Culture in the Cockpit: Implications for CRM Training

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Abstract Crew resource management (CRM) is an important airline training tool that was developed in the United States and has been used to train flight crews worldwide since the 1990s. Modern CRM programs cover a wide range of skill areas, including communication, interpersonal skills and decision-making. This paper describes the evolution of CRM and its underlying cultural assumptions. CRM has been criticized for being implicitly biased towards Western culture, and there have been calls for the development of different versions "culturally calibrated" to meet the needs of target participants around the world. This paper reviews research into national cultural differences, as well as airline organizational culture and pilot professional culture, and examines the implications for CRM training. This study is relevant to all international airline flight operations, especially those involving mixed-nationality crews.

Keywords Airline training · Crew resource management · Flight crew · National culture · Organizational culture · Professional culture

1 Introduction

Awareness has grown in recent decades that many airline accidents have been at least partly caused by cultural factors [1]. For historical reasons, cultural factors form part of crew resource management (CRM), a training methodology developed in the United States and now used by airlines around the world. This paper outlines the development of CRM and the cultural assumptions informing it. Culture is inherently difficult to define, but in the words of the Federal Aviation Administration it denotes "the norms, attitudes, values, and practices that members of a nation, organization, profession, or other group of people share" [2]. In line

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with this definition, it has been suggested that the study of cultural effects in aviation be divided into three categories: national, organizational and professional culture [3]. Considerable effort has been devoted to investigating national cultural differences, and this paper examines the implications for CRM training of four sets of research that have been applied to the aviation context. The paper also reviews several studies of the organizational culture of airlines and the professional culture of pilots. The overall goal is greater understanding of how cultural factors affect interpersonal interactions on the flight deck. This is an area of increasing relevance, given the sustained growth of international airlines based in the Middle East and Asia, especially China.

2 History of CRM

2.1 Origin in the 1970s

CRM is a method of training airline crews that developed in the United States at the end of the 1970s following several accidents involving American airlines. These accidents included: the 1972 crash of Eastern Air Lines Flight 401 in the Florida Everglades; the 1977 runway collision between KLM Flight 4805 and Pan Am Flight 1736 at Tenerife; and the 1978 crash of United Airlines Flight 173 near Portland. The last of these, in which the crew were so absorbed with a landing gear problem that they did not realize the fuel was running out, is often cited as the most important trigger for the creation of CRM [4]. Each of these accidents was complex and unique, but they all featured poorly functioning teams that combined over-bearing captains with junior officers unable to clearly articulate their concerns.

In 1979, NASA organized a workshop for researchers and industry representatives to discuss the concept of flight deck resource management. In the opening presentation, chairman John Lauber reviewed relevant research: interviews conducted by NASA with airline pilots; a simulator study involving flight crews from an American airline; a study of 62 airline accidents; and a study of 250 jet transport incidents [5]. This seminal workshop addressed a very real problem, but it is important to note that most of the research focused on American flight crews. In other words, there was limited cultural diversity in the data underpinning the establishment of CRM.

2.2 Evolution Since the 1980s

Following the 1979 conference, CRM training was adopted by American airlines and subsequently spread worldwide. Many changes were made over the following decades, with the result that Maurino and Murray identified six generations in the

evolution of CRM [6]. One early development was a name change in the 1980s from Cockpit Resource Training to Crew Resource Training in order to emphasize team dynamics and interactions with personnel outside the flight deck, such as cabin crew, dispatchers and air traffic controllers (ATC). In the 1990s increased emphasis was placed on cross-cultural issues in the model developed at the University of Texas, based on organizational research conducted by Geert Hofstede. More recently, the latest manifestations of CRM have an explicit focus on managing threats and errors.

