On Two Types of Thinking Patterns in Aviation Safety

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Abstract. The theories of flight safety are examined from the thinking pattern point of view. Due to the different evolving environments of western and Chinese cultures, the basic thinking patterns are fundamentally different. The western linear thinking, based on the "event" of flight operation, results in the causal sequential type of flight safety theories such as the domino, accident chain, cheese theories. The Chinese pictographic thinking forms the different theory like the Flight Safety Margin based on the "feature" of flight situation, although which can only represent a very preliminary trial. The flight situation composed of features with many interacting factors included is used to comprehend the accident by the Chinese. How the features are extracted from flight operation still needs to be studied scientifically. How the features are correlated to form the significance of safety is another difficult problem. To clarify the Chinese thinking patterns in aviation safety will be a valuable research field especially after the Chinese C-919.

Keywords: Thinking pattern · Flight safety margin theory

1 Introduction

There is no doubt that aviation technology is totally Western. From the invention of airplane, to the manufacturing, and the standard operation procedures are all Western creations. It will be very reasonable to say that aviation bears almost one hundred percent Western characteristics. Hence, globalization for sure will create serious culture conflict including aviation safety. Although cultural ergonomics has been a discipline in the corresponding fields for many years (Kaplan 2004), serious problem is still there, like B-737 Max. It does represent deeper consideration about culture is needed.

In Western culture, the understanding about aviation safety usually involves sequence. Accident models and explanations contain simple chains of failure events. However, these event-based models developed to explain physical phenomena are inadequate to explain accidents involving organization, social factors, human decisions, and software design errors in highly adaptive, tightly-coupled, interactive complex sociotechnical systems. In addition, the influence from deep level of culture could even never be seen.

Even talking about the so-called system approach, it is still constructed using individual components together with discrete connections representing causal sequence

between them. In a typical diagram for a complex system (Leveson 2011), there are only two kinds of elements, one is block while the other is arrow. Blocks represent individual components with the arrows discrete connections. For the connection, it can be understood as causal sequence appeared in theories as domino, accident chain, and cheese. In the West, the paradigm shift apparently observed in safety, as understood from event-based model to system model (Leveson 2011), represents only a shift about view point instead of the system itself. For the event-based model, the concentration is placed on the individual block, while the system model places concentration on the arrows, i.e., interactions between components. Obviously, it presents a progress although may not be enough.

In this research, a theory about the thinking pattern is considered. It is believed that the thinking pattern is the most important aspect in cultural study. The reason for the thinking pattern to be so fundamental is that it is the operating system of culture. A simple theory called the thinking pattern theory of culture is proposed from the knowledge of computer science. It is a three layer theory, environment-value-artifact, connected interactively with thinking pattern. The analogy between operating system in computer science and thinking pattern in culture will be provided. Therefore, all the application software in culture, like knowledge, science, music, painting, crafts, medicine, institution, social value, etc., have to be designed based on the thinking pattern, even including aviation safety.

There are two basic types of thinking patterns underlying all human civilizations. They are the one dimensional linear pattern created in ancient Greece, and the two dimensional pictographic pattern used by the Chinese. Both have cyclic form coming from the basic understanding process of human brain. All the human understanding about everything has to be a thinking cycle. Starting from the object to be understood, the process must go through a step of separation of information, followed by the essential "understanding", and through another step of assemblage, then back to the original object. Thus, the complete thinking cycle is then object → separation → understanding → assemblage → object. Although the basic cycles are the same for both the Western and Chinese thinking, because of the written scripts used, the contents are different. For the Western linear thinking, because of the alphabets, to understand means to find the essence of the object. The separation is the induction and the assemblage is the deduction. Therefore, the Western thinking cycle is then phenomenon → induction → essence → deduction → phenomenon. On the other hand, due to the Chinese pictographic written characters, the Chinese thinking is formed as phenomenon → analogy → feature → correlation → phenomenon. It is obvious that the understanding about everything of the Western culture is always through the essence of the object, while the Chinese through the feature. Countless examples can be found to reveal this fundamental difference in almost every aspect in both cultures.

2   Western Linear Thinking and Aviation Safety

In the Western minds, physical aspects of systems are thought to be decomposed into separate physical components whose behavior can be delineated as discrete events over time. And, the traditional scientific methods break the system into distinct parts so that

the parts can be examined separately. The decomposition assumes that the separation is feasible, that is, each component or subsystem operates independently, and analysis results are not distorted when these components work altogether as a whole. This assumption implies that the components or events are not subjected to feedback and other nonlinear interactions and that the behavior of the components is the same when examined singly as when they are playing their part in the whole. In this case, the principles governing the assembling of the components into the whole are straight forward, i.e., the interactions among the subsystems are simple enough so that they have no any influence on the subsystems and these subsystems work separately the same as they work in the systems.

Living in the cradle of the ancient civilization, a place full of clay soil and reed, people from Mesopotamia created the most influential written script: cuneiform. All the alphabetical writing systems used today are derived from it. When compared with Chinese characters, there is an obviously striking difference. In cuneiform, there exists basic constructing units! Of course, it is because of the reed pen used. With only a few units, through different combinations, so many different languages can be spelled. Inspired by the concept of basic constructing units for several thousand years, western people instinctively believe that the understanding about everything can be established through the "essence", the basic constructing unit of thought.

With basic constructing units in mind, the domino, link, cheese, also the event can thus be created to construct the understanding model about flight safety. Those models explain accidents in terms of multiple events sequenced as a chain over time, just like languages being different combinations in sequence of alphabets. The events considered almost always involve some type of component failure, human error, or energy-related event. The chains may be branching or there may be multiple chains synchronized using time or common event. Other relationship may be represented by the chain in addition to a chronological one, but any such relationship is almost always a direct, linear one. As such, event-based models encourage limited notions of causality, usually linear causality relationships are emphasized.

