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Do Cultural Characteristics Affect Investigations?

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The challenge for safety is not to ignore cross-cultural issues influencing safety but to manage the potential risks they may present.

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

The collective nature of Chinese society is consistent with its broad, contextual view of the world and the Chinese belief that events are highly complex and determined by many factors. On the other hand, the individualistic nature of Western society is consistent with a focus on particular objects in isolation from their context and with Westerners' belief that they can know the rules governing objects and therefore can control that object's behavior. Westerners have a strong interest in categorization, which helps them know what rules to apply to objects, and formal logic plays a major role in problem solving.

The Chinese attend to objects within their broad context. The world seems more complex to the Chinese than to Westerners, and understanding events always requires consideration of many factors that operate in relation to one another in a complex manner. From the *I-Ching* (the ancient Chinese book of philosophy): "*For misery, happiness is leaning against it; for happiness, misery is hiding in it. Who knows whether it is misery or happiness? There is no certainty. The righteous suddenly becomes the vicious; the good suddenly becomes the bad.*" Chinese are less concerned with finding the truth than with finding a harmonious way to live in the world. In part, the Chinese failure to develop science can be attributed to a lack of curiosity, but the absence of a concept of nature would also have served to inhibit the development of science.

C. Kluckhohm proposed one well-known definition for culture: "Culture consists 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 consists 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. According to A. Merritt and D. Maurino, a culture is formed by its environment and evolves in response to changes in that environment; therefore, culture and context are really inseparable.

Commercial aviation accident rates differ among global regions. Asia has a higher accident rate (5.1 and 8.0 accidents/million departures) than either America or Europe (1–1.5 accidents/million departures). The underlying causal factors also show differences between the regions. In Asia, failures in crew resource management (CRM) are the most frequent circumstantial factor in accidents. An analysis of accidents involving aircraft from Asia (Taiwan) by Li, Harris, and Yu using the Human Factors Analysis and Classification System found that poor CRM was related to subsequent errors in decision-making, perceptual errors, and violations in procedures. These subsequent error categories showed a thirty- to fortyfold increase in their likelihood of occurrence in the presence of poor CRM.

Regional differences in accident rates have a major impact on CRM implementation and crew performance. There is a difference in how CRM training is perceived across the world. In the U.S., CRM is normally seen as the primary vehicle to address human factors issues. Other countries perceive human factors and CRM as overlapping concepts, viewing them as close but distinct relatives.

However, cultural issues in aviation operations run deeper than simply issues in CRM. They pervade all aspects of operations (including standard operating procedures) and ultimately stem from issues in design. For example, Westerners tend to adopt a function-oriented model (where stimuli are grouped in terms of their purpose) connected to a task-oriented operating concept (where specific

actions are performed to achieve well-defined results) resulting in a preference for a sequential approach to undertaking tasks (inherent in checklists and SOPs). The Asian preference is for an integrated, thematic approach (where stimuli are grouped in terms of common, generic interrelationships); hence a task-oriented operating concept contradicts their preferred method of working.

There are also fundamental differences in the mental models of people in these cultures. As mentioned previously, Westerners have a strong interest in categorization, which helps them know what rules to apply to the objects. In contrast, the Chinese believe in constantly changing circumstances; they pay attention to a wide range of events and search for relationships between things. The Chinese think you can't understand the part without understanding the whole. Westerners apply a logical and scientific approach and occupy a simpler, more deterministic world. Westerners focus on salient objects instead of the larger picture,

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and they think they can control events because they know the rules that govern the behavior of objects. The Chinese are disinclined to use precisely defined terms or categories in many areas but instead use expressive, metaphoric language, e.g., "painting a dragon and dotting its eyes" (means hit the point). From the *Tao Te Ching*, *"The heavy is the root of the light; the unmoved is the source of all movement; to shrink something, you need to expand it first; to weaken something, you need to strengthen it first; to abolish something, you need to flourish first."* The dialectical thought of the Chinese Yin-Yang principle is in some ways the opposite of Western-style logical thought. It seeks not to decontextualize but to see things in their appropriate contexts. Chinese believe that what seems to be true may be the opposite of what it seems to be. However, from a Western viewpoint, the Chinese seem to not only lack logic but to even deliberately apply principles of contradiction.

