational safety culture and the concomitant importance of executive support and encouragement of such a culture. Nor is CRM training being restricted to error-management applications. Some organizations have expanded CRM training programs beyond the focus of error

management as a means by which to improve even routine team performance (Flin & O'Connor, 2001).

We emphasize that the instructional strategy known as CRM training is critical in aviation settings because aviation teams operate in high-impact environments where one mistake could result in the destruction of aircraft worth millions of dollars or, worse, the loss of many lives. In fact, empirical research has consistently demonstrated the importance of teamwork to successful aircraft team outcomes (Guzzo & Dickson, 1996; Salas, Stout, & Fowlkes, 1997). However, as our discussion of the case studies will show, aviation teams are not the only ones that operate in high-impact settings.

Furthermore, we propose that even routine teams, that is, the kind that operate in organizational settings, can benefit from enhanced teamwork skills. We believe that as the use of teams becomes more pervasive in organizations, the outcomes of those teams will directly impact organizational effectiveness (Salas & Cannon-Bowers, 2000; Stout, Salas, & Fowlkes, 1997; Tannenbaum, Salas, & Cannon-Bowers, 1996). Thus, the generalizability of the highly effective aviation CRM paradigm to other domains, both high impact and routine, is of interest to researchers and to practitioners who seek to optimize team performance (Helmreich, 2001).

Theoretical Foundations of CRM Training

CRM team training is based on a combination of theoretical perspectives, including theories of individual performance, team performance, pedagogy, human learning, and skill acquisition (Salas, Prince, Bowers, Stout, Oser, & Cannon-Bowers, 1999). For example, Helmreich and Foushee (1993) drew from research on social psychology and group dynamics. Salas and his colleagues (e.g., Cannon-Bowers, Salas, Tannenbaum, & Mathieu, 1995; Salas, Cannon-Bowers, & Blickensderfer, 1993) were influenced by the work of cognitive psychologists who studied human learning (e.g., Salas, Prince, Bowers, Stout, Oser, & Cannon-Bowers, 1999) and shared mental models (see Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995). They also incorporated the research findings of industrial-organizational psychologists whose research focused on small group and team effectiveness. For example, the theoretical model of team performance provided by Tannenbaum, Beard, and Salas (1992) has been used as a foundation for research.

As the generic model in Figure 2 shows, CRM training seeks to improve both individual and team-level skills, which in turn improves team processes

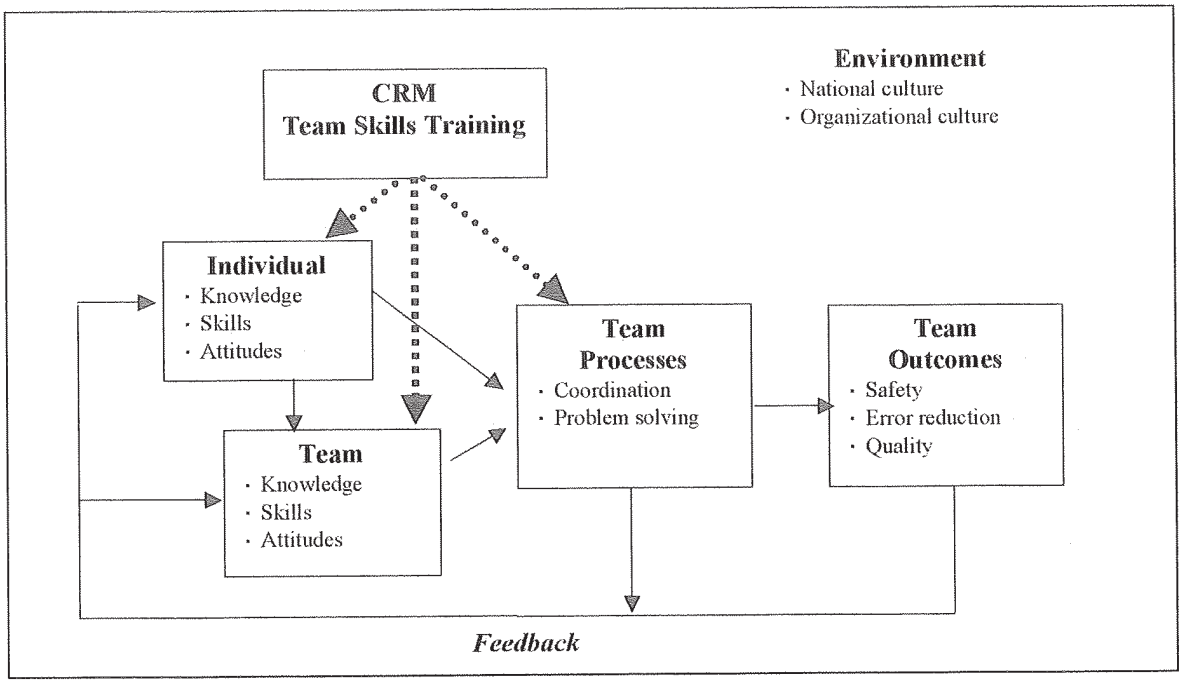

Figure 2. Model of CRM team skills training intervention on team outcomes.

