BEYOND THE WEST: CULTURAL GAPS IN AVIATION HUMAN FACTORS RESEARCH

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The majority of aviation human factors research today is conducted by institutions in North America and Western Europe. As such, much of this research has centered on U.S. and European operations and operators. Consequently, knowledge about behavior, human-computer interaction, cognition, and decision making are typically sourced from operators in Western cultures.

There is evidence that shows pilots from non-Western countries have different attitudes and expectations towards crewmembers' responsibilities and roles. Moreover, researchers have found significant differences in cognition and behavior between those from non-Western and Western cultures. With the growth in global air traffic, the frequency of multicultural interactions between and among pilots and air traffic controllers will increase. These differences will have global implications for training, safety and communications in aviation operations.

INTRODUCTION

Much of aviation human factors research has been driven by the need to ensure safety while maintaining the efficiency of flight operations. With the volume of flight operations placing renewed demands on the airspace capacity of North America and Europe, it is logical that human factors research has focused on the performance of humans who operate in the world's busiest airspaces.

However, the growth in aviation operations is now accelerating in areas outside of North America and Western Europe. International Air Transport Association (IATA) predicts the greatest growth in global passenger and freight traffic over the next 4 years will be from flights to and from Asia-Pacific, Europe and the Middle East (IATA, 2004). As such, the expansion of air traffic from these regions leads researchers to review their notions about the universal applicability of current aviation human factors research.

There is evidence that shows differences in cognitive processing, decision making, communication styles and social expectations between Westerners and non-Westerners. It is likely that these differences can lead to new avenues that address issues in human-systems interaction, communications, decision support and crew interaction. Therefore, some assumptions in current human factors research should be reexamined to gain a greater and more holistic understanding of human factors and human performance on a global scale. Variances in approaches to cognition, group behavior, decision making and human performance should be addressed to assure the safety, efficiency, and integration of global aviation operations in an increasingly interconnected world.

Growth of Global Air Traffic

From the IATA (2004) forecasts, the three fastest growing passenger markets over the next four years will be the routes within Asia-Pacific, Europe - Middle East and Europe - Asia-Pacific. Significantly, the volume of passenger traffic within Asia is forecast to grow at a rate of 8.3% p. a. over the next 4 years. In 2004, passenger traffic in this region grew by 19.5%.

Concurrently, Asia is also the world's fastest growing region for international freight. The Europe-Asia freight market is expected to grow at 7% per annum between 2004-2008 while the Europe-Middle East and intra Asia-Pacific markets are expected to grow at 6.1% per annum during this same period (see Figure 1).

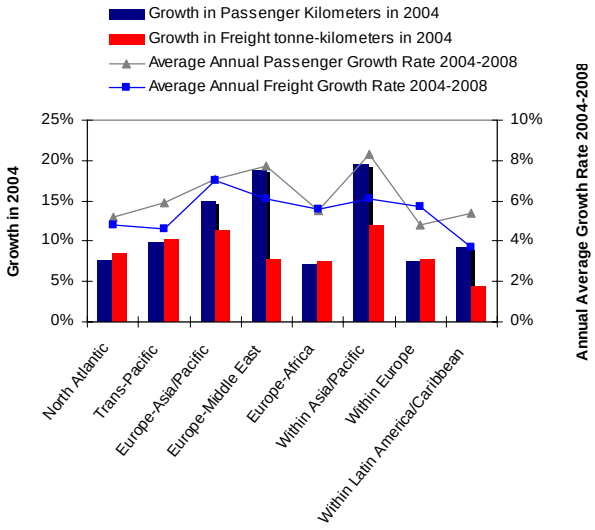

Figure 1. Air traffic forecasts predicts Asia-Pacific to be the world's fastest growing region over the next four years. Source: International Air Transport Association.

Asia's economic rise—in particular, China, India, Vietnam, Malaysia and Thailand—and a proliferation of low cost carriers (LCCs) have enabled Asians to fly in much greater numbers. As such, over the past 5 years, at least 15 low cost carriers have entered the Asia-Pacific airline market; and the number is still growing.

Safety

Aviation safety is not specific to any particular region. It affects not only those crews from airlines in the region, but all airline crews. Increased traffic flows will see European and American pilots increasing their presence in Asian airspace; Asian pilots, too, will increase their operations, mainly to Europe and across the Pacific.