Despite these changes, the fundamental goals remain the same: to train crews in techniques that enable them to work as effective teams and avoid problematic behavior patterns identified by accident research. Modern CRM programs typically cover the following skill areas: communication/interpersonal skills; situation awareness; problem-solving/decision-making/judgment; leadership/followership; stress management; and critique [7]. In addition to aviation, CRM training has now spread to other high reliability industries such as healthcare, firefighting services, nuclear power generation, maritime and rail transport, and the offshore oil and gas industries [8].

2.3   Criticisms of CRM

In terms of its longevity and worldwide usage, CRM has undoubtedly been a success. However, two extensive reviews of studies that evaluated CRM training were unable to determine whether there was any impact on organizational safety [9, 10]. Proponents of CRM point to cases when lives were saved, most notably the 1989 crash landing of United Airlines Flight 232 at Sioux City. This aircraft's crew made a remarkable landing despite losing all flight control surfaces, with the captain later observing they would not have survived without the use of CRM techniques [11].[1]

Notwithstanding the successes, a number of limitations of CRM have been identified over the years. Criticism has included the following: early programs relied on organizational training activities with little relevance to airline operations [13]; as team dynamics became more prominent, CRM was labeled "a form of 'New Age' brainwashing aimed at achieving group harmony" [14]; the integration of CRM techniques with technical flying skill training led to increased proceduralization, reducing the focus on leadership and team building skills [15]; and the expanded range of program content obfuscated the overall goals [16].

A further persistent criticism is that CRM is implicitly biased towards Western culture [17]. In the 1980s, there was a common belief that CRM could, with minor changes, be adapted for use by any airline in the world, but this view of

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[1]An important feature of this crew, enhancing their decision-making ability under stress, was that they were very experienced and had flown together before. The captain had 29,967 flight hours with United Airlines, while the first and second officers each had 15,000–20,000 flight hours. An off-duty check airman who assisted them had 23,000 flight hours [12].

"culture-free CRM" has now been discredited [18]. Problems associated with implementation in other countries, such as the translation of specialized vocabulary and the use of feedback questionnaires on personality or working styles, were highlighted by Johnston. He cautioned that the underlying causes of aviation accidents may vary by region, and that detailed research was required before CRM was applied worldwide [19].

Criticism continues to this day. Analyzing survey data from Taiwan and accidents involving Asian airlines, Jing and Batteau concluded that CRM is underpinned by cultural values alien to Chinese society, and moreover these differences are compounded by the increasing technological complexity of modern airliners [20]. Alongside these criticisms, there have been repeated calls for the development of different versions of CRM for different regions of the world, "culturally calibrated" to the needs of target participants [21–23].

3 Differences in National Culture

3.1 Hall's "Hidden Culture"

In a career spanning most of the twentieth century, the anthropologist Edward T. Hall identified numerous ways in which culture informs human behavior. He noted that people remain largely unaware of this "hidden culture" because it operates below the level of consciousness. Discussing the relevance of Hall's research to CRM, Hisam and Hampton provided examples of how individuals from various countries act differently. American pilots, for example, soon start addressing each other using first names whereas Europeans tend to remain more formal [24]. The following paragraphs describe specific implications for CRM arising from three of Hall's concepts.

High-Context and Low-Context. Hall contrasted high-context cultures (e.g. Japan), which have deep relationships and share information using simple messages rich in meaning, with low-context cultures (e.g. America), where people are not bonded so tightly and there is less distinction between insiders and outsiders [25]. He cautioned that meetings between the two cultures could present problems. Hall applied these concepts to communication, stating that high-context communications are fast and efficient because pre-programmed information is in receivers and settings, with minimal information in messages. By contrast, low-context communications encode most of the information in messages, with very little in the internal or external contexts.

The concept of a high- or low-context *culture* is problematic because Hall stated that a *person* may have both high- and low-context aspects depending on the situation. Scollon, Scollon and Jones resolved this dilemma by proposing the concept be applied not to entire national groups, but instead to particular speech events or situations [26]. The use of standard phraseology—a set of pre-fabricated

phrases for typical flight situations—between pilots and ATC is an example of high-context communication. Considerable time must be spent training operators to use this system, but the payoff is the quick and efficient exchange of information.