and leads to enhanced team outcomes. Examining this model further, we see that even though CRM training focuses on the training of team-level skills, individual knowledge, skills, and abilities and team KSAs will also improve. Teams are comprised of individuals; therefore, the training of individual-level skills is just as important in CRM training as the training of team-level skills. These individual and team KSAs also contribute to the development of team processes, such as coordination and problem solving. The value of improved team processes is realized in the team outcomes (e.g., increased safety and product/service quality, reduced errors) that result. Both the team processes and team outcomes provide feedback to individuals and teams regarding the KSAs on which further instruction is needed.

The path from CRM training to team outcomes, however, is moderated by the external environment. For example, if both the national culture and the organizational climate support the training of team skills and their subsequent use in the workplace, then high levels of training transfer will occur and team outcomes will be positive. On the other hand, a lack of support for team training and its use in the workplace could reduce transfer as well as team outcomes that result from it. We can use this model of CRM team skills training to determine at which point in the process certain factors will contribute to either the failure or success of a CRM training intervention on team outcomes.

CRM Methodology

The basic approach to developing a CRM training program has been described by Salas and colleagues (1999) and is summarized in Table 4. In the initial analysis phase (Steps 1-4), input is collected from a variety of sources, such as subject matter expert interviews, observation, and instructor guides. For example, in the original CRM training paradigm, content was created based on the input of experienced pilots and the research findings of aviation psychologists (Flin, 1995). Because the importance of a particular competency varies with the specific training application, this needs analysis phase is a critical component of the instructional design process.

After the needs analysis has been conducted and the training content has been determined, the instructional designers must decide on the training delivery method (Steps 5-7). CRM training is delivered through a variety of methods, including lecture, discussion, role-play and scenario-based exercises, videos, on-the-job training, as well as full-flight simulators (i.e., LOFT), computer-based training (CBT), part-task trainers, and desktop computers (see Helmreich, 2000; Kanki & Smith, 2001). Trainers define each critical teamwork dimension, explain how emergencies impact it, and provide techniques for responding appropriately under emergency conditions (Flin & O'Connor, 2001).

The evaluation of CRM training is critical both to determine its impact on team and organizational performance outcomes and to ascertain whether any changes to the training program are necessary (Steps 8-9). Various evaluation approaches are used to assess training effectiveness, but in general they usually involve a comparison either between two or more groups or groups at different time periods (e.g., pre-post) (see Holt, Boehm-Davis, & Beaubien, 2001). Several of the evaluation methods commonly used in aviation settings are attitude questionnaires (e.g., Cockpit Management Attitudes Questionnaire) (see Helmreich, 1984), pre- and post-training knowledge tests, and behavioral checklists used during flight scenarios.

Empirical research indicates that CRM training does improve critical team competencies that allow trainees to behave cooperatively and interact effectively with each other (Burke, Wilson, Salas, & Bowers, 2001; Salas et al., 1997). However, because positive attitudes and skills may decay over time (Helmreich et al., 1999), CRM training must be a recurring process (Helmreich, 2000). Although the timing of recurrent training depends on several factors, formal training sessions occurring every one-to-two years are common (see Davies, 2001; Grinde, 1994). As personal computers become more affordable, the use of low-fidelity training devices will continue to be viewed as a feasible alternative to supplement high-fidelity simulator training (Prince & Jentsch, 2001). The following section discusses how CRM training is being used in extended aviation settings and in non-aviation domains.