There is an interesting issue that results from these differences between cultures and regions. Culture is not just about the superficial, observable differences between counties, their food, their style of clothes, and even their languages. There are some fundamental cognitive differences in reasoning, organization of knowledge, structures of causal inference, and attention and perception between Eastern and Western cultures. These issues manifest themselves in the following manner. Westerners are likely to overlook the influence of the wider context on the behavior of objects and even of people. However, Asian cultures are more susceptible to "hindsight bias." Westerners



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HFACS Category		United Kingdom N=16		Taiwan N=16		Chi Square df = 1	
		Frequency	Percentage	Frequency	Percentage	Value	p
Level-4 Organizational Influences	Organizational process	15	93.8	11	68.8	3.29	<0.10
	Organizational climate	12	75.0	8	50.0	2.13	N/S
	Resource management	13	81.3	10	62.5	1.39	N/S
Level-3 Unsafe Supervision	Supervisory violation	12	75.0	12	75.0	0.00	N/S
	Failed to correct a known problem	10	62.5	13	81.3	1.39	N/S
	Planned inadequate operations	12	75.0	9	56.3	1.24	N/S
	Inadequate supervision	12	75.0	8	50.0	2.13	N/S
Level-2 Preconditions for Unsafe Acts	Technology environment	11	68.8	14	87.5	1.64	N/S
	Physical environment	5	31.3	5	31.3	0.00	N/S
	Personal readiness	5	31.3	8	50.0	1.16	N/S
	Crew resource management	15	93.8	15	93.8	0.00	N/S
	Physical/mental limitation	10	62.5	9	56.3	0.13	N/S
	Adverse physiological states	2	12.5	1	6.3	0.36	N/S
	Adverse mental states	15	93.8	6	37.5	11.22	<0.001
Level-1 Unsafe Acts of Operators	Violations	13	81.3	11	68.8	0.67	N/S
	Perceptual errors	5	31.3	11	68.8	4.50	<0.05
	Skilled-based errors	14	87.5	11	68.8	1.64	N/S
	Decision errors	15	93.8	15	93.8	0.00	N/S

Table 1. Frequency and Percentage Counts of Causal Factors Deemed as Being Present in the Ueberlingen Accident in the HFACS Framework Broken Down by Eastern and Western Investigators

are more likely to apply formal logic when reasoning about events, but Easterners are more willing to entertain apparently contradictory propositions.

Do differing cognitive styles matter?

The aim of this research on which this article is based was to establish if the different cognitive styles of European and Chinese accident investigators have an effect on the conclusions drawn when conducting an accident investigation.

Participants—The participants in the study were 16 Chinese (Taiwanese) accident investigators and 16 British accident investigators. As much as possible, the participants were matched for experience. They had a background as pilots, air traffic controllers, airline safety officers, and maintenance staff.

Data—The research data were based on the narrative descriptions from the Ueberlingen accident report (BFU: AX001-1-2/02) occurring on July 1, 2002.

Analytical tool—The Human Factors Analysis and Classification System (HFACS, Wiegmann and Shappell, 2003) was used as a basis upon which to classify the factors in the accident. HFACS 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. Latent failures are characterized as inadequacies or mis-specifications that lie dormant within a system for a long time and are only triggered when combined with other factors to breach the system's defenses. 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."

Research design—All participants were trained for 2 hours by an aviation human factors specialist in the use of the HFACS. This was followed by a debriefing sessions, then a summary of the events in the Ueberlingen mid-air crash was presented. All the participants then received a blank form to code their HFACS data to classify the contributing factors underlying this accident. This study used the version of the HFACS framework described in Wiegmann and Shappell (2003). The presence (coded 1) or absence (coded 0) of accident factors falling within each HFACS category was assessed by the investigators. To avoid overrepresentation from any single accident, each HFACS category was counted a maximum of only once per accident. Thus, this count acted simply as an indicator of presence or absence of each of the 18 categories in the Ueberlingen accident.

