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What We Know About Teamwork and Multiteam Coordination in Aviation: Teamwork Communication and Decision Making in Aviation

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A variety of teams operate within aviation and decisions are made both within individual teams and with multiteam collaboration as well. As a result, multiple decision contexts exist and communication issues are ubiquitous. Two different approaches to decision making are described. The utility of each approach may vary across situational factors such as time pressure and attentional capacity. This is the fourth in a five-article series discussing theory and research relating to teamwork in aviation. This article presents a core piece of the comprehensive model of teamwork in aviation,

Permeating Teamwork Processes

Four overriding teamwork processes are involved in both of the sequential processes of teamwork (planning and implementation) and in the development and maintenance of emergent states. The permeating processes of interpersonal teamwork processes, leadership, communication and decision-making are necessary to effectively accomplish both collaborative planning and implementation. In this article we will cover communication and decision making.

Communication

Communication is characterized as a permeating process because it is intertwined with all the processes and emergent states. Meta-analysis indicated that both the sharing of relevant information and the openness of communication were related to team performance (Mesmer-Magnus et al., 2009). Communication provides a mechanism to share individual situation awareness, impact collective efficacy, serve as a vehicle for planning, or backup behavior, coordination, and so forth.

Communication is needed to convey relevant information (Waller, 1999), but more communication may not always be better (e.g., Zijlstra et al., 2012). Consistent patterns are reported concerning the nature of communication in effective cockpit crews. Communications about the environment and flight status promote shared situation awareness and are related to performance (Bowers et al., 1998; Foushee & Manos, 1981). Compared to less effective cockpit crews, effective ones quickly settled into stable patterns of reciprocal communication (Zijlstra et al., 2012). In effective cockpit crews, commands were likely followed by acknowledgements and questions were likely to be followed by answers (Kanki et al., 2019).

Other communication factors relating to effective flight crew performance include assertive communications to question decisions and point out problems (Bowers et al., 1998) and the use of directives (Bowers et al., 1998; Foushee & Manos, 1981). Directives are more likely to be associated with high performance when they are explicit, provide reasons, and are framed in terms of shared goals rather than status (Orasanu-Engel & Mosier, 2019, 2010; Mosier & Fischer, 2015). These studies indicate the importance of clear, assertive, respectful, and proactive two-way communication among the cockpit crew. Despite this consistent pattern, some evidence suggests a more task-contingent approach to communication. A simulation study with experienced pilots found that relatively long dialogues with frequent speaker switches were associated with high performance under routine conditions, but were negatively related to performance under difficult, non-routine flight segments (Lei et al., 2016). This may also suggest that frequent communication is appropriate under routine conditions, but may detract from effective adaptation, especially under time pressure.

Observation of experienced ATC teams indicated that they tend to use clear, concise, meaningful, and timely communications and proactively communicate within the team and with other ATC teams (Malakis et al., 2010). ATC communication problems can lead to altitude and lateral displacement (course heading) errors that can result in serious air traffic issues (Grayson, 1981). ATC communication problems are most common under two conditions: shift change and sector handoffs. Both of these conditions involve passing control of aircraft to another controller team.

Communications between ATC and pilots can be problematic. Although text-based communication systems are sometimes used, much of the communication between ATC and pilots is verbal contact via radio. Both accident investigations and incident reports indicate that errors in communications between ATC and pilots can cause serious safety risks (Billings & Cheaney, 1981; Kanki, 2019). Another issue is script-based anticipation errors which involve pilots or controllers hearing what they expect to hear (National Aeronautics and Space Administration, 2009).

Communication issues between flight attendants and pilots have been cited as a factor in aircraft accidents (Chute & Wiener, 1996; Ford, Henderson, & O'Hare, 2013). Communications to pilots are sometimes less effective because attendants are unaware of proper terminology for airplane components or the functional significance of issues they observe (Chute & Wiener, 1996). Attendants sometimes notice abnormal conditions (e.g., vibrations, unusual noises, ice on wings), but fail to report their concerns to pilots (Bienefeld & Grote, 2012).