Contrasting CRM Training With Other Team Training Techniques

As was indicated earlier, effective teams comprise a wide range of knowledge, skills, and abilities (e.g., Salas & Cannon-Bowers, 2000). Therefore, interventions that address only one or two of these

Table 4
A Methodology to Design and Deliver CRM Training

Step	Descriptors
1. Identify operational/mission requirement	Review existing training curriculum, including course master material lists, instructor guides, standard operation procedures (SOPs); interview aviation subject matter experts (SMEs); observe crews performing missions; review relevant mishap/accident reports.
2. Assess team training needs and coordination demand	Use same data sources as in Step 1, with emphasis on identifying deficiencies in existing team training and specifying all tasks required to perform missions that involve a teamwork element.
3. Identify teamwork competencies and knowledge, skills, and attitudes (KSAs)	Link team training needs to a theory of team performance that allows delineation of competencies (our emphasis initially was on skills) required to perform each of the team task identified in Step 2.
4. Determine team training objectives	For each teamwork KSA, develop a training objective that can be empirically evaluated to determine whether or not it was accomplished.
5. Determine instructional delivery method	The method for accomplishing the instruction should be specified (e.g., information, demonstration, or practice and feedback, or all) in this step. Consideration should be given to costs and availability of simulators.
6. Design scenario exercises and create opportunities for practice	Design scenarios or exercises in which events are embedded to provide trainees an opportunity to demonstrate each of the required KSAs identified in objectives in which accomplishment requires practice and feedback.
7. Develop performance assessment/ measurement tools	In conjunction with scenario design, develop measures that can reliably assess whether each of the KSAs was demonstrated at an observable behavioral level.
8. Design and tailor tools for feedback	Design or tailor (or both) measurement tools for use in debrief, in which trainees are made aware of those required team behaviors that they did and those that they did not perform successfully. This tool should also help instructors diagnose the causes of poor performance and provide guidance for specific improvement in future operations.
9. Evaluate the extent of improved teamwork in the cockpit	Design experiments to assess the effectiveness of the training. Because of operational constraints, quasi-research methods may need to be applied.

Note. Adapted from "A methodology for enhancing Crew Resource Management training," By E. Salas, C. Prince, C. A. Bowers, R. J. Stout, R. L. Oser, & J. A. Cannon-Bowers, 1999, *Human Factors, 41* (pp. 168-169).

elements may be successful, but overall team effectiveness cannot be optimized unless all of the elements are aligned. Other major training techniques, such as team building, cross-training, and team leader training are widely used in industry, but are less effective than CRM team training because they address only a limited number of these critical factors (Salas & Cannon-Bowers, 1997). For example, team building is one component of CRM training. Cross-training is another. CRM training does methodically address all of the other factors which research has shown to impact team effectiveness. CRM training is a "family of instructional strategies" not a single technique. CRM's strength is that it takes a systems approach to evaluating not only the immediate job environment, but also the larger organizational and national cultures in which the job environment is embedded.

Expanded Application of CRM Training

CRM training is no longer used exclusively in aviation applications, but has spread to other industries which are characterized by high-impact teams whose failure to perform effectively can also result in serious consequences. For example, CRM has been adapted for use in firefighting (Lubnau & Okray, 2001), U.S. Air Force Medical Service nursing (Brannon, 2001), pharmacies (Jaklevic, 1997), merchant navy ships (Flin, 1995), and ships and control rooms of petrochemical and nuclear plants (Helmreich, 1997). In the following section, the application of CRM training to offshore oil rigs, medicine, commuter aviation, aviation maintenance and naval aviation will be discussed. The discussion will include the reason for the adoption of CRM by each industry, how the particular application differs from the classic commercial aviation paradigm, the organizations' perception of the success of CRM, and domain-specific guidelines for implementing CRM.

CRM in Offshore Oil Installations

Flin and O'Connor (2001) described the following incident. In July 1988, the world's worst offshore oil rig disaster resulted in the deaths of 167 people when Occidental Petroleum's North Sea Piper Alpha oil rig exploded after a gas leak. An investigation revealed that poor communication between the day and night crews contributed to the accident; that is, the day crew had shut down a pump for repair yet failed to communicate this to the night crew. The night crew, unaware of any problems with the pump, switched it back on. The temporary seal on the pipe later gave way and the line exploded. For an hour after the initial explosion, two other platforms continued to pump into the same oil export line, which continued to feed the fire. Another contributing factor was the reluctance of the offshore installation manager (OIM), the individual in charge, to shut down oil production and the operating superintendent's lack of assertiveness in forcing the issue. The post-explosion investigation found that the Piper Alpha OIM did not exercise good leadership during the emergency, and concluded that the OIM panicked, took no initiative to save lives, demonstrated poor leadership and decision-making skills and did not exhibit good stress control. In response to the Piper Alpha accident, CRM training was implemented as a way to teach oil rig crews how to understand the human and organizational factors that affect accident prevention and causation. In particular, oil companies sought to improve decision making and leadership in emergency conditions (Flin & O'Connor, 2001).

As illustrated above, offshore oil installations are high-impact settings in which effective teamwork is a precursor of safe operations. Offshore workers perform complex operations in an isolated, constrained, and remote environment. Because safety is a significant concern on the installations, CRM training is an appropriate team-training method on offshore oil and gas installations (Flin, 1995; Flin & O'Connor, 2001).