It may be hypothesized that people who favor low-context communications require more extensive programming to use standard phraseology effectively. There is anecdotal evidence to support this idea. In an analysis of a radio exchange reported by Kim and Elder, experienced Korean pilots and controllers described an American pilot's "verbosity and inappropriate word choice… when phraseology would have sufficed" as "typical of native English-speaking aviation personnel" [27].

Monochronic and Polychronic Time. Hall differentiated between monochronic people, who like doing one thing at a time, and polychronic people, who prefer doing several different activities at once [28]. Interactions between the categories may again be problematic, with polychronic behavior liable to disorientate monochronic people. This has implications for flight crew composition: for example, an American (i.e. monochronic) captain and a Latin American (i.e. polychronic) first officer may approach the same set of tasks differently. In the context of international business interactions, Hall suggested that judicious office design could ameliorate problems, but at present this is not a viable option on confined flight decks [29].

Hisam and Hampton noted that monochronic people are vulnerable to interruptions [30]. In airline operations it is commonplace for disturbances, such as unexpected ATC calls, to put task completion at risk. Citing dozens of incidents in which American crews experienced disturbances, Loukopoulos, Dismukes and Barshi stressed the importance of CRM techniques for managing workload effectively [31]. Techniques for dealing with interruptions seem to be especially important for monochronic personnel, but there is no research evidence to support this. Instruments for measuring polychronicity have, though, been applied to other organizational contexts [32].

Action Chains. The action chain is a sequence of actions that two or more individuals carry out in order to complete a task. Action chains play a vital role in the cockpit both in the formulaic exchanges between pilots and ATC, and also in the form of standard operating procedures (SOPs), or written descriptions of tasks for each flight phase. Hall noted that monochronic people tend to focus on completing tasks, while polychronic people place more emphasis on maintaining good human relations [33].

Misunderstandings may occur when monochronic and polychronic people work together on the same action chain, as illustrated in the 1990 crash of Avianca Flight 052 near New York. Shortly before the crash, one of the Columbian flight crew commented that an American air traffic controller was *angry*. In his analysis of the accident, Helmreich interpreted this comment as indicating a failure to focus on the task of safely landing the plane [34]. However, a polychronic interpretation suggests the crew member was expressing concern about the human relations involved in the situation, rather than neglecting the task of landing. CRM training in interpersonal skills should at the very least raise awareness of these different cultural perspectives.

Criticism of Hall's Assumptions. Hutchins, Holder and Pérez stated that much of Hall's work was "based on rather dated and oversimplified models of the role of cultural and linguistic knowledge in thought" [35]. They warned against regarding culture as a set of "traits" exhibited by all the members of a group and stressed the importance of cultural variability within social groups. Notwithstanding these comments, which may equally be directed at many studies of national culture, researchers in aviation, intercultural communication and organizational studies continue to draw on Hall's concepts, as noted above.

3.2 Hofstede's Cultural Dimensions

The social psychologist Geert Hofstede investigated differences in national culture in a research program starting in the 1960s. Applying factor analysis to data aggregated from surveys of 88,000 workers in 66 countries, four cultural dimensions were identified and numerical values calculated for each country on each dimension [36, 37]. With easy-to-comprehend national scores, seemingly validated by the huge amount of input data, Hofstede's work has been influential in many fields including aviation. Indeed, it has been described as the third leg of the "three-legged stool upon which broad, systematic-oriented aviation safety and efficiency endeavors rest" [38].

Hofstede's Dimensions in Aviation. Using test items and methodology adapted from Hofstede, a team led by Robert Helmreich at the University of Texas conducted surveys of the attitudes of more than 8,000 airline crew in over 20 countries. They found a strong correlation with Hofstede's results for the dimensions of power distance and individualism-collectivism, with a weaker correlation for uncertainty avoidance [39]. This research fed directly into fourth-generation CRM programs in the 1990s.