Differences in the frequency of use of each HFACS category by Chinese and British investigators were examined using a chi-square (χ^2) test of association. Further analyses examining the association between the categories in higher and lower levels of the HFACS framework were also performed. As there is no identifiable dependent or independent variable in a χ^2 test of association, these analyses were supplemented with further analyses using Guttmann and Kruskal's tau (χ), which was used to calculate the proportional reduction in error (PRE).

Results and discussion

The results of frequencies and percentages of HFACS categories used by Chinese and British investigators when analyzing the Ueberlingen accident are shown in Table 1. In general, there were few significant differences in the frequency of use of the HFACS categories between British and Chinese accident investigators. The only significant differences were related to the frequency of use of the categories concerned with "adverse mental state" (HFACS Level-2) and "perceptual error" (Level-1). As has been noted previously, UK investigators were more likely to attribute "adverse mental state" as a psychological precursor to the accident, and the Taiwanese participants were more predisposed to attributing the accident to a "perceptual error." This may reflect reluctance on the part of Eastern participants to utilize the category of "adverse mental state" as it possibly has a degree of stigma attached to it. Chinese investigators may have opted to use the less blameworthy category of "perceptual error."

However, there are interesting findings with regard to the different patterns of causality between the different levels of the HFACS analyses between the Chinese investigators and British investigators. Using the analytical methodology described in W-C. Li and D. Harris's *Pilot Error and Its Relationship with Higher Organizational Levels: HFACS Analysis*

Data from Eastern Participants (Taiwan)	Pearson Chi-square test			Goodman & Kruskal Tau		Odds ratio
	Value	df	P	Value	p	Value
Organizational process * Inadequate Supervision	7.27	1	.002	.46	.009	NS
Organizational climate * Supervisory violation	5.33	1	.021	.33	.025	NS
Organizational climate * Planned inadequate operations	6.35	1	.012	.40	.015	21.00
Organizational climate * Inadequate Supervision	16.00	1	.000	1.00	.000	NS
Resource Management * Inadequate Supervision	9.60	1	.002	.60	.003	NS
Supervisory violation * Personal readiness	5.33	1	.021	.33	.025	NS
Planned inadequate operations * Personal readiness	6.40	1	.012	.40	.015	21.00
Inadequate Supervision * Physical environment	7.27	1	.007	.46	.009	NS
Inadequate Supervision * Personal readiness	9.00	1	.003	.56	.004	49.00
Inadequate Supervision * Physical/mental limitation	6.35	1	.012	.40	.015	21.00
Technology environment * Perceptual errors	5.03	1	.025	.31	.030	NS
Technology environment * Decision errors	7.74	1	.006	.47	.008	NS
Personal readiness * Perceptual errors	7.27	1	.007	.46	.009	NS
Physical/mental limitation * Skill-based errors	3.88	1	.049	.24	.050	10.667

Table 2. Chi-square Test of Association, Goodman and Kruskal's Tau and Odds Ratios Summarizing Significant Associations Between Categories of HFACS Framework for Chinese Investigators

Data from Western Participants (United Kingdom)	Pearson Chi-square test			Goodman & Kruskal Tau		Odds ratio
	Value	df	P	Value	p	Value
Planned inappropriate operations *Technology environment	4.75	1	.029	.30	.025	15.00
Personal readiness * Skill-based errors	5.03	1	.025	.31	.030	NC
Adverse physiological states * Perceptual errors	5.03	1	.025	.31	.030	NC
Adverse mental states * Decision errors	16.00	1	.000	1.00	.000	NC
Adverse mental states * Violations	4.62	1	.032	.29	.037	NC