The adaptation of CRM to offshore oil rig installations began with the identification of key non-technical CRM skills (Flin & O'Connor, 2001). These skills were based on an analysis of workforce surveys and human factors explanations for incidents and accidents. In addition, control room trainers worked together with industrial psychologists to review aviation CRM training packages and select modules on decision making, stress, communication, and assertiveness. After a review of the relevant research, industrial psychologists designed a CRM training package customized to the needs of the offshore control room operators. Control room trainers then served as subject matter experts working with the psychologists to refine the material (Flin & O'Connor). In the end, training was developed for control room operators, OIMs, and their emergency teams. The training development and delivery approach described by Flin and O'Connor (2001) was similar to the aviation CRM paradigm described previously.

Following the implementation of the CRM program, evaluation data were gathered through a course evaluation form, attitude measurement forms, and an analysis of incident and accident data (Flin & O'Connor, 2001). The authors also indicated that a six-month post-training behavior evaluation would be conducted. However, evaluations to determine the impact of CRM training will be difficult because of the limited number of accidents that occur on an offshore installation. Furthermore, the lack of similarity among oil installations (e.g., equipment, conditions, age of platform) made inter-installation comparisons difficult (Flin, 1995).

Nevertheless, Flin concluded that offshore teams can be successfully trained in emergency response procedures by utilizing CRM techniques. Flin and O'Connor (2001) also reported that CRM training

is appropriate for improving safety and increasing productivity in routine operations that require effective teamwork. They described a two-day training program that was aimed at integrating CRM competencies into routine work practices, to make crews aware of the human factors related to production or safety, and to develop positive safety-related skills and attitudes.

Flin and O'Connor (2001) offered the following seven CRM training guidelines:

1. Use a multifaceted approach to determine the key skills to be trained;
2. Review existing CRM training programs and adapt them with the advice of experts;
3. Select appropriate participants, (a hierarchical cross-section representing a single shift from one platform) to generate a variety of viewpoints;
4. Secure management support by identifying a committed member of senior management as well as an experienced local champion;
5. Evaluate the impact of training using a multifaceted approach that considers the impact of CRM training on attitudes, knowledge and skills, and performance;
6. Continually revise the training based on participant feedback, psychological research, and safety reports; and
7. Customize the CRM materials for the audience, thereby ensuring relevant case studies and examples for practice.

These guidelines, which are highly generalizable, were also recommended by the authors of the four case studies presented next (see Boehm-Davis, Holt, & Seamster, 2001; Davies, 2001; Oser, Salas, Merket, & Bowers, 2001; Robertson, 2001). Essentially, the training approach is similar across all domains, yet changes to the content of the CRM training program provides the domain-specific customization that is required for specific applications.

CRM in Medical Settings

According to the American Medical Association's National Patient Safety Foundation, medical mistakes in hospitals cause approximately 3 million patient injuries and deaths annually, with an associated cost estimated at $200 billion (Jaklevic, 1997). In contrast to aviation's usually highly publicized errors, in which million-dollar aircraft and hundreds of lives are lost, operating room errors are less publicized and result in the injury or death of only one individual (see Helmreich, 2000). However, doctors and pilots share a high degree of professional pride and have similar personal cultures (e.g., beliefs of invulnerability to error making) (Helmreich, 2000). According to Davies (2001, p. 267), "doctors, nurses, and paramedical personnel are taught that they are to function without error, despite the knowledge that this goes against all understanding of human error." Davies points out that medical personnel need to recognize that teamwork can help manage errors, but that optimally the workers must also understand and accept how stress and illness affect their performance (Davies, 2001).

With the switch in medical settings from "doctor-centered" to "team-centered" care (e.g., nurses performing some doctor duties), CRM has become a useful tool for teaching effective teamwork strategies in this domain. Whereas many medical problems are now due to breakdowns in teamwork and team communication, Helmreich (2000) suggests that patient safety can be improved only if problems in communication, leadership, interpersonal relations, conflict, preparation, planning, and vigilance are addressed. In addition, Davies argues that the outcomes of CRM training should be improved patient safety, improved morale of health care workers, greater organizational efficiency, and better quality decisions made by regulatory agencies. Extensive CRM training is critical for medical teams, because, as Helmreich (2000) pointed out, problems with patients are even less predictable than aircraft problems. Therefore, CRM training is appropriate because it provides trainees with a set of response repertoires that are available when these infrequent errors do occur.