Hofstede's cultural dimensions were used by Helmreich to analyze the actions of the Columbian flight crew in the aforementioned crash of Avianca Flight 052. Since Columbia scores highly in power distance—the extent to which less powerful members of organizations accept unequal power distribution—Helmreich posited that the first officer and flight engineer were reluctant to suggest alternative courses of action to the captain. Columbia is also strongly collectivist, with people defining themselves through social groups rather than as individuals, so the flight crew may have been reluctant to declare an emergency and push themselves ahead of other crews they perceived to be in similar straits. In addition, Columbia scores highly in uncertainty avoidance and therefore the crew may have preferred to continue with the initial flight plan, rather than face the ambiguity of discussing possible alternate airports [40].

Hofstede's model appears to be of particular value in making sense of accidents featuring junior officers unable to voice concerns to experienced captains, such as the Avianca 052 crash and the accidents that led to the inception of CRM. It should be noted, though, that cockpit operations typically involve dyadic or triadic

interactions, whereas Hofstede's research was based on large-scale surveys. As Hofstede himself has observed, claims made about national cultural characteristics are "common trends, but individuals may differ from them" [41].

Criticism of Hofstede's Model. Outside of aviation the limitations of Hofstede's research have been widely documented. McSweeney challenged several underlying assumptions, such as the use of limited sets of survey respondents to represent national populations, and the identification of cultural dimensions through analysis of questionnaire responses [42]. Analyzing the political subtext of Hofstede's methodology, Ailon cautioned against an uncritical application of the dimensions to other cultures [43]. In a study of multicultural work teams, Aritz and Walker raised several questions: whether Hofstede's data may be reliably applied to countries not covered by the initial surveys (such as China); whether the data are applicable to other workforces or national populations, given that the participants were sales managers and engineers; and what insights the dimensions offer into everyday intercultural interactions, such as team decision-making [44].

Within aviation, Hofstede's model was criticized by Hutchins, Holder and Pérez on numerous counts, including: the absence of data regarding intra-country variability in the dimensions; the methodology used to determine the probes; the problem of translation effects in cross-cultural surveys; and the fundamental issue of how survey responses relate to cockpit operations [45].

Hofstede responded to some of the criticism with further surveys that included East Asian participants, and with investigations of organizational culture and cultural differences within a single country. Two new cultural dimensions were identified, but the underlying methodology remained unchanged [46].

3.3 Trompenaars' Cultural Dimensions

During the 1980s and 1990s the management consultant Fons Trompenaars conducted large-scale surveys of cultural diversity in companies operating in 50 countries. From this data he developed a model with seven cultural dimensions describing relationships with people, time and the environment [47]. This model has not been incorporated into CRM programs but it has been used in a correlational study of airline accident rates and attitudes to authority [48].

Trompenaars' use of survey data to identify cultural differences is open to similar criticisms to those leveled at Hofstede's work, but a point of difference is that Trompenaars draws on business anecdotes to contextualize the dimensions in interpersonal interactions. However, Trompenaars' cultural dimensions are not conceptually distinct, and Hofstede claimed that only two could be confirmed statistically [49]. There is also overlap with other models so that, for example, Trompenaars' specific-diffuse dimension corresponds closely to Hall's concept of high- and low-context. The following paragraphs discuss implications of two of the dimensions for CRM.

Individualism-Communitarianism. Trompenaars' individualism-communitarianism is similar to Hofstede's individualism-collectivism, with both measuring the extent to which people regard themselves as individuals or part of groups. To illustrate national differences in this dimension, Trompenaars and Hampden-Turner described a "critical incident" in a factory owned by an American multinational where a Japanese worker made a "serious error" causing the loss of a production batch. After the work group accepted responsibility, the factory director—to the amazement of a Western investigator—did not try to identify or punish the errant worker because in Japanese culture the shame of letting the group down was considered punishment enough [50].