Europe and the U.S. have long been faced with the challenge of maintaining safety while traffic levels—despite a few years of negative growth—have continuously increased. Low accident rates have been achieved through strict regulatory oversight, a robust aviation infrastructure, implementation of decision support technologies (e.g., ground radar) and the application of knowledge gained from research into new operational procedures (e.g., free flight). However, in Asia and the Middle East where some states have less sophisticated aviation infrastructure, oversight and resources, the National Aviation Authorities (NAA) have just begun to face the challenges of accommodating a fast-growing aviation industry. Some NAAs have implemented new technologies and training for their operators. Other regional stakeholders, such as India, Indonesia and China, are in the midst of modernizing their civil aviation infrastructure (Centre for Asia Pacific Aviation, 2004).

Because of the growth of air traffic within Asia and between Asia-Europe, the procedures and dynamics of mono- and multicultural-crew interactions and air-ground communications require further attention. To date, 42% of all regularly scheduled flights originated in North America and 28% originated in Europe—only 17% of departures originated in Asia. However, over a 10-year period (1992-2001), the majority (26.8%) of aircraft accidents involved airlines from Asia-Pacific operating within the Asia-Pacific region (see Figure 2) (Aviation Safety Network, 2005).

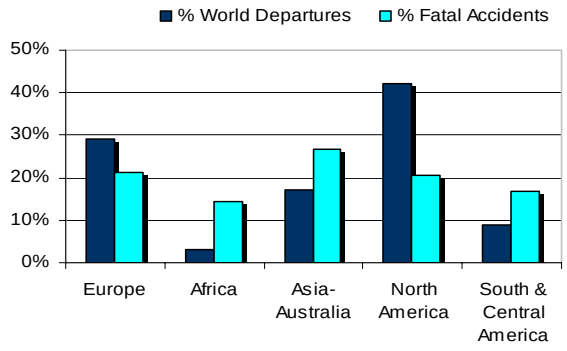

Figure 2. Accident rates around world (over 10 years) are disproportionate to departure rates. Source: Aviation Safety Network

Accident rates are influenced by the degree of regulatory oversight and aviation infrastructure present in a region. In a comparison of worldwide accident rates of air cargo operators, Roelen, Pikaar, and Ovaa (2000) found the most significant contributor to accidents, particularly in developing countries, is a lack of financial resources. However, an improved understanding of human factors issues such as organizational culture, crew communications, safety management and training can contribute to safer operations despite infrastructure shortfalls.

CULTURE & HUMAN FACTORS

Culture is the behavior, customs, values, language and beliefs of a social group. Individuals inherently adapt behavioral traits and socialization skills learned from immersion in large and small groups. However, it is critical that researchers understand the importance of recognizing national culture as a variable, and not an agent for predicting aviation safety performance.

It should also be noted that there is no correlation between national culture and the state of aviation safety. Rather, the standard of infrastructure and regulatory oversight have been shown to directly affect accident rates, particularly in Africa (IATA, 2003; Roelen, Pikaar, & Ovaa, 2000). Aviation safety is the product of not only national culture, but also organizational and professional cultures. Underpinning these elements is the technical infrastructure and regulatory oversight of each country and/or continent. Thus, the safety record of a region is reliant on the interactions of many dependent elements—both tangible and abstract—in the aviation environment.

In an analysis of behavior and performance in the medical and aviation domains, Helmreich and Merritt (1998) regarded the notion of equating accident rates with national culture, as being not only simplistic, but also ethnocentric. Nonetheless, comparative aviation human factors research across national cultures could yield results that are significant for an improved understanding of human-automation interaction, communication, intent information and crew resource management (CRM) practices.

Research to Date

In a Flight Management Attitudes Questionnaire (FMAQ), Helmreich and Merritt (1998) evaluated responses from 15000 pilots in 23 countries along the four dimensions: Power Distance, Individualism-Collectivism, Masculinity-Femininity, and Uncertainty Avoidance. They found that U.S., Australian and British pilots tended to identify with individualistic attitudes whereas pilots from Malaysia, Korea and Taiwan tended towards collectivist attitudes. Despite the collectivist attitude, Taiwanese and Korean pilots preferred relationships where an authority figure conferred with subordinates about decisions. However, most of these pilots stated they operated in cockpits that were authoritarian in nature and the captain had sole discretion in making decisions.

Hutchins, Holder and Pérez (2002), in their analysis of culture and the cockpit, point out that the approach of Helmreich and Merritt (1998) fails to account for intra-

cultural variability and as such, the tendencies of national cultures are oversimplified. Rather, Hutchins' (1995) distributed cognition approach analyzes culture and cognition by evaluating not only the tools and expertise employed by the internal knowledge of crews, but also how an environment is organized so to support cognitive tasks.

