

Brief Report of Journal Article:

Crew Coordination Behaviors as Predictors of Problem Detection and Decision Making Times

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Abstract

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Introduction

Aeronautical Decision Making (ADM) training at the time of this study was based mostly upon an arguably simplistic understanding of *individual* decision making factors; namely dangerous attitudes and risky behaviors. While emphasizing these factors for pilot training methods resulted in improvements in individual pilot awareness with respect to hazardous attitude and risky behavior, the dynamic effects from outside circumstances and from interactions between multiple crew members were thought to play a more essential role for Team Situational Awareness (TSA). The majority of flight tasks in modern commercial and military transport aircraft require interaction of multiple crew members, and crews that use effective coordination and good time management were believed to improve group ADM significantly (Oranasu, 1995; and Kaempf & Klein, 1994 as cited in Jentsch, Salas, Sellin-Wolters & Bowers, 1995). Previous studies revealed that group ADM required increased factual communication and well-defined leadership roles between crewmembers (Bowers et. Al., 1993 as cited in Jentsch, et al.).

The authors of this article studied the relationship between crew coordination behaviors and the time required to identify and solve a typical flight problem. They noted that individual

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ADM training at the time was primarily descriptive instead of prescriptive, and did not provide the skills required to identify and solve a problem or decide among alternatives. Pilots that learned only to identify hazardous attitudes for internal decisions were not as well equipped at dealing with uncontrollable external events. Therefore, the purpose of this study was to help create a more crew coordination skill-based ADM training approach specifically for multi-crew aircraft that would take crew interaction and external events into account.

This study analyzed the theoretical model of recognition-primed decision making (RPD), which occurs in three phases: situation recognition, serial option evaluation, and mental simulation (Klein, 1993 as cited in Jentsch, et al, 1995). The authors identified the situation recognition phase as most vital and hypothesized that improving it in aircrews was a necessary first step for developing a crew-based ADM training model. Crew Resource Management (CRM) training already included behaviors that were shown to improve situation recognition; such as adaptability and mission analysis. Such CRM attributes were also shown to improve active sampling of the external environment, increase the exchange of information within a crew, and foster problem-sharing. The authors thus hypothesized that good crew coordination behaviors would improve a crew's problem detection and decision making times.

Method

Sixty-eight military crew members, randomly paired into 34 two-pilot crews, were observed during a flight simulation following aircrew CRM training. The simulation involved a situation that required the crews to identify, diagnose and solve a typical problem. The US Navy's PC-based Table Top Aircrew Coordination Training System (TTACTS) was used for the study. TTACTS utilized Microsoft's Flight Simulator software specifically adapted

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to present training scenarios for CRM. There were a total of three monitors; two for the crew and one for the simulator instructor. The monitors presented a simulated outside view and instrument panel with basic flight and navigation instruments. The proceedings were audio and video taped.

The crews were presented a communications problem which involved being unable to contact a controlling agency after being directed to change frequencies. The pilots had to identify the problem and self-select to switch back to the original frequency, whereupon they were asked to state intentions after being advised of a problem at the controlling agency. Dependent variables were the time needed to initially identify the problem, and the time to then state intentions. CRM behaviors used by the crew were identified with the audio and video tapes. Observers of these tapes used the Aircrew Coordination & Observation Scale (ACOE) (Prince, et al., 1992 as cited in Jentsch, et al, 1995) to code the frequencies and sequences of the following six classes of crew coordination behaviors both during the problem event and for 5 minutes preceding it:

- 1- Mission Analysis
- 2- Adaptability
- 3- Assertiveness
- 4- Leadership
- 5- Situation Awareness
- 6- Communication (quantity of standard communications)

Observers also gave subjective rating scores of their own perception of the crew's performance.

Discriminant function analysis (DFA) was used to perform a multivariate test of differences between two groups of slow and fast times, divided into two categories; problem-detection and problem-solving. The frequencies of the six behaviors observed in the five minutes

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preceding the problem were used as predictors of membership in the slow or fast group for each category. The 34 teams were divided by quartiles according to the time used to detect or to solve the problem. Jentsch et al. hypothesized that more frequent use of the six crew coordination behaviors would predict how fast or slow that crew detected and solved the problem.

Results

Problem-Detection

Out of the 34 teams, seven fell into the slowest quartile ($T > 1\text{min}$; mean=1min20sec); and nine were in the fastest quartile ($T < 45\text{sec}$; mean=39sec). The faster teams took about half the time for detection, a significant difference ($p < .001$).

DFA showed a significant correlation between groups and predictors and suggested that the best predictors for distinguishing between slow and fast teams were number of communications, leadership statements, and situational awareness observations and statements. The other three behaviors did not show a reliable discrimination between the slow or fast team.

Problem-Solving

Twelve teams fell into the slow group ($T > 1\text{min}$; mean=1min25sec); and 12 were in the fast group ($T < 45\text{sec}$; mean=34sec). The teams in the fast group were about 2.5 times faster at solving the problem than the slow group, a significant difference ($p < .001$). DFA showed no significant difference between groups and the six behaviors, nor were any behaviors significantly correlated with the time needed to solve the problem.

Discussion and Conclusion

Three of the six crew coordination behaviors reliably predicted the time to identify, but not to solve the problem presented within a crew dynamic. An important element of ADM in a crew aircraft is problem recognition. This study showed that communication efficiency, leadership, and situational awareness observations verbally shared within the group were reliable group behavioral predictors of problem recognition times. This was an important finding because it allowed flight instructors to structure training for ADM beyond simple awareness of individual hazardous attitudes and develop methods of training crews to use good radio communication practices, develop leadership abilities, and instruct crews in the use of factors known to enhance TSA. At the time of the study, current ADM training tended to overlook such team behaviors vital for problem recognition. The study showed that established CRM training and theory is a vital extension of crew ADM. The study allowed the combination of separate ADM and CRM training into one model that established links between the different skills needed to quickly and correctly identify a problem.

While accurate and fast problem recognition is a vital aspect of effective ADM, the study showed that the associated CRM behaviors are only one step in a larger ADM process in terms of problem-solving. The studied CRM behaviors did not reliably predict problem-solving times, which can be thought of as the desired outcome of good ADM. Therefore, skills other than and in addition to those obtained in CRM training were necessary for a complete and enhanced aircrew ADM training model that improved both problem recognition and problem-solving.

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