Reluctance of individuals in communitarian cultures to openly accept responsibility for errors may impact on two aspects of the error management training that forms an important part of modern CRM programs. Firstly, on the flight deck individual crew members are trained to assertively communicate problems, including errors. Secondly, inside an organization it is essential for employees to report errors as part of an effective "safety culture". It is clear that attitudes to error vary significantly, which may necessitate different CRM solutions for different cultures.

Achievement-Ascription. In achievement cultures (e.g. the United States) people are accorded status based on work performance and recent accomplishments. By contrast, in ascription cultures (e.g. Japan or China) status is accorded based on age, kinship, gender, connections and educational record. Status is thus perceived differently in different cultures, which may affect leadership and communication on the flight deck.

Status is integral to a person's authority. One of the assumptions of CRM leadership training is that captains can learn how to establish an appropriate level of authority. Ginnett described three techniques used by effective captains: establish competence in the pre-flight briefing; disavow perfection in order to allow other crew members to take responsibility; and engage the crew during the briefing and group formation process [51]. These techniques, based on NASA research with American flight crews, may prove effective in achievement cultures but less so in ascription cultures where status is not related to work performance.

If a large difference exists between the status of the captain and junior officers, then a steep authority gradient may result. This can hinder communication and decision-making, and has been identified as a causal factor in accidents such as the 1977 collision at Tenerife. CRM programs teach polite assertiveness techniques to help junior officers overcome this problem, but these may not be effective in ascription cultures where status derives from intrinsic characteristics such as age and gender.

3.4   Jing's Differentiated Order Model

In the 1990s, using a modified version of a questionnaire developed by Helmreich, Professor Hung-Sying Jing surveyed approximately 1,000 pilots and managers at

airlines in Taiwan, including a significant number of foreign pilots. The results highlighted differences between Chinese and foreign pilots in attitudes to inter-personal relations and authority. Believing these differences could not be ade-quately explained by uni-dimensional concepts such as power distance, Jing developed a framework to account for interpersonal relations and authority in Chinese culture [52].

Drawing on research by the scholar Fei Xiao-Tung, Jing outlined a differentiated order model to describe how the Chinese categorize people around them. This model has four levels of intimacy: kin, acquaintance, fellow and alien. According to the model, Chinese pilots consider that: close family are kin; other Chinese pilots are acquaintances; other Chinese workers in the same company are fellows; and foreign workers in the same company are aliens. The structure is not fixed and individuals can change level, for example by marriage or a serious falling out. To this model of interpersonal relations, Jing added a description of the Chinese concept of authoritarianism, which is dominated by the father-son relationship.

Jing's Model in Aviation. This differentiated order model has been used to analyze accidents involving Asian airlines, such as the 1995 crash of a TransAsia Airways ATR72 aircraft in Taiwan. Immediately before the crash, the captain (pilot not flying) was talking to a cabin attendant in the cockpit, which disrupted com-munications with ATC and distracted him from monitoring the aircraft's status. Jing suggested that the captain regarded the cabin attendant as an acquaintance but considered the air traffic controller to be a stranger, adding that "Every Chinese person would be inclined by instinct to attend to a friend first, not the stranger" [53]. Western pilots may consider such behavior to be a blatant dereliction of duty, but Jing's work highlights the impact that cultural factors can have on cockpit inter-actions. Interestingly, it echoes Hall's description of the emphasis placed by polychronic people on personal relations.

The circumstances of this accident were unusual: it occurred on New Year's Eve; the plane was carrying no passengers; and the captain was *junior* to the first officer in terms of their previous air force service. With regard to training, this underlines the importance—even in unusual circumstances—of adhering to rules, such as the sterile cockpit rule, which prohibits non-essential speech when flying below 10,000 ft. As noted by Hisam and Hampton, different cultures have differing interpretations of a sterile cockpit, so CRM training should be tailored accordingly [54].