Davies (2001) reviewed how CRM training is being applied to the domain of anesthesiology in medical settings where training is provided to both anesthesiologists and practitioners. Although anesthesiologists experience low accident rates, Davies states that the need still exists for anesthesiologists to respond correctly when an error does occur (citing Cooper, Newbower, & Kitz, 1984). The Anesthesia Crisis Resource Management (ACRM) program developed by the Stanford University School of Medicine is the mostly widely used model for medical CRM programs (Davies, 2001). Davies states that the goal of such programs was to improve patient safety by (a) pre-training a repertoire of responses to specific critical incidents, and (b) teaching participants to coordinate and integrate resources. The training was delivered with the use of an anesthesia simulator in a setting in

which the following personnel were present: the anesthesiologist and his/her backup, a surgical resident, and two operating room nurses. Training included a half-day of lectures, videotapes, and discussions which covered a variety of topics including factors that affect human performance. The following day trainees familiarized themselves with the operating room and engaged in six crisis management scenarios, which were followed by debriefing sessions.

A slightly different approach to CRM anesthesiologist training was developed at the University of Basel in Switzerland. There, surgeons used a high-fidelity laparoscopic surgery simulator ("Wilhelm Tell" actually bled if a blood vessel were cut) and an entire operating room (OR) team was assembled: anesthetic and surgical nurses, staff anesthesiologists and surgeons, and orderlies. Further, the team performed a preoperative review of the patient's condition. A final difference from the Stanford approach was that the three senior faculty members (nurse, anesthesiologist, surgeon) responsible for training residents and nurse trainees also received specialized human factors training.

Overall, Davies (2001) pointed out two major differences between aviation and anesthesiology CRM models. First, the Stanford model is restricted in that the training focuses on the anesthesiologist, not the entire OR team, which means that teamwork improvements are not optimal; thus, no shared mental model is developed among the team members. Second, whereas in aviation simulators are used routinely to improve team performance, in medical settings the simulator is used almost exclusively to teach basic crisis-management technical skills, with an emphasis on individual performance. As a result, teamwork training is only a minor subset of the training program. However, as in aviation settings, the teamwork skills of health care workers must be fostered under routine conditions so that when emergencies are encountered, the teams' interpersonal responses are already in place.

Davies concluded that the greatest impact of CRM on medicine currently is at the interface points between medical personnel. The short-term effectiveness of CRM training in anesthesiology has been demonstrated by the increased teamwork skills shown by medical personnel during simulated post-training crises. Overall, anesthesiology has an excellent safety record, that is, the mortality rate is less than 1 in 200,000 (Davies, 1994, as cited in Davies, 2001). The low accident rate makes it difficult to evaluate the long-term impact of training programs like CRM. To counter that difficulty, Davies proposed that "near hits" should be analyzed to judge the impact of CRM training. Further, she recommended that CRM training be linked with the organization's quality assurance program.

In addition to the general guidelines that were described previously in the section on offshore oil platforms, Davies offered a number of medical-specific guidelines. First, senior staff must actively promote a culture that acknowledges that because errors are inevitable, they cannot be ignored but must be addressed. In addition, interface problems can be resolved only through the involvement of each of the medical specialties in an OR team: anesthesiologists, surgeons, nurse anesthesiologists, OR nurses, anesthetic assistants and therapists, perfusionists, orderlies, technicians, and clerical staff. Next, evaluation elements should include actual case data, objective benchmarking evaluations of strengths and weaknesses of the training program, performance feedback, trend tracking, and performance data. Finally, Davies recommended that CRM training programs be initiated as early as possible in the training programs of doctors, nurses, and other affected health care workers to supplement their technical training.

CRM at a Regional Airline

As a result of the Federal Aviation Administration's (FAA) interest in evaluating proceduralized CRM and because of its specific requirements, a small, regional airline upgraded and customized its current CRM procedures to better fit its own operational needs (Boehm-Davis, Holt, & Seamster, 2001). The authors discussed how a tailored CRM training program was developed for the airline.

Because trainers at the regional airline recognized that the existing standardized CRM training program was ineffective in addressing their specific operational needs, they sought to develop customized CRM training for flight crews that focused on both normal and abnormal conditions (Boehm-Davis, Holt & Seamster, 2001). This application differed from traditional CRM training in that classroom lecture material was incorporated into standard operational procedures (e.g., changing checklists, changing briefings). Needs assessment included an organizational climate survey, identification of problem areas based on National Transportation Safety Board (NTSB) studies, data from voluntary

reports produced by the Aviation Safety Report System, and input from the airlines' instructor/evaluators. The following training needs were identified: reduce distractions to the pilot, increase the structure of briefings', and design checklists. The design team of the airline, the CRM coordinator, instructional designer, and human factors psychologists jointly developed the training procedures. Throughout the following year, the organization developed the pilot training course and provided training to both the trainers and the pilots, who were trained in small groups. As a comparison of this case study with the other studies shows, this training program is differentiated because of its particular emphasis on training the trainers who would be instructing and evaluating the trainees. In addition, the need for standardized evaluation processes (e.g. checklists, formalized procedures) was also stressed.

