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'Best in Seminar'

By Espersion Martinez, Editor

International Cooperation and Challenges: Understanding Cross-cultural Issues is the technical paper judged to be "Best Seminar Paper" of those papers presented at the annual ISASI 2007 Singapore seminar on aviation accident investigation held in Singapore, August 27-31. Of the paper's four co-authors, two made the verbal presentation to the assembly. Presenters were Dr. Wen-Chen Li and Thomas Wang, who accepted the Award of Excellence plaque during the Awards Banquet on the last evening of the seminar. The other two co-authors are Dr. Hong T. Young and Dr. Don Harris

The award was established through an anonymous donation by an ISASI member who wished to acknowledge a paper at the annual seminar that made an outstanding contribution to the advancement of technical methodologies in aircraft accident investigation. For the first time since its inception, the "Best Paper" selection carried with it a monetary award of $500. At the award presentation, the winners announced that the $500 was being contributed to the ISASI Rudolph Kapustin Memorial Scholarship Fund, established in the memory of all deceased ISASI members.

For the ISASI 2007 selection, a judging panel was made up of four ISASI members. ISASI co-chairs of the selection panel were Dr. Graham Braithwaite and Capt. Richard Stone (Ret.). Other members were 20007 ISASI Memorial Scholarship winners Ruth Martin and Philip Gregory. The young scholars were selected in the belief that they would provide a fresh perspective to the process of evaluating technical papers based on the cited criteria and on reflecting the overall theme of the seminar "International Cooperation: From Investigation Site to ICAO."

Dick Stone commented that the criteria used for the selection were that it had to provide new methodology for accident investigation, it had to be useful for a field investigator, and the paper and graphics had to be professional. He noted that the selected paper reflects outstanding work and will add a new dimension to international accident investigation. ◆



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ABOVE: Thomas Wang (left) accepts congratulations and the award plaque from ISASI President Frank Del Gandio. Dr. Wen-Chen Li (center) beams his delight with the selection of the authors' work. RIGHT: Award of Excellence plaque presented to "Best Seminar Paper" authors.

International Cooperation and Challenges:

Understanding Cross-cultural Issues

By Wen-Chin Li, Hong-Tsu Young, Thomas Wang, and Don Harris

(In the publication of this award-winning technical paper, Forum *is departing from its usual style format and is publishing the following as a "technical paper" as accepted by the ISASI 2007 seminar technical committee.—Editor)*

Abstract

The idea that national cultural characteristics play a part in aviation safety had been suggested by Helmreich and Merritt (1998). This research involved around 45 aviation accident investigators from different cultural backgrounds and investigated attribution of causal factors in the Ueberlingen accident report through the application of the Human Factors Analysis and Classification System (Wiegmann and Shappell, 2003). Hofstede's (1991 and 2001) cultural dimensions draw a clear picture of the attributable patterns of human errors based on cultural differences. As a result, it is necessary to develop a better understanding of the differences in attribution of accident causes and contributory factors across cultures to promote both aviation safety and international cooperation for accident investigation to be achieved. Furthermore, when suggesting safety enhancements resulting from accident investigations it needs to be noted that the same remedy may not work in different cultures. Remedial actions must be "culturally congruent." This process starts with understanding the cultural factors at work in the accident investigation process itself.

Introduction

There has been a great deal of research regarding the relationship between national culture and aviation safety (e.g., Braithwaite, 2001; Helmreich and Merritt, 1998; Jing, Lu, and Peng, 2001; Lund and Aaro, 2004; Merritt and Maurino, 2004; Patankar, 2003; Rose, 2004). Culture is at the root of action; it underlies the manner by which people communicate and develop attitudes toward life. Accident investigation is supposed to be an objective exercise, but different cultures may produce different interpretations for human factors issues based upon different cultural preconceptions. In the aviation industry, pilots not only fly in foreign airspace transporting passengers around the world, but also in multicultural crews. Furthermore, according to ICAO Annex 13, the accident investigation team should include representatives from the state of the aircraft's design and manufacture, the state of the occurrence, the state of the operator, and the state in which the aircraft was registered. As a result, by its very nature, accident investigation is a multicountry, multicultural undertaking. International cooperation has always been a great challenge for accident investigation as a result of the many cultures often involved in an accident. It only requires a little imagination to demonstrate how culture may impact upon the accident investigation process. Take a hypothetical example, where an Airbus aircraft, operated by a Chinese airline, equipped with General Electric's engines crashes in Japan.