In aviation maintenance, communication is needed between technicians working on the same aircraft (either concurrently or across shifts), between technicians and the lead technician, with other maintenance facilities concerning deferred maintenance, and with other organizational units. A high number of maintenance errors occur following shift transfer. Shift change errors tend to involve more critical aircraft systems and are more likely to result in serious consequences (Endsley & Robertson, 2000). For example, one fatal accident was caused because a technician removed stabilizer screws, but did not inform the incoming technician (Flight Safety Foundation, 1991). Following a flight with mechanical issues, best practice is for the pilots and a maintenance technician to meet and discuss the issue. When this does not occur, the technician must use the pilot's log notes to diagnose the problem. Frequently the log notes provide only a cursory description of the problem, making accurate diagnosis difficult (Munro et al., 2008).

Decision-Making

Vigilant decision-making. Many decisions are relatively routine and made without extensive time pressure (e.g., calculating fuel load or planning for potential diversions based on weather forecasts). In these situations, vigilant decision models may apply (e.g., Forsyth, 2019; Janis, 1989). These models suggest specific sequential steps such as analysis of the nature of the problem, generation of multiple alternatives, evaluation of positive and negative consequences of various alternatives, choice, and implementation. Pilots face varying degrees of time pressure. Frequently, during the preflight phase (where transition processes occur) there is time for vigilant processing. But, during some action phases of the flight, particularly during the takeoff and approach/landing phases, decisions may need to be made quickly (Thomas, 2004).

Naturalistic decision-making. An important component of aviation decision-making is understanding and managing threats. Decisions are often made in reaction to threats (e.g., severe weather, mechanical malfunction) or errors made by the crew or other parties. Thomas (2004) found that threat and error management was a critical component of decision-making across all phases of flight. Because aviation is often a dynamic environment where decisions have to be made under time pressure, with incomplete information and competing goals, the naturalistic decision-making model (NDM) is appropriate for many team decisions (Lipshitz, Klein, Oransu & Salas, 2015). Expertise plays a strong role in NDM as experts often make decisions by pattern matching the current situation to past experiences or recognition-primed decision making (Klein, 2008).

When issues arise, there are often regulations, decision rules and standard operating procedures (SOPs) that apply; in these cases, situation assessment is the critical process. In other cases, teams may face situations where they need to develop novel solutions to novel problems (Canas, Antoli, Fajardo, & Salmeron, 2005). Good decision-making under these conditions requires not only accurate situation awareness and risk assessment, but also metacognitive processes, shared mental models, and efficient resource management. Team decision making is also facilitated by an open communication climate and high levels of trust (Oransu-Engel & Mosier, 2019).

As Salas et al. (2005) noted, the specific ways team concepts manifest are often dependent on context. In aviation, task contexts vary in many ways. For pilots, initial flight planning involves transition teamwork processes while in-flight operations represent action processes. Thus, flight planning and in-flight operations are two distinct phases of flight that provide different contexts with potential to moderate the relationship between communication, decision-making, and leadership with outcome measures (Cahill et al, 2014; Thomas, 2004). Furthermore, task requirements vary across the in-flight operations phases of takeoff, cruise, and approach/landing. Likewise, task demands differ between routine and non-routine tasks. Greater appreciation of the moderating effects of task conditions is likely to result in a more refined understanding of emergent states and processes affecting team performance in aviation. It appears that the most appropriate communication strategies, leader behavior, and decision-making approach may be task contingent. Simpler and directive communication may be needed when non-routine events are experienced while more explanation and solicitation of input may be appropriate when conditions are routine. Vigilant decision-making may be effective for important decisions when time is available, but naturalistic decision making seems to be more appropriate under time pressure. Shared leadership may be appropriate in many situations, but directive leadership may be more appropriate when time demands are extreme. Thus, the ability to adapt leadership and team behavior to situational demands is critical.

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