Evaluation of this program was based on the changes in observed performance that occurred over a three-year period between the trained group and a control group (Boehm-Davis, Holt, & Seamster, 2001). Multiple measurement devices were employed to assess changes. For example, the standardized evaluation consisted of a line-operation evaluation (LOE). An LOE is a performance evaluation that uses a work sample based on a structured script emphasizing specific crew behaviors. In addition, random line check evaluations were conducted during normal operating conditions, along with jumpseat observations, instructor/evaluator ratings, and pilot surveys. The authors concluded that the revised CRM program led to increased cockpit effectiveness.

Boehm-Davis, Holt, and Seamster (2001) recommended guidelines that are similar to those proposed by the authors of the previous case studies (see the recommended guidelines for offshore oil rigs). An exception was their recommendation that appropriate data be reported to the crews, union representative, instructor/evaluators, tracing department, quality assurance, and relevant fleet personnel. They suggested that such data could be used in various ways to improve the training program.

CRM in Aviation Maintenance Teams

In 1988, Aloha Airlines Flight 243 was flying at 24,000 feet when 18 feet of fuselage skin ripped off the aircraft, forcing it to make an emergency landing (Robertson, 2001). An investigation into the cause revealed over 240 cracks in the aircraft's skin, suggesting that poor maintenance was a contributing factor in this accident. Robertson discussed how maintenance resource management (MRM) programs, which are an adaptation of CRM, could enhance airline maintenance operations through improved communication, increased coordination and performance effectiveness by error reduction, and increased safety. Coordination and communication within maintenance teams are critical because common errors lead to ground damage incidents, flight delays, turnback, and in-flight engine shutdowns. The effect of poor coordination and communication is exacerbated by the fact that maintenance teams typically perform their tasks across shifts and in different geographic locations.

According to Robertson (2001), MRM differs from CRM in that MRM training is based on a systems view of aircraft maintenance that considers the entire organization. As a consequence, training is provided to a wider range of trainee specialists: aviation maintenance technician staff, support personnel, engineers, inspectors, and managers. MRM encourages workplace communication, situation awareness, and corporate culture. Robertson describes in detail the steps for designing and implementing an MRM program.

Robertson (2001) summarized the evaluation of an MRM training program that was implemented at a major airline company. He concluded that MRM training had a positive and significant impact on all outcome measures. In particular, aircraft safety, personal safety, departure dependability, and on-time maintenance were strongly correlated with attitude changes and performance.

In addition to offering the generalized guidelines described earlier in this paper, Robertson also recommends that all affected employees should be involved in training development, including aviation maintenance technicians, engineers, inspectors, managers, quality assurance personnel, and FAA regulators.

CRM in Naval Aviation Settings

Oser, Salas, Merket, and Bowers (2001) discussed the adaptation of CRM training to the U.S. Naval Aviation service (Navy and Marine Corps). The purpose of their research was to develop a systematic methodology for applying CRM training. Their subgoals were to improve understanding of how crew coordination affected performance,

develop measures of aircrew coordination, and produce and test training strategies.

In general, the methodology Oser et al. (2001) used was similar to that of other aviation applications, with the exception of three important differences: they emphasized practice and feedback in simulation environments, the need to tailor tools and methods to team training environments, and the need to produce quantifiable performance improvements in training teams working on complex tasks. They adopted a multifaceted approach to evaluating CRM training, from which they concluded that CRM training in naval aviation settings is effective.

The guidelines presented by Oser and colleagues (2001) were also similar to those proposed in the earlier case studies. The specific exceptions included an emphasis on the need to integrate all aspects of the training program and to provide a learner-centered approach. For more detail on the guidelines for this domain, refer to the recommended guidelines provided for offshore oil rig applications.

How Successful is CRM Training?

The authors of the above applications concluded that CRM training is effective in teaching teamwork skills and improving organizational performance in offshore oil, medical, and a variety of aviation settings. Additional empirical evidence to support the use of CRM training exists.