There are many definitions of culture. Kluckhohm (1951) proposed one well-known definition for culture—"culture consists

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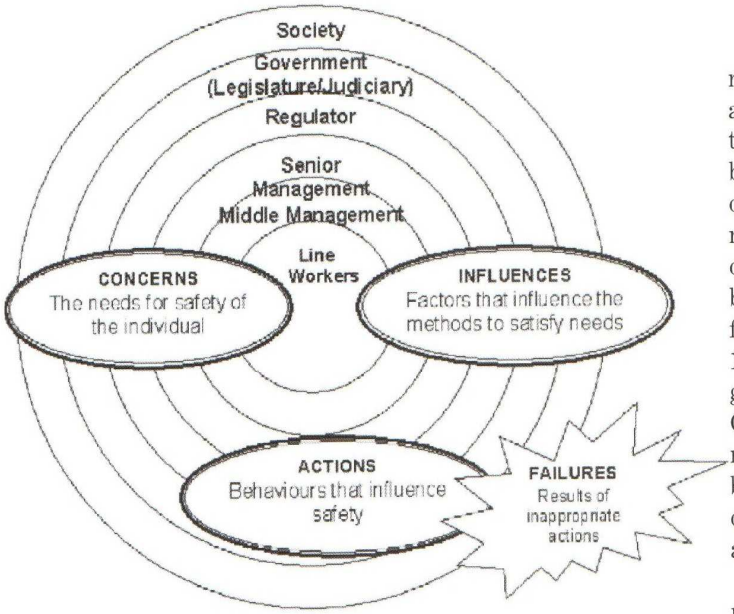


Figure 1. Layers of influence and categories comprising the Ripple Model of safety culture (Morley and Harris, 2006).

in patterned ways of thinking, feeling, and reacting, acquired and transmitted mainly by symbols constituting the distinctive achievements of human groups, including their embodiments in artifacts; the essential core of culture consist of traditional ideas and especially their attached values." If the majority of people in a society have the same way of doing things, it becomes a constituent component of that culture (Jing, Lu, and Peng, 2001). A culture is formed by its environment and evolves in response to changes in that environment; therefore, culture and context are really inseparable (Merritt and Maurino, 2004).

Cultures can be divided into different levels: families, organizations, professions, regions, and countries. The power of culture often goes unrecognized since it represents "the way we do things here." It is the natural and unquestioned mode of viewing the world as national cultural characteristics play a significant part in aviation safety (Helmreich and Merritt, 1998). Johnston (1993) suggested that regional differences have a major impact on CRM implementation and crew performance. There is a marked difference in how crew resource management (CRM) training is perceived outside the United States. In the United States, CRM is normally seen as the primary vehicle through which to address human factors issues. Other countries, notably those in Europe, see human factors and CRM as overlapping, viewing them as close but distinct relatives. Orasanu and Connolly (1993) have suggested that a great deal of decision-making occurs within an organizational context, and that the organization influences decisions directly (e.g., by stipulating standard operating procedures) and indirectly through the organization's norms and culture. Culture fashions a complex framework of national, organizational, and professional attitudes and values within which groups and individuals function.

To a certain degree, aviation human factors has been dominated by research into psychological and psycho-physiological attributes such as motor skills, visual perception, spatial abilities, and decision-making (Hawkins, 1993). This may crudely be classified as the "hardware" of human factors. However, for operating hardware, codes and instructions are required that may be referred to as the "software of the mind." This software of the mind may be considered to be an indication of culture because culture provides "a toolkit" of habits, skills, and styles from which people construct "strategies of action" (Hofstede, 1984). National cultures provide a functional blueprint for a group member's behavior, social roles, and cognitive process. Culture provides rules about safety, the basis for verbal and nonverbal communication, and guidelines for acceptable social behavior. Culture also provided cognitive tools for making sense out of the world. National culture was rooted in the physical and social ecology of the national groups (Klein, 2004).

