

Human Engineering Perspective to Explore the Interfacial Ambiguity among Cognitive Resources

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ABSTRACT

The ultimate goal of human computer interaction is to explore the human nature on socio-technical system. The cognitive process with the allocation of cognitive resources is the matter of how a human communicate with a human machine system (HMS). Some human errors may be described by the hidden and unknown cognitive process which is a matter of why a human communicate with HMS. It is hard to design or even define the hidden cognitive resource causing human errors such as a spirit (so much controversial term) since the boundary among cognitive resource is somehow fuzzy and ambiguous. This paper propose the human engineering perspective to define and design the boundary between cognitive resources (i.e., the interface between mind and spirit) by means of HCI design methodology such as ecological interface design.

Keywords: Interface, Cognitive, Spirit, Complexity

1. Introduction

Many engineering researchers may agree with a conclusion that the ultimate goal of human machine system (HMS) research is to explore the human nature on socio-technical system and use the knowledge from it for human welfare. The most emergent findings from the human engineering research are human errors from their fallibilities: physical fallibility, cognitive fallibility and moral fallibility.

Human is known to be comprised of three well-known human nature: body, soul (or mind) and spirit. While human body is a physical entity, human soul or mind (*mind* is often used for the scientific term of human soul) is a perceptual and cognitive entity to control human body by allocating human cognitive resources such as knowledge, emotion and behaviors. Human spirit represents human identity (ontology), which has been controversial with religious issues to be identified and differentiated from human mind.

These three human entities are interactively

communicated on socio-technical system. Human cognitive system is about how a human communicates with a HMS while spiritual process is about why a human communicates with a HMS. The interactive communication among human three entities can be described with an engineering perspective in such a way to explore human nature through human computer interaction.

Human computer interaction (HCI) is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. An *interface* is a boundary across which two independent system meet and act on or communicate with each other.

While HCI concerns with a communication between human body and mind, the boundary concept such as a cognitive interface may be used to explain a phenomenon of communicating human mind and spirit.

This paper proposes the one of the feasible and systematic approaches to explain human fallibility from a deep down human nature such as a human spirit in terms of engineering perspective so that unexplainable human errors on socio-technical system can be

explored.

2. Interface Issues

2.1 Cognitive Interface

As more amount of information is processed and delivered in a digitalized system, and as the information should be displayed on relatively limited space, the level of cognitive complexity, hence mental workload, in managing the human-system interaction is being increased. Human operators also tend to show over-reliance to the automated system which was developed to reduce human errors from the misuse of the digitalized interface different from the stereotyped one. In fact, the more the computerized devices and procedures are used in the system, the mental model of computer users has been more changed from analogue stereotype to digitalized one (Cha, 2002).

All the information to be processed in a digitalized system cannot be displayed on the limited interface space so that crews make a decision relying on mental resources for abstracted information. For reducing the mental workload, the cognitive interfaces seem to work well by visualizing and displaying the abstracted information on the human machine interface. Cognitive interface suggests that the higher-order functional constraints governing the process be made directly available to operators in a manner allowing them to pick up that information using their cognitive capabilities.

Cognitive engineers have used two theoretical frameworks to design a cognitive interface; Information Rich Design (IRD) and Ecological Interface Design (EID). While Information Rich Display (IRD) is mainly focused on providing stereotyped information to the user, EID method effectively enables operators' mental resources to be concentrated on highly abstract information-based tasks such as diagnosis and problem solving.

Being a relatively new approach to designing user interfaces, EID has been focused on the human-machine interfaces (HMI) for large-scale dynamic systems such as power plants, aircrafts, and ships. In EID methods,

combined are the analytical tool of the Abstraction Hierarchy, human decision making strategies, and the insights of SRK taxonomy. The resulting design provides more intuitive and direct information to the human decision making tasks. The design is also expected to be more robust in unanticipated situations (Vicente, 2002).

2.2 Cognitive oriented Human Errors

Human errors occurs due to inappropriate behaviour of the person directly working with the human machine system. The accidents are known to be occurred through latent failure pathway shown at figure 1 [Reason 1990] but it still exists unknown causes which cannot be explained by cognitive oriented human errors taxonomy [Cha, 2013].