NC: *Not computed due to a zero frequency in one cell of the contingency table*

Table 3. Chi-square Test of Association, Goodman and Kruskal's Tau and Odds Ratios Summarizing Significant Associations Between Categories of HFACS Framework for British Investigators

of 523 Accidents (2006) and Li, Harris, and Yu's *Routes to Failure: Analysis of 41 Civil Aviation Accidents from the Republic of China Using the Human Factors Analysis and Classification System* (2008) to analyze the relationships between HFACS categories, the data sets from the Chinese and British investigators were analyzed separately. The results of the Chi-square, Goodman and Kruskal's tau and odds ratios for the Chinese investigators, are given in Table 2; the results for the British investigators are given in Table 3. These results are also depicted graphically in Figures 1 and 2, respectively.

What is noticeable is that there are differences in the pattern of results described by Goodman and Kruskal's tau between the investigators from Britain and China. Goodman and Kruskal's tau has the advantage of being a directional statistic. In the analyses described in Tables 2 and 3 (and Figures 1 and 2), the lower-level categories in the HFACS were designated as being dependent upon prior actions in the categories at the immediately higher level in the framework, which is congruent with the theoretical assumptions underlying HFACS. The value for tau in these tables indicates the strength of the relationship, with the higher levels in the HFACS being deemed to influence (cause) changes at the lower organizational levels, thus going beyond what may be deemed a simple test of co-occurrence between categories, which is the basis of the simple χ^2 test of association.

There were 14 pairs of HFACS categories in adjacent organizational levels that had significant associations between causal factors in the Ueberlingen accident based on the analysis provided by Chinese investigators. Further examination of Goodman and Kruskal's tau showed five significant associations between categories at Level-4 and Level-3, five significant associations between categories at Level-3 and Level-2, and four significant associations between categories at Level-2 and Level-1 (see Figure 1). There are also five pairs of associations between categories that had a high odds ratio. These suggested that "poor operational practices" were more than 21 times more likely to occur when associated with poor higher levels of "organizational climate." For the Chinese investigators, the highest odds ratio was for "personal readiness," which was 49 times more likely to occur in the accident sequence when associated with "inadequate supervision" (see Table 2).

There were five pairs of HFACS categories in adjacent organizational levels that had significant associations between causal factors in the Ueberlingen accident based upon the data provided by British investigators. There were no significant associations of categories between HFACS Level-4 and Level-3, one significant association between categories at Level-3 and Level-2, and four significant associations between categories at Level-2 and Level-1 (see Figure 2). Furthermore, from the analyses performed by the British investigators, there was only one pair of association between categories that had a high odds ratio. This suggested that the problem of "technology environment" was more than 15 times more likely to occur when associated with "planned inadequate operations" (see Table 3).

This pattern of associations described diagrammatically in Figures 1 and 2 may reflect the different cognitive styles of Eastern and Western accident investigators, who are in turn products of their respective cultures. For Eastern investigators, many categories were associated with each other reflecting a predisposition for a holistic understanding of the events in their wider context.

However, the British (Western) accident investigators preferred patterns of explanation that ultimately lead directly to the accident event. Focus was on specific objects (categories). The decontextualization and object emphasis favored by