Hofstede (1984, 1991, and 2001) proposed four dimensions of national culture:

- Power distance (PDI) focuses on the degree of equality, or inequality, between people in the country's society. In countries with a large power distance, subordinates are subordinate to their superiors. A relatively small power distance between superior and subordinate results in informal relationships and a great deal of information and discussion. If necessary, the subordinate will contradict his superior.
- Uncertainty avoidance (UAI) is the extent to which the members of a society perceive a threat in uncertain or unfamiliar situations, and the extent to which they subsequently try to avoid these situations by means of regulations and bureaucratic sanctions, among others actions. Uncertainty avoidance concerns the situations of unclearness events, preferred more predictable, and which risks are more clearly defined events.
- Individualism (IDV) focuses on the degree that society reinforces individual or collective achievement and interpersonal relationships. In a highly individualistic society, rights are paramount. Individuals in these societies may tend to form a larger number of moderately distant relationships. A society with low individualism is typical of a society of a collectivist nature with close ties between individuals.
- Masculinity (MAS) exemplifies the traditional masculine work role model of male achievement, control, and power. Expressions of this are an orientation toward competition and performance and the desire for recognition of one's performance. A highly masculine social order is one in which males dominate a significant portion of the power structure, with females being controlled by male domination. A low masculinity ranking indicates the country has a low level of differentiation and discrimination between genders. Women are treated equally to men in all aspects.

More individualist cultures show a lower probability of total-loss accidents; collectivist cultures exhibit a greater chance of accidents. A high level of uncertainty avoidance in a national

culture has also been found to be associated with a greater chance of accidents (Soeters and Boer, 2000). As aircraft have become increasingly more reliable, human performance has played a proportionately increasing role in the causation of accidents. Recently, research comparing the underlying patterns of causal factors in accidents comparing Eastern and Western cultures has suggested underlying differences attributable to culture. Using the Human Factors Analysis and Classification System (HFACS), it was observed that issues concerning inadequate supervision at higher managerial levels and a suboptimal organizational process were more likely to be implicated in accidents involving aircraft from Eastern cultures (Li, Harris, and Chen, 2007). It was suggested that small-power-distance cultures with a high degree of individualism seemed to be superior to collective, high-power-distance cultures for promoting aviation safety, especially in terms of the processes and procedures at the higher organizational levels. Such an analysis may provide additional explanatory power to elucidate why national differences in accident rates occur.

The effects of national culture have yet to be considered as part of the multinational, multicultural accident investigation process. It needs to be established if culture has an effect on the interpretation of the underlying causes of accidents as well as their causation.

Morley and Harris (2006) developed an open system model of safety culture—the Ripple Model (see Figure 1). This Model has been used to interpret the wider influences underlying several major accidents (e.g., the China Airlines 747 accident—Li and Harris, 2005; Dyrden Fokker F28 accident at Dryden—Harris, 2006). This Model identified three threads running throughout the personnel within (and without) an organization, irrespective of their level and role. These were labelled "*Concerns*," "*Influences*," and "*Actions*" and were evident in line personnel, middle management, senior management, the industry regulator, government, and society as a whole.

- Concerns *were associated with threats to the needs of the individual and worries about meeting the requirements placed on them by others.*
- Influences *were concerned with the factors that dictated the methods by which safety needs could be accomplished.*
- Actions *described the behaviors that directly impacted upon safety, in either a positive or negative manner.*

In this Model, the authors argued that elements outside an organization have a profound effect on safety culture. The boundaries for the conceptualization of safety culture must be extended beyond the organization if a comprehensive model of the evolution of safety culture is to be developed. Authors such as Merritt and Helmreich (1995) and Glendon and Stanton (2000) propose that safety culture is a subculture of organizational culture, which is itself a subculture of the industry culture, which in turn is a subculture of national culture. If attempts to separate safety culture from organizational culture are difficult enough, trying to fully separate these entities from national culture is almost impossible.

Culture has already been demonstrated to have a considerable impact upon aviation safety and accident causation; however, as alluded to earlier, the effects of national culture have yet to be considered as part of the multinational, multicultural accident investigation process. It needs to be established if culture has an effect on the interpretation of the underlying causes of accidents as well as their causation. To this end, the manner in which accident investigators from Eastern and Western (high power distance versus low power distance) cultures attributed the underlying causes of the Ueberlingen midair crash of a Boeing 757 and Tu-154 were investigated using the HFACS analytical framework.

The inter-rater reliability of HFACS has been demonstrated to be quite good both by using a simple percentage rate of agreement and Cohen's Kappa (e.g., Wiegmann and Shappell, 2001; Gaur, 2005; Li and Harris, 2005 and 2006). However, in all these cases reliability was established between two raters coding multiple accidents. In this study, a different approach is undertaken to evaluate reliability. In this case, many raters (from two different cultures—a high-power-distance and a low-power-distance culture) code a single accident.

Method

Participants

There were 29 Chinese accident investigators including pilots, air traffic controllers, airlines safety managers, and maintenance staff and 16 British accident investigators consisting of pilots, air traffic controllers, airlines safety officers, and maintenance staff.