Finally, regarding flight procedures, Jing and Batteau observed that Chinese pilots are conditioned by the non-linear ideographic Chinese language and therefore have difficulty following sequential SOPs. They see this as one manifestation of a systematic problem whereby Chinese pilots are not culturally programmed to use either commercial aircraft or an air transport system largely designed by Westerners [55].

4   Organizational and Professional Culture

The research strands described in the preceding section focused on national culture, but in the case of Helmreich's team at the University of Texas research extended into airline organizational culture and pilot professional culture. Organizational culture consists of observable behavior and items such as uniforms, logos and documents, as well as the beliefs, values and assumptions shared by members of the organization. Drawing on James Reason's research into accident analysis, Helmreich and Merritt stressed the importance of organizational culture to safety and cited several accidents that featured organizational culture as one of the causal factors, including the 1991 crash of Continental Express Flight 2574 following a failure in maintenance procedures [56]. The University of Texas surveys of flight crew attitudes identified positive aspects of pilot professional culture, such as high levels of motivation, and negative characteristics, such as a feeling of invulnerability [57].

In Norway Mjøs conducted a survey of pilots at three airlines and received 242 usable responses [58]. The variables included cultural indices (based on Hofstede's four original dimensions), social climate, barriers to communication, and operational problems experienced in the previous year. This survey identified differences between the airlines, with the pilots of one company—almost all from a military background—being more experienced and scoring higher on power distance and masculinity. The pilots of all three airlines had higher mean scores for individuality and masculinity than the national scores reported by Hofstede, indicating that the cultural dimensions for a *professional* group within a country may differ from the *national* characteristics.[2] This led Mjøs to caution against applying national cultural dimension data to research comparing aviation safety records in different countries.

Hutchins, Nomura and Holder reported on an ethnographic study that investigated the impact of culture on cockpit communication and interaction at three airlines in the Asia-Pacific region [59]. The study included flight deck and simulator observations, as well as interviews with airline personnel. An interesting aspect of this research is that it identified specific differences in cockpit practice (e.g. how checklists and charts were actually used) between airlines in different countries. However, since only a limited number of airlines were studied it is not clear to what extent the variation was due to *national* culture as opposed to *organizational* culture. For instance, Japanese pilots in the study annotated their charts whereas pilots from New Zealand were not allowed to do so, but it is possible that other New Zealand airlines permit chart annotation. Difficulties posed by this form of research include the need to gain access to flight decks and the requirement for expertise in a range of fields such as piloting, human factors, anthropology, language and culture.

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[2]It should be noted that this survey was conducted decades after Hofstede's data collection.

5   Conclusion

CRM training has proved enduring and successful, but its validity outside of Western cultures has been questioned and there have been repeated calls to develop "culturally calibrated" versions of CRM for different regions of the world. Hofstede's research has been incorporated into CRM programs, and it clearly has value for training Western pilots and analyzing certain types of accident. However, both the model and its applicability to aviation have been criticized. The three other models of national culture examined in this paper have not been incorporated into CRM, but each offers valuable insights into national characteristics, especially regarding differences between Americans and East Asians. Elements of each model could be incorporated into a modular CRM package, with the important proviso that cultural variability exists within national groups, as many commentators have noted.

This paper highlights the value of continued research into airline organizational culture and pilot professional culture, areas which have hitherto been under-researched. In addition, the studies presented at the 1979 NASA workshop that launched CRM were extensive, but were largely limited to American crews and are now dated. There is a pressing need for a major research effort on a similar scale but covering airlines from all major regions of the world. This should adopt a mixed methods approach to collect both quantitative and qualitative data. As well as incident and accident studies, it would incorporate modern ethnographic techniques including interviews and observations of flights and simulator training.

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