For example, a major purpose of training teamwork skills is to ensure that the skills are available when needed, that is, in high workload or crisis situations (Salas, Fowlkes, Stout, Milanovich, & Prince, 1999). In recent studies, Salas, et al. (1999) determined that CRM training does provide teams with these needed skills. The researchers found that trained teams had more positive attitudes toward using teamwork, knew more about teamwork principles, engaged in more teamwork behaviors during pre-flight briefs, and outperformed baseline teams during high-workload situations. As noted, Salas, Burke, Bowers, and Wilson (2001) reviewed 58 evaluations of CRM training efforts using Kirkpatrick's (1976) approach and concluded that CRM training does in fact result in positive trainee reactions, learning, and the demonstration of trained behaviors. However, due to a lack of systematic evaluations to determine the impact of training, the researchers were unable to form conclusions about the impact of CRM training on aviation safety.

The demonstrated success of CRM training is largely due to its strong theoretical underpinnings. That is, CRM was founded on the empirical research findings of military, cognitive, industrial/organizational and human factors psychologists. At the beginning of this article, we raised the question, "How generalizable is CRM training from high-impact teams, such as those found in aviation, operating rooms, and offshore oil platforms, to other high-impact teams as well as to routine teams working in other industries?" We now discuss how CRM training may be applied to teams in other kinds of organizations.

Applying CRM Training to Industry

For which kinds of teams will CRM training produce the greatest return on investment for organizations? As with any training effort, a situation analysis of organizational needs, task needs, and individual needs must be conducted before any solution can be designed because no training technique is necessarily appropriate for all circumstances. We now elaborate on the conditions most suitable for implementing CRM team training and identify the ingredients of a successful CRM team-training program.

Suitable for Most Types of Teams

The use of CRM training to improve teamwork skills is applicable to any situation in which teams are: (a) similar in size and structure to the teams used in these studies, (b) the teams operate in conditions resembling those faced by aviation teams, and (c) effective team performance depends on comparable teamwork skills (Salas, Fowlkes, Stout, Milanovich, & Prince, 1999). For example, CRM training would be appropriate for any form of emergency-services teams, such as fire, police, paramedic, and medical teams of all types (see Flin & O'Connor, 2001). CRM training could also improve outcomes for any team that requires between-shift coordination, such as manufacturing teams (see Davies, 2001). CRM training would also be appropriate for teams whose members have not interacted together previously, especially when the teams are put into time-constrained or other stressful situations, such as surgical teams or combat teams.

What about teams that operate under less critical conditions? In some cases, the successful

implementation of CRM training requires a fundamental change in how organizations and individuals view teamwork and their beliefs about how teams can contribute to personal, team, and organizational outcomes. The culture of an organization (see Schein, 1996; Schneider, 1972) must support team efforts. Over the past decade, major organizational change and development approaches (e.g., total quality management and business process re-engineering) have frequently implemented team-based operations as a means by which to achieve increased individual performance and organizational outcomes. It certainly follows that if organizations believe that teamwork is important, then the teamwork skills that lead to effective team performance must be identified and fostered. Training teamwork skills must be a system-wide imperative to ensure that support for teamwork is embedded throughout the organization.

In which lower-impact settings might CRM team training be suitable? Customer-service organizations are a logical testbed for examining the efficacy of CRM training in non-aviation settings. For example, the hospitality industry could benefit from teamwork training. Restaurants, conference centers, and hotels could realize improved organizational performance if every member of a service team supported an integrated customer-service vision. Retail teams might see increased sales and customer satisfaction if all elements of the organization were actively working together to provide customers and clients with a positive service experience, while up-selling services and products.

Ingredients of Successful CRM Training Programs

All training programs are embedded within a larger organizational context. The effectiveness of work teams is affected by such organizational support systems as leaders' roles, staffing, rewards, measurement of performance, features of the physical environment, information systems, and emerging communication technology (Sundstrom, McIntyre, Halfhill, & Richards, 2000). As a result, the organizational climate exerts a powerful influence on the perceptions of trainees before, during, and after training (e.g., Baldwin & Ford, 1988; Ford & Weissbein, 1997). Therefore, an organization that wishes to ensure optimal CRM training must be attentive to certain conditions that support and promote successful training.