Stimulus material

The data were derived from the narrative descriptions of accident reports occurring at Ueberling on July 1, 2002. The synopsis of the accident is as follows (BFU: AX001-1-2/02).

The investigation was carried out in accordance with the international standards and recommended practices contained in ICAO Annex 13 and the German investigation law under the responsibility of the BFU. The Kingdom of Bahrain, the Russian Federation, Switzerland, and the United States were involved in the investigation through their accredited representatives and advisers. In the first phase of the investigation, the investigation team worked simultaneously in a headquarter at the airport Friedrichshafen, at ACC Zurich, at the different accident sites in the area around the city of Ueberlingen, and at the BFU in Braunschweig. On July 1, 2002, at 21:35:32 hours, a collision between a Tupolev Tu-154M, which was on a flight from Moscow to Barcelona, and a Boeing B-757-200, on a flight from Bergamo to Brussels, occurred north of the city of Ueberlingen (Lake of Constance). Both aircraft flew according to IFR (instrument flight rules) and were under control

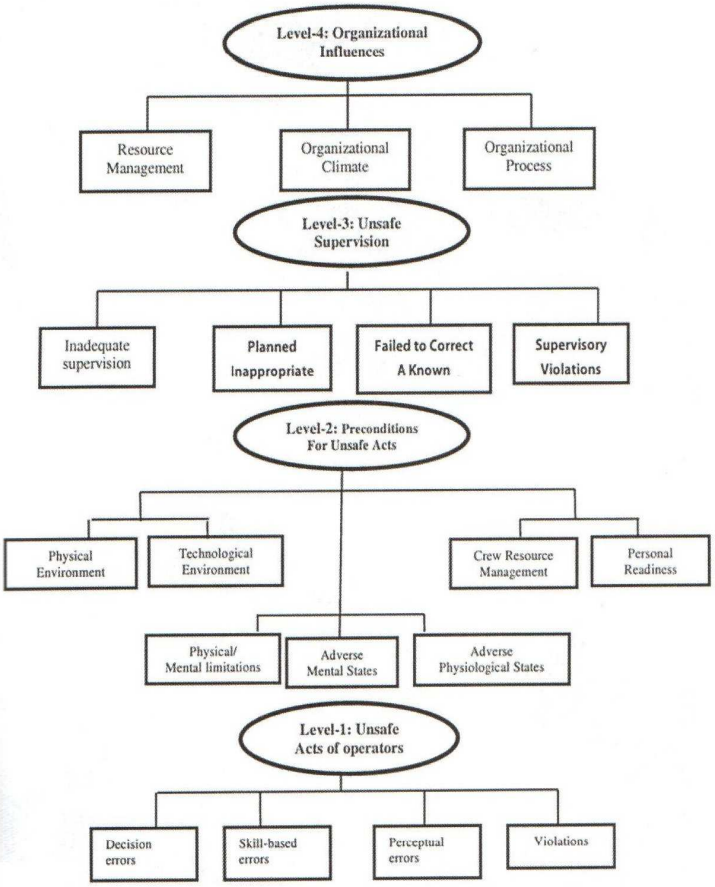


Figure 2. The HFACS framework—each upper level would affect downward level, proposed by Wiegmann and Shappell (2003).

of ACC Zurich. After the collision, both aircraft crashed into an area north of Ueberlingen. There were a total of 71 people on board the two airplanes, and none survived the crash.

The following immediate causes have been identified: (1) The imminent separation infringement was not noticed by ATC in time. The instruction for the Tu-154M to descend was given at a time when the prescribed separation to the B-757-200 could not be ensured anymore; (2) The Tu-154M crew followed the ATC instruction to descend and continued to do so even after TCAS advised them to climb. This maneuver was performed contrary to the generated TCAS RA.

The following systemic causes have been identified: (1) The integration of ACAS/TCAS II into the aviation system was insufficient and did not correspond in all points with the system philosophy. The regulations concerning ACAS/TCAS published by ICAO and as a result the regulations of national aviation authorities, operations, and procedural instructions of the TCAS manufacturer and the operators were not standardized, were incomplete, and were partially contradictory. (2) Management and quality assurance of the air navigation service company did not ensure that during the night all open workstations were continuously staffed by controllers. (3) Management and quality assurance of the air navigation service company tolerated for years that during times of low traffic flow at night only one controller worked and the other one retired to rest.