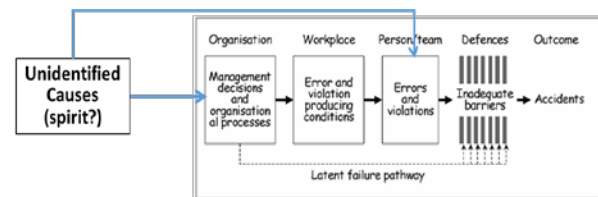


Figure1. Potential root cause for accident by human error

The unidentified root causes for accident by human error can be explained by defining and designing the boundary (or interface) between human cognition and spirit on socio-technical system.

2.3 A cognitive boundary

It is very hard to design or even define a boundary between two independent and intelligent system (i.e., mind and spirit) since it is abstract, complex, and biased. An abstract and ambiguous boundary has an attribute of any concept, idea, and statement or claim whose meaning, intention or interpretation cannot be definitively resolved according to a rule or process consisting of a finite number of steps.

And a boundary is complex so that it has a structural complexity with various type of components and the connections, functional complexity with an order and constraints of systems and subsystems, and interface

complexity with a level of interaction.

An also a boundary design is so much biased to one subsystem design(criteria, philosophy) so that it is very hard to stand and keep on a boundary(human-centric vs. m/c-centric).

Well-designed boundary reduces human errors like the *Spiritual Interface* designing a boundary between human mind and spirit considering the ambiguity and complexity

2.4 Design a cognitive boundary

The cognitive Interface design process (Figure 2) starts with work domain analysis (WDA) and proceeds with information analysis and EID (Ecological Interface Design) element design and integration [Cha & Yoon, 2013].

WDA uses Abstraction Hierarchy (AH) as a fundamental scheme to analyse the dynamic environment or the work domain. Abstraction levels are reflecting goal-means relationship. Starting with the purpose level at the top, it goes down to the levels of abstract function, generalized function, physical function, and physical form.

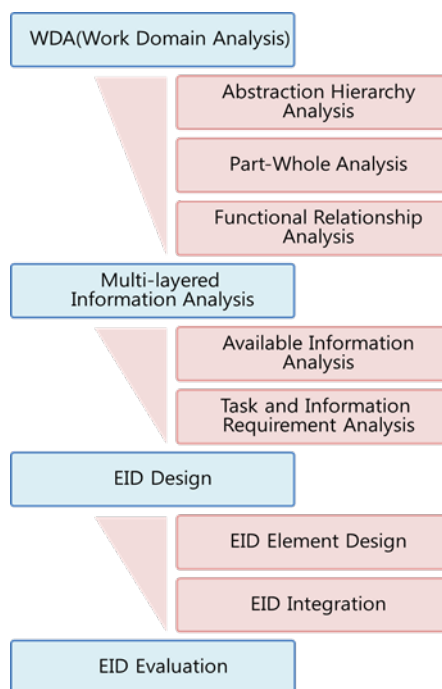


Figure2. Cognitive interface design process

Functions at a level have semantic representations and relationships that are characteristic at the level. Thus, functional organization should be identified for each level of abstraction. For example, the functional organization analysis, when performed at the physical function level, would provide a diagram that is similar with the schematic in the large display panel in the control room. AH analysis may be performed at various levels of detail according to a part-whole hierarchy, but the functional organization analysis at each AH level achieves important parts of the purpose of the part-whole analysis.

Information analysis phase connects WDA and EID design phases, translating the functional description produced by WDA into information description that is required in actual EID design. As in the WDA phase, the information analysis is also performed in multiple layers according to the AH. An information item that appears at a higher level of abstraction is usually related to one or more items at the lower level, which are summed up to the higher level information item. These relationships are what the EID should attempt to preserve visually in the display.

Another source of EID's visual relationships is the causal or grouping relationships among information items that may be identified on the basis of the functional organization at each AH level. These relationships, when they are considered in human reasoning during tasks that use the information items, should be visually represented to aid the inference.

3. toward Spiritual Interface

The spiritual interface (SI) is defined as a boundary across which two intelligent human subsystems, human mind and spirit, meet and communicate with each other. The SI may be a key role to explore human nature with a human engineering perspective. Human mind is implicitly controlled by his spirit while human body is explicitly controlled by his mind. SI has a similarity to human machine interface which is a discipline about the relationship between human body

and mind.

A boundary between human mind and spirit can be somehow explained in terms of cognitive interface design methodology such as Work Domain Analysis with abstract hierarchy and SRK taxonomy working on socio-technical system.

At this moment, it proposes the feasible approach to explain the relationship between human soul and spirit on the biblical perspectives but it may show a feasible solution for the issues of system automation with a human intervention or moral judgment.

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