The above mentioned methodology about system approach of safety (Leveson 2011) still represents a typical western conception about making sense of reality. Shaped by the alphabetical writing system, western thinking is always automatically looking for something like arche or essence for everything to understand, even when the object is called "system". This is the reason why western philosophy concentrates on metaphysics and ontology before any theory can be established (Jing 2012).

3 Chinese Pictographic Thinking and Aviation Safety

In China, on the contrary, with totally different landscape, the ancient Chinese created the famous oracle bone scripts, the direct ancestor of Chinese characters used today. When compared to cuneiform with obvious basic constructing units, Chinese characters has simply no basic unit! This is exactly the right reason why the Chinese characters do not have alphabets. For several thousand years, in Chinese minds, there is never anything like basic constructing units. Therefore, the Chinese always understand everything as itself, or as a whole, which is called holistic view. However, human brain

cannot process all the information entering into the brain, the Chinese thus understand everything by extracting the "feature" of the object, the most representative portion of information.

Opposite to the Western thinking, Chinese thinking is always automatically looking for holistic characteristics for everything to comprehend (Jing 2016). The ideographic thinking is of networking type instead of sequential, with emphasis placed on the connections. This is the most fundamental difference between linear and pictographic thinking, since that linear thinking focus on the substance or entity, as described by Aristotle, while pictographic thinking focus on the correlation among entities. In the Chinese thinking, there is no such thing as individual component and discrete connection. Hence, to have a real Chinese theory for flight safety, the concept of individual component and discrete connection have to be abandoned, at least modified. Otherwise, we will be still discussing event-based model with more complex structure at most.

Operationally, originating from an alphabetical system, the linear mode of thinking of Westerners stresses sequence composed of elements, and values logic, with analytical capability as its specialty. On the other hand, the Chinese pictographic mode of thinking, is holistic with stressing equilibrium between features. The special capability as different from the western counterpart is called insight, finding system features with given only very little information. Moreover, this fundamental difference has already existed for at least two thousand years due to the fostering geographical environments. As long as the Chinese people still use their writing characters, and Western cultures also keep on using alphabets, the difference will definitely persist in the foreseeable future. Consequently, it would be quite helpful to have alternatively a theory derived from the Chinese mode of thinking and create a Chinese theory for flight safety as the insufficiency of the Western linear thinking has already been exposed.

There is still no any rigorous flight safety theory based on the Chinese pictographic thinking even today, although the very crude Flight Safety Margin theory can be recognized as the very first one (Jing and Batteau 2015). The most fundamental reason for this peculiar situation is from the development of philosophy. Basically, philosophy is a kind of knowledge about thinking itself. Ancient Greeks had already spent huge amount of time to clarify the linear thinking pattern, and the result is quite spectacular. However, it never happened in Chinese history because of the separation of the language and the written scripts, and the pictographic nature of Chinese characters. Thereafter, the ancient Chinese intellects had almost never discussed the Chinese thinking itself. This is also the basic reason for the existence of the argument about whether China has philosophy (Jing 2016).

However, after thousands of years of development, it is still very hard to say that the Chinese holistic thinking has being clarified. It is still in the deep midst although it has being used successfully in different fields in the long history of China. This is the reason why some western scholars argued, and agreed by certain amount of Chinese scholars, that there is no philosophy in China. The main reason for this peculiar phenomenon is that the Chinese thinking pattern had being discussed seriously only in a very short period of time two thousand years ago. After that, the discussion ended almost forever. The group of scholars seriously discussed how the Chinese think is called the School of Names. Although the Chinese system thinking is still not clear, the key feature has been already revealed to some extent.

The Flight Safety Margin theory represents the first step to use Chinese thinking in flight safety. To proceed, more typical features of Chinese thinking have to be incorporated. The next step will be to use holistic characteristics to replace individual parameters. Everything must be understood interactively as a whole. Consequently, every flight parameter must be understood as a group of parameters. The term "event" can also be modified to incorporate the Chinese thinking. "Event" means there are certain components going wrong so that something bad happens. In Chinese system thinking, the appropriate term is symptom. Symptom means situation deviating away from normal and being understood from the characteristics point of view, or deviation of a group of parameters with certain characteristics representation. Of course, this step will be very difficult. The reason is that the analogy, similar to the induction in Western thinking, has to be done first for any meaningful step can proceed. Analogy here means we have to identify features, group of interrelated parameters, related to flight safety through comparison with lots of data from accidents and events. Just like the Chinese five operations, wood, fire, earth, metal, water, flight safety symptoms can be defined as well. If that can be done, a real Chinese pictographic theory without individual components and discrete connections, and different from the simple multilinear aggregation of discrete elements, can then be discussed seriously.

4   Future Development

A scientific theory about flight safety based of the Chinese pictographic thinking is surely possible, although it is extremely difficult. Up until now, the process about how the object is decomposed into features through analogy, and how the features are correlated into the understanding of the corresponding phenomena is still in the deep midst. As for flight safety, the flight situation composed of features with many interacting factors included should be used to comprehend the accident. How the features are extracted from flight operation also needs to be studied scientifically. How the features are correlated to form the significance of safety is another difficult problem. To clarify the Chinese thinking patterns in aviation safety will be a valuable research field to be explored along with the increasing influence of China in aviation, e.g., C919. It is expected that it will be a special topic in aviation psychology.

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