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Crew resource management in aviation safety

Based on the research that was conducted at the Department of Aerodynamics and Aircraft Flight Safety in National Aviation University, and flight practice in organizations that have their own safety management system.

Contribution of the crew resource management to aviation safety

Crew resource management was developed in response to new understandings of aircraft accident causes that emerged with the introduction of flight recorders and cockpit voice recorders in modern jet aircraft. Data from these devices revealed that many accidents do not stem from technical malfunctions of the aircraft or its systems, nor from deficiencies in aircraft handling skills or technical knowledge among the crew. Instead, these incidents were often attributed to crews' inadequate responses to the situations they encounter during flight operations.

Generally, critical phases of fight, which are take-off, initial climb, final approach and landing, take approximately 6% of total flight time. According to research made by Boeing in 2023, during these phases 64% of all fatal accidents took place (fig. 1), among those accidents 80% were caused by human error (fig. 2). That means most of the fatal accidents that happened had a solution, and the crew either did not know about the solution, or did not make it, or made a mistake. That's the main goal of the CRM system — to deal with routine and abnormal operations and help crew make safe and correct decisions in critical situations.

Percentage of Fatal Accidents and Onboard Fatalities | 2014-2023

	Taxi, load/ unload, parked, tow	Takeoff	Initial climb	Climb (flaps up)	Cruise	Descent	Initial approach	Final approach	Landing
		21%						43%	
Fatal accidents	11%	14%	7%	11%	11%	4%	0%	7%	36%
Onboard fatalities	0%	16%	2%	32%	26%	7%	0%	9%	8%
		18%						17%	
Exposure (percentage of flight time estimated for a 1.5-hour flight)		1%	1%	14%	57%	Initial approach fix 11%	Final approach fix 12%	3%	1%

Note: Percentages may not sum to 100% because of numerical rounding.
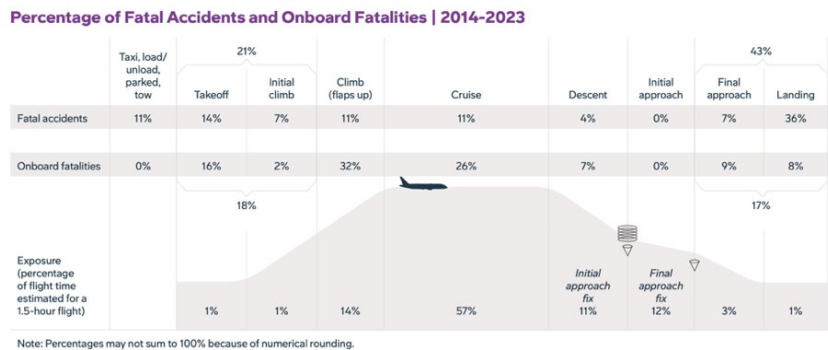
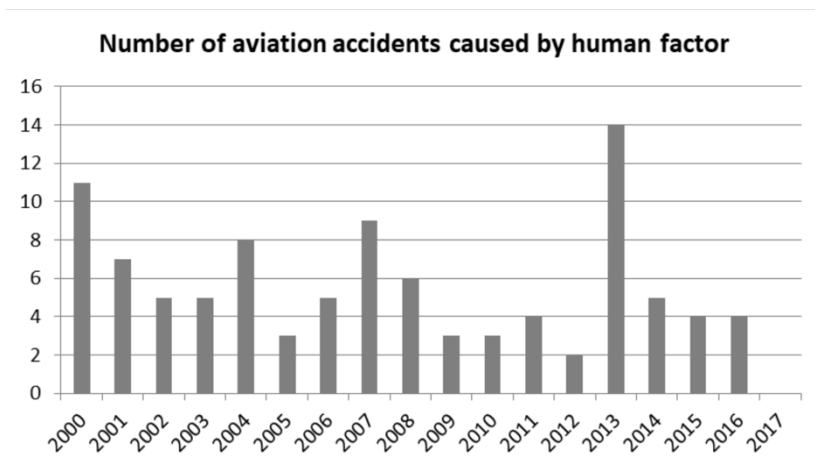Fig. 1. Percentage of fatal accidents, 2014 – 2023

Fig. 2. Number of aviation accidents caused by human factor

The elements which comprise CRM are not new but have been recognized in one form or another since aviation began, usually under more general names as «Airmanship» or «Crew Cooperation». Crew resource management includes a wide range of knowledge, skills and attitudes including, situational awareness, decision making, problem solving, communications, and teamwork (figure 3).

Figure 3. Crew resource management components

Situational awareness entails the conscious recognition of all factors that influence the safe operation of an aircraft — operational, technical, and human. For

pilots, a significant portion of the information that informs situational awareness is derived from flight instruments and onboard navigational systems. However, the construction of an accurate mental representation of the aircraft's position in space, it's condition, and the status of the crew can be compromised by factors such as inattention, distraction, low arousal, stress, boredom, and fatigue. In such circumstances, validating the accuracy of these mental models through communication with other crew members by sharing information, perceptions, and intentions, becomes critically important for the safe and effective management of the flight.

Proper flight planning, and preparation enables individual crew members to contribute effectively to in-flight decision-making. It is crucial for the captain to regularly inform the crew about any changes to the original plan as the flight progresses, ensuring that all members maintain situational awareness. This is especially critical during abnormal operations or emergency situations, where conditions impacting the flight's progress and aircraft safety can change rapidly. In such scenarios, frequent updates on the flight status help each crew member stay adequately informed, allowing them to contribute most effectively to the decision-making process.

Effective communication among crew members is a critical component of successful CRM. It aids in the development of a shared mental model among the crew regarding the issues that need to be addressed during the flight, thereby enhancing situational awareness. Most importantly, communication shapes the interpersonal dynamics between crew members, playing a key role in establishing the overall tone and climate for the management of the flight.

Successful teamwork occurs when the collective output of the team exceeds what could be achieved by the sum of individual crew members working independently. It arises from the interactions among crew members, where each individual is empowered and encouraged to contribute effectively to the team's overall objectives. However, this interaction is unlikely to happen unless each team member fully understands their role within the group and how that role may shift depending on the situation in which decisions are made and actions are taken. So, effective communication within the team, a high level of situational awareness, and a thorough understanding of the decision-making process by all members are essential for creating synergy and ensuring the team's optimal performance. Given that crew members often work with new teams on each flight, it is crucial for the organization's culture to support and nurture an environment conducive to strong teamwork. A healthy organizational culture that actively promotes CRM will naturally foster effective teamwork, as CRM and teamwork are closely interconnected within the framework of successful flight management.

We can conclude that integration of Crew Resource Management (CRM) into aviation safety culture has proven instrumental in enhancing threat and risk management across the industry. CRM focuses on optimizing the use of all available resources to manage threats and mitigate risks, thereby reducing the likelihood of errors that can lead to incidents and accidents. In modern aviation it's clear that crew resource management includes a lot of components that crew members must be familiar with, as it plays a vital role in cultivating a resilient safety culture that prioritizes threat anticipation, risk assessment, and collaborative problem-solving to ensure safer skies.

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