First, CRM training must be a partnership between management, the trainers, and the trainees. Each has a role in promoting successful outcomes. Second, top management support must be visible and ongoing from the analysis phase through training delivery to post-training analysis and feedback. Third, training must be embedded in a supportive organizational culture that reinforces the major CRM values: that teams can accomplish more than individuals merely working together, that teamwork training is critical and cannot be left to chance, and that the mission of the team contributes to important organizational outcomes. Congruency is necessary because successful full-scale CRM is expensive. Furthermore, it requires an ongoing commitment to long-term training, re-training, and evaluation. Organizations must be willing to expend resources in designing, delivering, and evaluating the training, which requires a corporate culture oriented toward safety and teamwork. Supervisors, managers, and executives must show tangible support for CRM training (see Fleishman, 1953). Fourth, management, trainers, and trainees' supervisors must actively manage conditions within the job environment to ensure that trainees will transfer skills learned in training to on-the-job performance. Possible hindrances to training transfer must be identified, and, if necessary, trainees must be taught coping strategies to overcome any barriers that cannot be removed. Fifth, a successful CRM program requires a thorough evaluation of trainee reactions, learning, behavior change, and when possible, the impact of training upon the organization's outcomes. The evaluation is required both to demonstrate a positive return on investment to management and to enable fine-tuning and improvements to the training program. Finally, a CRM training program must be an on-going program. Not only do skills atrophy over time, but improvements to the training program based on results of evaluation may suggest additional training content to be delivered.

Future Research Topics

In spite of its successes to date, CRM training has not stopped evolving. Among the questions that have yet to be addressed comprehensively are issues concerning alternative evaluation mechanisms, team diversity and multiculturalism, the use of technology to deliver training, and on-the-job training.

In some of the applications presented earlier, empirical evaluations were not practical because of the low error rate specific to the industries (e.g.,

medical settings, offshore oil installations). Davies (2001) suggested that alternative measurement techniques, such as near "hits", need to be identified to work around the problem. Researchers should also seek other measurement techniques that can provide an estimate of the influence of CRM training programs. For example, evaluation can be accomplished on the job, on line, or with simulators (see Salas et al., 2001).

In many countries, the workforce is becoming increasingly diverse (see Guzzo & Dickson, 1996) due to immigration and ethnic-subgroup birth rates (e.g., U.S., Canada). Moreover, many organizations are becoming progressively more involved in the global economy. Thus, a notable omission in the discussion of the case studies was the researchers' failure to consider the impact of national origin on team performance. Originally, CRM was designed for an environment in which the typical pilot was from a developed, Anglo-Western country working for a large, financially stable airline (Merritt & Helmreich, 1996). Because team processes may not be the same for all situations, team training may need to be modified to suit local constraints and local conditions (Merritt & Helmreich, 1996). For example, in a 16-country survey of over 13,000 pilots, researchers found that cockpit behavior was influenced by nationality (Helmreich, 1997). Specifically, role perceptions and attitudes about rules and procedures differed among cultures. Helmreich pointed out that only 36 percent of pilots from an Asian country believed that crewmembers should verbalize safety concerns, compared to 98 percent of respondents from one Western culture. Future research should address this issue and determine when and how training should be modified to accommodate national culture.

Rapid changes in technology are providing increasingly sophisticated training-delivery mechanisms, e.g., distance training. In fact, the use of distributed training is becoming widespread in government and industry (Kosarzycki, Salas, DeRouin, & Fiore, 2002). Distributed training refers to "training that is generally managed from a central control site and is provided to individuals or teams who are located at one or more remote sites" (Dwyer, Fowlkes, Oser, & Salas, 1997, p. 137). Research is needed to determine, first, if CRM team training can be delivered effectively via distance-learning technologies, and second, if distance learning delivery is feasible, how best to optimize delivery.

Finally, on-the-job training has always been an important means by which trainees are taught critical knowledge, skills, and attitudes. Smith-Jentsch, Baker, Salas, and Cannon-Bowers (2001) recommended on-the-job training as a means by which to provide trainees with practice and feedback opportunities to develop skill in information exchange, supporting behavior, team feedback skills, and flexibility. However, more research is needed to determine the best techniques by which to teach CRM team skills via what is usually an informal and unstructured training method.

Conclusion

Organizations are increasingly using teams because they believe that synergy results from combining efforts of individuals, that integrated efforts contribute more to organizational outcomes, that continuity is possible even if one group member leaves, that the structural complexity of organizations requires more coordinated efforts, that technological complexity requires coordination, as does the increased conceptual sophistication within organizations (West, 1996).

The fundamental premise of CRM training is that because teams are more than just individuals working together, teamwork skills are as important as task skills and therefore must be trained. The authors of each case study discussed above concluded that CRM training can be successfully implemented beyond aviation settings. With suitable modifications to reflect the requirements of distinct domains and industries, off-the-shelf CRM training programs can be applied to a variety of work settings. Therefore, as the use of teams becomes more prevalent in industry, the opportunity to adapt CRM principles and guidelines to train such teams will grow.

To survive both internal and external pressures, organizations will always react by changing. The use of teams is one mechanism by which organizations will attempt to control and manage the change. It is imperative, therefore, that researchers and practitioners continue to investigate how best to prepare teams to perform effectively to meet individual and organizational goals.

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