Classification framework

The Human Factors Analysis and Classification System is based upon Reason's (1990) model of human error in which active failures are associated with the performance of front-line operators in complex systems and latent failures are characterized as inadequacies or mis-specifications that might lie dormant within a system for a long time and are only triggered when combined with other factors to breach the system's defenses. HFACS was developed as an analytical framework for the investigation of the role of human factors in aviation accidents. This study used the version of the HFACS framework described in Wiegmann and Shappell (2003). The presence (coded 1) or the absence (coded 0) of each HFACS category was assessed in each category of HFACS. To avoid over-representation from any single accident, each HFACS category was counted a maximum of only once per accident. The count acted simply as an indicator of presence or absence of each of the 18 categories in the Ueberlingen accident.

The first (operational) level of HFACS classifies events under the general heading of "unsafe acts of operators." The second level of HFACS concerns "preconditions for unsafe acts." The third level is "unsafe supervision," and the fourth (and highest) organizational level of HFACS is "organizational influences." This is described diagrammatically in Figure 2.

Procedure

All participants were trained for 2 hours by an aviation human factors specialist in the use of the Human Factors Analysis and Classification System. This was followed by a debriefing and a summary of the events in the Ueberlingen midair crash. Finally, all participants received a blank form for coding their HFACS data before watching the film of Ueberling midair crash accident investigation to code the contributing factors underlying this accident.

Results and discussions

The frequency of participants indicating that a particular HFACS category was a factor in contributing to the Ueberlingen accident is given in table 1.

According to Wiegmann and Shappell (2001) and Li and Harris (2006), factors at the level of "unsafe acts of operators" were involved in 63.4% of accidents in U.S. sample and 41.1% in Taiwan; factors at the level of "preconditions for unsafe acts" were involved in 26.8% of accidents in United States and 31.3% in Taiwan; at the level of "unsafe supervision," 4.5% of causal factors were associated with accidents in United States and 12.5% in Taiwan; at the level of "organizational in-

fluences," 5.3% of causal factors were associated with accidents in United States and 15% in Taiwan. However, it is difficult to suggest with any certainty if the true explanation for the differences in the data were attributable to the U.S. data being taken from civil aviation or if it was a national, cultural difference between the United States and Taiwan.

As Hofstede (1991) pointed out, the culture of the United States is characterized as small-power-distance and individualist. Subordinates acknowledge the authority of their superiors but do not bow to it, and emphasis is firmly placed on individual initiative (and reward). This supports the findings of Wiegmann and Shappell (2001) that individual operators have greater bearing on accidents in the United States. On the other hand, in Taiwan, a high-power-distance collectivist culture, it has been found in this research that supervisory and organizational influences have a greater influence in accidents. The U.K., from which the comparison data in this study were derived, is also a low-power-distance culture (according to Hofstede's classification system).

The results in Table 1 show that at HFACS Levels 3 and 4 (the higher organizational levels) there were significant difference between the Taiwanese and U.K. sample in two categories: "Organizational Climate" and "Planned Inadequate Operations." In both cases, participants in the U.K. sample were more likely to attribute shortcomings at the organizational level than were their Taiwanese counterparts. This may reflect the differences on Hofstede's power-distance dimension, where, as a result of being a low-power distance culture, U.K. participants were more likely to be critical of higher level management than the Taiwanese participants who are more likely to defer to superiors.

According to Hofstede's classification, the Taiwanese culture is predisposed toward organizations with tall, centralized decision structures and that have a large proportion of supervisory personnel. In these cultures, subordinates expect to be told what to do. However, members of these high-power-distance cultures frequently experience role ambiguity and overload. Group decisions are preferred, but information is constrained and controlled by the hierarchy and there is resistance to change. Members of society in high-power-distance countries are also unlikely to speak out when their opinions may contradict those of their superiors. Confrontation is generally avoided. Low power distance and high individualism promote greater autonomy of action at the lower levels of an organization. The Taiwanese culture, on the other hand, which is less reactive as a result of its preferred organizational structures that discourage autonomy, is also resistant to change.