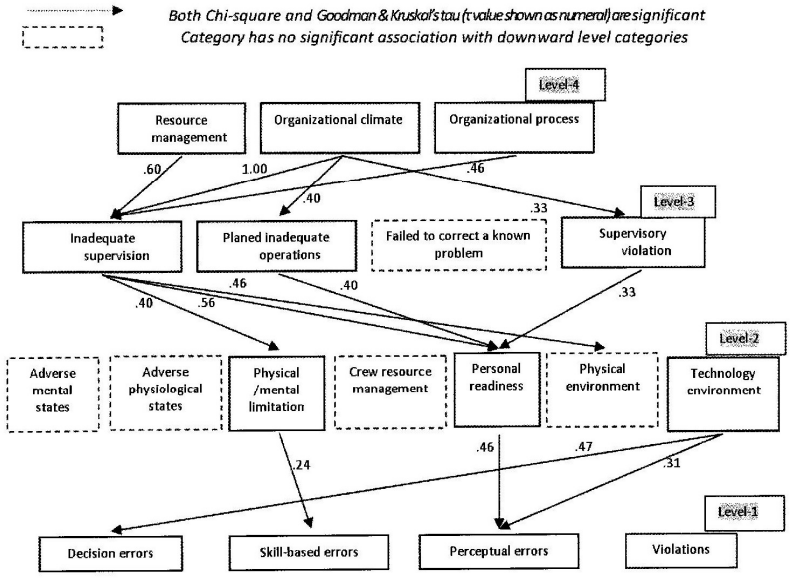


Figure 1. Significant association of causal factors for the Ueberlingen accident at the four levels of the HFACS framework as categorized by Eastern (Taiwanese) aircraft accident investigators.

Westerners and the integration and focus on many complex relationships by Easterners resulted in very different ways of making inferences about the accident, as was evident in the patterns of associations depicted in Figures 1 and 2. These may reflect the fundamental differences between Chinese and Western minds.

In terms of patterns of attention and perception, Eastern cultures attend more to the environment; people from Western cultures attend more to objects. In science and technology, Western truth stimulated analytic thinking, whereas Eastern virtue led to synthetic thinking. Through these different logics, Eastern and Western people followed different paths in developing government and in developing their respective science and technology. This analysis further demonstrates that people from different cultures differ in cognition in ways that result in different perceptions, judgments, and decisions concerning the factors at play in the sequence of events in an accident.

As a result, it is argued that Chinese investigators will be predisposed to approaching accident investigation in a holistic manner, attempting to understand the complex relationship of causal factors leading to an accident. The Chinese conviction about the fundamental relatedness of all things made it obvious to them that objects are altered by context. Trying to categorize objects with exactness would not have seemed to be of much help in comprehending events. The world was simply too complex for categories for understanding objects or controlling them. The Chinese might be right about the importance of the field to understanding the behavior of the object and they might be right about complexity, but their lack of interest in categories prevented them from discovering laws that really were capable of explaining classes of events.

As H. Nakamura in *Ways of Thinking of Eastern Peoples: India, China, Tibet, Japan* (2003) noted, the Chinese advances reflected a genius for practicality, not a penchant for scientific theory and investigation. The process of accident investigation is almost akin to a Western notion of art. British (Western) investigators are more predisposed to approaching accident investigation (and human behavior) using rules of logic. Accident investigation is almost a scientific process.

When Western engineers develop flight operation systems, training manuals, and standard operation procedures, they integrate their own vision of the world, which itself is heavily influenced by their cultural norms. They implicitly assume that all users around the world share their reasoning and values. H.A. Klein in *Cognition in Natural Settings: The Cultural Lens Model* (2004) observed that people from different nations differ in their cognition in ways that result in dissimilar perceptions, judgments, and decision-making. National culture provides a fundamental basis for a group member's behavior, social roles, and cognitive processes. A frequently used example is that Western copilots (British) from a low power distance culture are more likely to question the actions of their captains. However, copilots from Eastern (China) high power distance countries dare not to speak out when their opinions may contradict their captain.

According to G. Hofstede's classification of national culture, the working environments of Taiwan prefer tall organizational pyramids with centralized decision structures and have a large proportion of supervisory personnel. In these cultures, subordinates expect to be told what to do. However, members of these cultures frequently experience role ambiguity and overload. In general, group decisions are preferred but information is constrained and controlled by the hierarchy and there is resistance to change.