In this vein, in an effort to better understand the role of culture and cognition in the cockpit, Fischer & Orasanu (1999) examined the interactions and communication styles of U.S. and European pilots, and male and female pilots. Significantly, the results reflect a limited degree of cultural diversity—that of Western pilots. As such, the results can only be inferred onto the wider Western population. Indeed, it is possible that the results could be different in cockpits managed by non-Western crews. Below are a few examples of human factors research and the national culture of the population used in the human-in-the-loop simulation or taxonomy development. The research, if replicated on non-Western pilots and controllers, may yield different results.

Examples of Aviation HF Research Domains	Non-Western Crews/Controllers	U.S. / European Crews/Controllers
Fischer & Orasanu (1999) *Cultural Diversity and Crew Communication*		✓
Isaac & Pounds (2001) *Taxonomy for analyzing human errors in ATM*		✓
Farley, Hansman, Endsley, Amonlirdviman & Vigeant-Langlois (1998) *Effect of Shared Information on Pilot/Controller Situation Awareness and Re-route Negotiation*		✓
Kramer, Prinzel, Bailey & Arthur (2003) *Synthetic Vision Enhances Situation Awareness and RNP Capabilities for Terrain-Challenged Approaches*		✓

Figure 3. A review of a random sample aviation human factors research found that all experimental participants were from the U.S. or Europe.

The influence of national culture on performance in the cockpit has also been addressed by Yong (2003). In an overview of the Taiwanese civil aviation authority, Yong discusses the training procedures for pilots and the prevalent national and organizational cultures. One significant point was the attitude towards the distribution of power in the cockpit—first officers are hesitant about expressing disagreement with their captains. This is not surprising since the Taiwanese national culture is heavily influenced by Confucian teachings that advocate harmony, and a respect for elders and those with higher rank.

DIFFERENCES IN COGNITION

With respect to the differences between Eastern and Western cognition and reasoning, Nisbett (2003) integrates cultural evolution, philosophy, and social values with cognition and linguistic development. He also highlights:

1. The fundamental differences between Aristotelian logic (from which the scientific method is derived) and Confucian philosophy.

2. The contrasting attitudes of the individualistic Americans against the more collectivist and hierarchical structure of East Asian cultures.

3. The contrasting perspectives and worldviews between Westerners and East Asians. East Asians have been found to perceive the world as a complex and constantly changing place while Westerners tend to have a deeper belief in their ability to control their situation.

Nisbett's (2003) research supports the results from Helmreich and Merritt's (1998) FMAQ study where American, Australian and British pilots had the lowest scores when ranking the power distance (the degree to which individuals accept relationships with uneven power distribution) of their cockpit operations. These results underscore an individualistic rather than collectivist attitude to crew communications. Cockpits with high power distance tend to have First Officers who are reluctant to point out errors or omissions to their Captains due to the respect for those with higher status. The results are also supported by the results from Fischer and Orasanu's (1999) study of crew communication styles and crew diversity. They found European and American pilots had similar status preferences and also European first officers were more likely to issue commands and to use self-directives than their American counterparts. A similar study comparing the communication styles of East Asian and Middle Eastern pilots with American and West European pilots may yield interesting results.

The Perceptual Field

To test for differences in information processing between Eastern and Western populations, Masuda and Nisbett (2001) conducted an experiment whereby a group of American students and a group of Japanese students were

shown a short film clip of fish in a tank. The students were then asked to describe the scene. The results were surprising. The American and Japanese students made a similar number of references to the focal fish, but the Japanese students commented 60% more often about the background elements (e.g. color of the water, rocks).

In another study, students were shown a series of objects against different backgrounds and were asked to identify which objects had already been viewed. This time, the American students were much more successful at identifying objects; conversely, Japanese students found this task to be quite difficult. In the short-term memory of the Japanese students, the objects were integrated with the background. As such, it became more difficult to remember the foreground object separately.

This study underscores a key theme: there are salient differences in the cognitive processes and reasoning of East Asians and Westerners. East Asians tend to take a more holistic approach while Westerners tend to view the world as being composed of separate parts. Each of these approaches have their pros and cons.