U.K. participants were also more likely to attribute "adverse mental state" as a psychological precursor to the accident, whereas the Taiwanese participants were predisposed to attributing the accident to a perceptual error (see Table 1). This may reflect some reluctance on the part of Eastern participants to utilize the category of "adverse mental state,"

	HFACS Categories	Taiwan (n=29)	U.K. (n=16)	Overall (n=45)	Chi-Square (df=1)
HFACS Level 1	Decision Error	29 (100%)	15 (93.8%)	44 (97.8%)	χ^2=0.093*; p=0.760
	Skill-Based Error	24 (82.8%)	14 (87.5%)	38 (84.4%)	χ^2=0.000*; p=1.000
	Perceptual Error	24 (82.8%)	5 (31.3%)	29 (64.4%)	χ^2=11.939; p=0.001
	Violation	20 (62.1%)	13 (81.3%)	31 (68.9%)	χ^2=0.988; p=0.320
HFACS Level 2	Adverse Mental State	15 (51.7%)	15 (98.3%)	30 (66.7%)	χ^2=8.195; p= 0.004
	Adverse Physiological State	9 (31.0%)	2 (18.2%)	11 (24.4%)	χ^2=1.046*; p=0.307
	Mental/Physical Limitation	17 (58.6%)	10 (62.5%)	27 (60.0%)	χ^2=0.000; p=1.000
	Crew Resource Management	28 (96.6%)	15 (93.8%)	43 (95.6%)	χ^2=0.000*; p=1.000
	Personal Readiness	15 (51.7%)	5 (31.3%)	20 (44.4%)	χ^2=1.751; p=0.186
	Physical Environment	11 (37.9%)	5 (31.3%)	16 (35.6%)	χ^2=0.201; p=0.654
	Technological Environment	23 (79.3%)	11 (68.8%)	34 (75.6%)	χ^2=0.182*; p=0.670
HFACS Level 3	Inadequate Supervision	25 (86.2%)	12 (86.2%)	37 (82.2%)	χ^2=0.285*; p=0.593
	Planned Inadequate Operations	12 (41.4%)	12 (75.0%)	24 (53.3%)	χ^2=4.683; p=0.030
	Failed to Correct a Known Problem	25 (86.2%)	10 (62.5%)	35 (77.8%)	χ^2=2.121*; p=0.145
	Supervisory Violation	18 (62.1%)	12 (75.0%)	30 (66.7%)	χ^2=0.776; p=0.378
HFACS Level 4	Resource Management	22 (75.9%)	13 (81.3%)	35 (77.8%)	χ^2=0.002*; p=0.967
	Organizational Climate	12 (41.4%)	12 (75.0%)	24 (53.3%)	χ^2=4.683; p=0.030
	Organizational Process	27 (93.1%)	15 (93.8%)	42 (93.3%)	χ^2=0.000*; p=1.000

Table 1. Number (and percentage) of participants who indicated an HFACS category was a factor in contributing or causing the Ueberlingen accident, broken down by country and overall. In instances where the expected cell count for one (or more) cells was less than five, Yates's correction was applied (designated by *).

which may have a certain degree of stigma attached to it. Instead, they opted to use the (perhaps) less blameworthy category of "perceptual error."

In all previous studies, the reliability of HFACS has been demonstrated using just two raters coding multiple accidents. Inter-rater reliability, calculated either by simple percentage agreement or Cohen's Kappa, has demonstrated the categorization system to be moderately highly reliable. The method for demonstrating reliability in this study, however, suggests that reliability estimated

using multiple raters and a single accident is somewhat lower. Looking at the third column in Table 1, it can be seen that the overall percentage use of each category differs across the categories. However, some care should be taken when interpreting this table.

For example, in instances where the overall count for a category was low (e.g., "Adverse Physiological States"), this was indicative of agreement across the raters that a particular category was not a factor (i.e., high rater reliability). Nevertheless, reliability calculated this way is significantly lower than that calculated the more conventional manner. However, this could be a product of either the degree of training received on the HFACS framework or the clarity of the factors in the stimulus material or HFACS itself. Further research is required to clarify this issue.

There seems to be some evidence that there are cultural differences in the manner in which participants from different cultures interpret the same factors in a sequence of events leading to an accident. This is something that investigators from different cultures need to be aware of as the same events will be interpreted quite differently by representatives from different cultures, especially when interpreting human actions.

Conclusion

There seems to be some evidence that there are cultural differences in the manner in which participants from different cultures interpret the same factors in a sequence of events leading to an accident. This is something that investigators from different cultures need to be aware of as the same events will be interpreted quite differently by representatives from different cultures, especially when interpreting human actions. This demonstrates that despite the best efforts of all concerned, there is sometimes no such thing as an objective truth when analyzing and interpreting the events leading to an accident. These cultural differences are evident in the interpretation of the influences and subsequent actions (as described in Figure 1) surrounding an accident. Investigators need to understand this when working in multicultural teams, not only when interpreting the events leading to an accident but also when suggesting remedial actions to ensure that they are congruent with the national culture of the operators. ◆

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