On the other hand, the working envi-

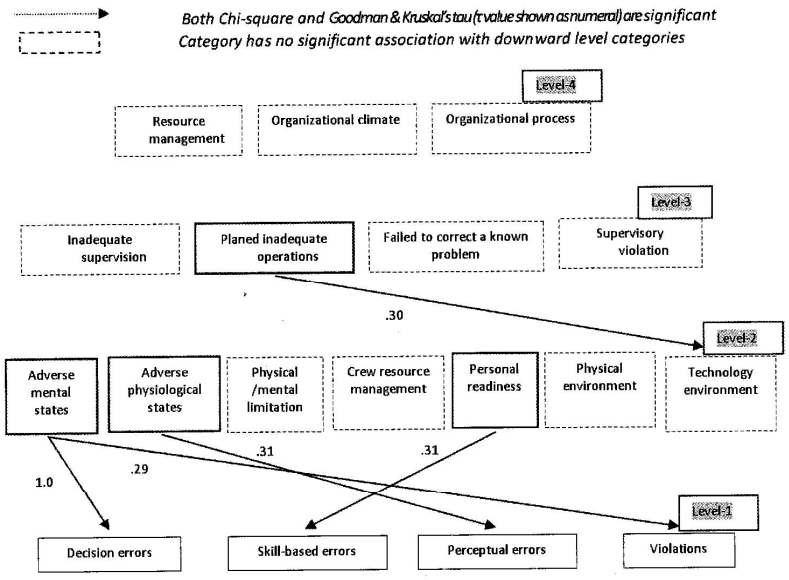


Figure 2. Significant association of causal factors for the Ueberlingen accident at the HFACS framework as categorized by Western (British) aircraft accident investigators.

ronment of the UK exhibits low power distance and is a culture high on individualism. Flat organizational structures are preferred with a relatively small proportion of supervisory personnel. Subordinates expect to be consulted. Self-orientation and identity is based on the individual, and individual decisions are regarded as being superior.

The design of the aircraft, the management procedures, and the nature of safety regulation all have a strong Western influence. So it is not too surprising that a Western country comes out better when using the HFACS to analyze the underlying causes of accidents. However, it could even be argued that the accident analysis system itself has an implicit cultural bias within it. The way Chinese investigators and British investigators attribute the causal factors at play in the same accident seems to be completely different. A simple frequency count of the categories used by accident investigators would seem to suggest that there is no difference between investigators from the two cultures. However, when the underlying causality between categories at different levels of HFACS is analyzed, a completely different pattern emerges between Eastern and Western investigators. It is difficult to say that either of these views is either right or wrong. You may only conclude that they are different. Global aviation is strongly influenced by Western mindsets; however, the challenge for safety is not to ignore these cross-cultural issues influencing safety but to manage the potential risks they may present. The ultimate purpose of accident investigation is to find the best approach for accident prevention strategies around the world. This may require local, culturally congruent solutions, not the universal solutions currently being pursued in many cases.

Conclusion

Separating the people from the problem assumes an individualist value set underlying the Western approach to investigation. In collectivist cultures, where relationships prevail over tasks, this is an almost impossible demand. Effective investigation of aviation accidents within different cultural contexts demands insight into the range of cultural values to be expected among partners from other countries, in addition to an awareness of the investigator's own culturally determined values. Effective international investigations also demand language and communication skills to guarantee that the messages sent to the other professional investigators from different cultures with different approaches to accident investigation will be understood in the way they were meant to be.

The global interaction between different cultures involves sharing the values of all partners. It is important to know more about the similarities and differences in culture-influenced accident investigation philosophies, e.g., when European and Asian culture collaborate together. The cognitive orientation and mechanisms of Eastern and Western cultures are sufficiently different that they may draw completely different inferences from the same set of data (as in this case), especially in the case where human factors are concerned. The best approach may be to try to understand the events in the accident from the viewpoint of the culture of the pilots/airline involved in the accident and not from the cultural viewpoint of the investigator. This way there might be a better chance that culturally congruent remedial actions can be proposed. However, by better understanding these cultural differences it seems highly likely that they can only serve to complement and enrich each other.

There is no one "objective" truth to any accident investigation. Whether we realize it or not, all conclusions (and the process by which we reach them) are deeply influenced by our culture. ◆



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