One advantage of having a more holistic perspective is the improved ability to appreciate relationships between disparate parts. Moreover, the individuals have a more natural tendency to consider events and information in context. However, there is a diminished ability to simplify and appreciate a single object or piece of information separately from the greater whole. Thus, the ability to create novel solutions from parts of other systems is diminished. In situations where a novel event or uncertain situation (e.g., engine shutdown) requires quick problem solving, there may be significant differences in the communication, situation awareness, and behavior of the crew.

Risk Seeking

Different perceptions of risk have been found between Western and Eastern populations too. However, the degree of risk taken depended on the activity. In a series of experiments comparing the risk behaviors of American and Chinese groups, the Chinese population exhibited more risk-seeking behavior than the American population when it came to financial decisions. However, when it came to risk in the social domain, their behaviors reversed (Nisbett and Norenzayan, 2002). The differences in risk-seeking behavior between population groups have implications for the development of safety training programs.

Communications

The clear communication of intent information is critical for safe operations. For this reason, the International Civil Aviation Organization (ICAO) has mandated that pilots and controllers who are involved with international operations be rated for English proficiency (Mathews, 2004). However, the ability to speak a language proficiently does not always result in the message being interpreted with the same meaning by both parties. In each conversation, there is implicit and explicit information.

In his study of national culture and crew resource management (CRM), Hayward (1997) compared the implicit meanings present in language despite the same explicit communication. For example, the word *yes* to a Westerner is an acknowledgment and agreement with another party. However, the same word, to an East Asian can be just an acknowledgement without any intent to express agreement. Misunderstandings of implicit information can have serious consequences for aviation safety and can lead to faulty situation awareness and strategic planning. Proficiency in English is thereby only one hurdle to creating commonalities in aviation communications. An understanding of implicit and explicit meanings across communication corridors may serve to prevent future incidents and accidents.

HUMAN FACTORS

Training

Few engineering systems are as complex or dependant on logic than a cockpit. Yet, with the significant differences between Eastern and Western cognition, pilots, irrespective of their cultural origins, are expected to use the same logic and approach to understanding the operation of Western-designed jets and avionics (e.g., Boeing, Airbus, Thales, Honeywell). Moreover, the training given to pilots is largely through Western flight schools. In a discussion of the culture issues in Taiwan's civil aviation community, Yong (2003) noted that many pilot trainees are sent to the U.S. for 15-20 months of training.

These pilots are thus trained in a cultural environment that is strongly individualistic. But when they return home, they enter a society that values harmony through a collectivist and hierarchical social structure. These pilots then have to bridge the gap between social norms (e.g. respecting those of higher rank, not pointing out errors made by the captain in order to maintain harmony) and their professional training.

Decision Support

The implications for information design should be examined for the notable cognitive differences between people from different national cultures. This is not to imply that there should be different equipment for populations from different cultures. But, in an effort to develop error-tolerant systems and systems that are sympathetic to the divergent streams of logic, designers should be more aware of the different ways in which technology can be employed.

Differences in the way Easterners and Westerners remember focal objects have implications for the design of information displays. Research that investigates visual search, workload and situation awareness of both pilots and controllers may also find notable differences with the way operators source and use radar information. That Westerners tend to remember focal objects as being separate

from their background prompts another set of questions vis-à-vis the difference between the visual search performance of Western and Eastern air traffic controllers. Would Westerners be faster at identifying potential conflicts on a radar screen since they tend to categorize focal objects as distinct from their background? Or would Eastern controllers be faster at predicting a conflict pair because they tend to be more holistic in cognitive reasoning? And after these questions are answered, what information design solutions would best support the decision making and situation awareness of each population?

CONCLUSION

The differences in cognition and reasoning between Westerners and non-Westerners can be traced back to the national cultures of individuals (Nisbett, 2003) and the behaviors learned through socialization. As such, human factors research procured from Western populations has value mainly to operators in Western cultures. However, aviation is a multicultural domain and thus, international operations could be served better by an understanding of human factors issues faced by those with different approaches to cognition and reasoning.

With the expected surge in traffic not only within Asia, but between Asia, Europe and the U.S., Western operators will be increasing the frequency with which they work with non-Western operators. Hence, a better understanding of communication styles, CRM, cognition and reasoning would ameliorate situation awareness and safety for all stakeholders. Future research would benefit from investigating the implications of cultural differences on visual search (and subsequently information design and display), multicultural cockpit communications, risk-seeking behavior, communications and situation awareness of cockpits staffed by crews from different cultures. Finally, the possible impact of cultural differences on operational concepts (e.g., free flight) and equipment design may yield interesting results for future consideration.

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