On Cognitive Properties of Human Factors and Error Models in Engineering and Socialization

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ABSTRACT

Human factors are the most predominated factors in all systems where humans are part of the systems. Human traits and needs are the fundamental force underlying almost all phenomena in human task performances, engineering organizations, and socialization. This article explores the cognitive foundations of human traits and cognitive properties of human factors in engineering. A comprehensive set of fundamental traits of human beings are identified, and the hierarchical model of basic human needs is formally described. The characteristics of human factors and their influences in engineering organizations and socialization are explored. Based on the models of basic human traits, needs, and their influences, driving forces behind the human factors in engineering and society are revealed. A formal model of human errors in task performance is derived, and case studies of the error model in software engineering are presented.

Keywords: cognitive informatics; engineering applications; human factors; hybrid systems; inspection; management; model of hierarchical needs; model of human errors; personality; principle of reviews; quality assurance; socialization; traits

INTRODUCTION


Because the basic objects under study in sociology are individual human beings and their interactions, social psychology is the key to understand a wide range of complicated social
phenomena and the driving forces underpinning them. The study on human traits forms the foundation of sociology because every individual’s social behavior is driven and constrained by those axiomatic human traits, characteristics, and the derived needs based on them. The study on human traits also forms the foundation for engineering organization.

This article explores the cognitive foundations of human traits and cognitive properties of human factors in engineering and socialization. In the remaining sections, a comprehensive set of fundamental traits of human beings are identified. A human needs hierarchy (HNH) model is rigorously developed on the basis of Maslow’s (1970) model of motivation and personality. The characteristics of human factors in engineering are elaborated, and the influence of the human factors in socialization is formally discussed. Based on the models of basic human traits, needs, and their influences, the driving forces behind the human factors in engineering and society are revealed. A formal model of human errors in task performance is then derived and its applications in work product review, inspection, and quality assurance in software engineering are presented.

**COGNITIVE FOUNDATIONS OF HUMAN TRAITS**

Studies on human traits form the foundation of sociology because every individual’s social behavior is driven and constrained by those axiomatic human traits and the derived needs based on them (Wang, 2002, 2003, 2007a, 2007c; Wang et al., 2006; Wickens et al., 1998; Wiggins et al., 1994). The studies on human traits also form the foundation for engineering organization.

**Axiomatic Human Traits**

The basic evolutionary need of humans is the tendency to maximize the inclusive fitness of both individuals and the whole of mankind. It can be described by the philosophical doctrines of egoism and altruism.

**Definition 1.** Egoism is a social behavior of human beings in which individuals put their own interests first in decision making.

Both sociologists and economists believe that egoism drives most of the behaviors of individuals. However, statistically, all individual behaviors as a whole form the natural force toward the development and welfare of the entire society.

The basic forms of egoism of individuals are to maximize personal life span, profit, pleasure, esteem, and power; to possess information; and to minimize costs, energy consumption, and inconvenience. It is noteworthy that most forms of egoism are dependent on the cooperation or recognition of others collectively known as the society. This basic constraint is the sociological foundation of altruism.

**Definition 2.** Altruism is a social behavior in which individuals sacrifice their own interests for the welfare of a group or society.

Altruism can be explained by the term inclusive fitness as defined below (Westen, 1999).

**Definition 3.** The inclusive fitness of human beings is their own reproductive success and those of genetically related individuals.

**Lemma 1.** Egoism is constrained by altruism, and the implementation of altruism is dependent on the natural egoism.

Lemma 1 provides an explanation of the relationship between egoism and altruism. Based on Lemma 1, the following theorem can be derived.

**Theorem 1.** The basic evolutionary need of mankind is to preserve both the species’ biological traits via gene pools and the cumulated knowledge base via various information systems.

History indicates that evolution favors species like human beings and other organisms