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THE CONFLUENCE OF 'ANCIENT WISDOM AND FUTURE TECHNOLOGY' IN OUR PROFESSION

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The panel assembled for this session has been asked to think metaphorically about the theme of the Meeting and how it relates to our profession. The invited panelists represent diverse perspectives in human factors and ergonomics, and this should make for stimulating discussion.

INTRODUCTION

The theme of this year's Annual Meeting is "Ancient Wisdom-Future Technology." It was created by the local host committee to acknowledge, and pay respect to, the juxtaposition of advanced-technologies such as fusion reactors, massively parallel computers, and large radiotelescope arrays against an ancient desert and mountain landscape, full of culture, artifacts, and wisdom from millenia of human inhabitants. The Land of Enchantment is repleat with contrasts. She has more PhDs per capita than any other state, but an average income level near the bottom of the list. The flat desert complements the mountainous high country, the red rock mesas stand intransigent against the azure sky; the list goes on and on. But no contrast compares to the one the theme addresses. It is pervasive and undeniable. It describes the people of New Mexico.

The Topic

The panel assembled for this session has been asked to think metaphorically about the theme and how it relates to our profession of human factors and ergonomics. Originally conceived as a debate centering around the older technologies and research techniques versus the newer ways of finding answers, it was soon realized that there was no dichotomy, but more of a synergy between the old and the new. If human factors is truly a philosphy of design rather than simply a body of knowledge, then we would expect consistency in approach regardless of field of application or new discoveries of human performance. Just as when two or more rivers combine to become a force mightier than the simple summation, the synergistic power of established techniques or knowledge and recent innovation is available to everyone in our profession.

The Panel

The invited panelists represent diverse perspectives in human factors and ergonomics. This was not accidental. We have the areas of information-technology interface development, environmental psychology, cognitive systems, and industrial ergonomics represented. The speakers were kind enough to provide abstracts on their thoughts, which follow. As you can infer from their statements, each is working with emergent technologies, but is classically educated and extremely philosophical about observed change and constancy in our profession.

I would like to thank my cochair, David Meister, for participating. His sage observations and analyses of our profession are particularly relevant to the context of this forum.

DISCLAIMER

PANELISTS' STATEMENTS

Anna Wichansky
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New Technologies, Old Usability Problems

As technology has advanced over the past 15 years, I have seen telephones turn into computers and vice versa. I have engineered televisions with graphical software user interfaces, and designed computers with 3-D moving images and sound. One thing I have not observed yet is a decline in the usability problems which typically accompany the user experience of modern technology. As the pace of technological development has gotten faster, the rate of human evolution has not kept up. Miniaturization of control devices has not led to the evolution of miniaturized fingers. The technology to bombard viewers simultaneously with a "data soup" of images, graphics, text, and full bandwidth CD audio has not been met with the human ability to parse and process sensory input any faster than our ancestors did. In this panel, I will focus on the basic cognitive and perceptual problems which seem to emerge whenever technology takes another leap, and how those of us in high tech have invented new methods to study these human factors. I will include primarily examples from interactive television and the World Wide Web.

James A. Wise
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Ancient Wisdom: Future Technology

The biologist Richard Dawkins writes of a 'River out of Eden'--a river of genetic information that links us in an unbroken flow back to our earliest ancestors. This river is the source of 'Ancient Wisdom' that is biologically bound into the chemistry of our blood and the trichromacy of our color vision, recalling our origins in early seas and adaptation to terrestrial landscapes. We perceive and behave along channels formed by DNA flows that have persevered through those eons; and the success of new technologies is determined by how well they enact that ancient wisdom in a continuing conversation between person and environment.

Ancient Wisdom: Future Technology are 'duals' in that they enable and re-express each other. Ancient Wisdom suggests ways in which Future Technology is conceived, and technology creates new frontiers for the emergence and re-expression of the Ancient Wisdom. Two recent research projects illustrate this duality. One involved creating software for text visualization; the other, seeing if "Green Buildings" are as good for their occupants as they are for the environment.

The software spatializes text by automatically stripping thematic terms from unstructured text documents and sedimentarily depositing them to build a 'thematic landscape'. Interpreting this image, users grasp the content and relationships of literally thousands of documents without having to read them all. Our Ancient Wisdom lends us the intuition to read and interpret natural landscapes. Incorporating this ability into a visualization interface now provides a means to handle the 'information explosion' generated by Future Technologies.

Case studies of 'Green Buildings' have surprisingly indicated that occupants benefit in terms of enhanced health and well being, and even work productivity. Our ongoing research results suggest that modern buildings which recreate the essential habitability features of African savannas will be especially appealing and have both positive physical and psychological impacts on people. In short, 'Green Buildings' appear to provide occupant benefits as well as environmental ones because they analogously recreate the

most biologically preferred conditions of humans' early savanna habitat.

Again, Ancient Wisdom is recapitulated within a building technology, reminding us that what we do to the world, we do to ourselves. It informs both software and building design, and codetermines what will enhance our beings and what will not. Ancient Wisdom:Future Technology are duals, once shaping stones to lead us from the savanna, and now taking us into the Information Age of our calendar's third millenium.

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Error: At the Dawn of Experimental Psychology, At the Dawn of Human Factors, Today

An episode of "human error" in 1796 was the stimulus for one of earliest developments in the history of experimental psychology. One hundred and fifty years later, one of the earliest activities of the emerging field of Human Factors was designing human error out of systems (for an example see Fitts and Jones' 1947 study of pilot error). Thirty two years later, the Three Mile Island accident and other complex system failures became huge stimulants for work on the human contribution to risk and safety. In all of these cases, two themes stand out: first, stakeholders have claimed the failures were due to unreliable or erratic performance of the individuals at the "sharp end;" second, researchers looking more closely showed how design can induce error.

A fundamental part of Human Factors has always been to study systems to identify and modify points where design induces error. Yet, technological disasters still happen; Human Factors people still poke around the rubble and recognize "classic" deficiencies (albeit today these typically are deficiencies in human-computer cooperation and are classic only relative to the history of Cognitive Engineering and HCI); and stakeholders still protest it was the erratic behavior of the individuals in question that undermined systems which worked as designed (see the history of pilot-automation accidents in Billings, 1996).

Why do we, as a community, remain in what seems the same position? Why are we unable to warn organizations about likely design-induced errors? Can we effectively predict contributors to failure?

Human Factors has always focused its efforts on front line or "sharp end" operators, those who maintain and operate some process. Much, much less often do we carefully study "second order operators" -- designers, regulators, managers. Yet, the recurring theme of design-induced error indicates that our subject matter is design error (predicting how designs will shape cognition, collaboration and performance of first order operators), our target is understanding how design errs (in the sense that it creates conditions which will produce errors by first order operators), our practice is changing designs (re-shaping technological change). And how has Human Factors as a field performed on these criteria? Do we accurately predict design-induced errors before there are incidents and accidents? Do we understand how second order activities of design and certification break down (in the sense of inducing errors)? Do we influence the course of technology and organizational change or do we just react to the failures after-the-fact?

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Ancient Wisdom and Future Technology: The Old Tradition and the New Science of Human Factors/Ergonomics

Today, our relatively new and relatively ancient discipline of human factors/ergonomics is at the crossroads. It has matured in some respects, but it is still in its infancy in many others. While practical applications of design principles developed over the last 40 years flourish, the theoretical basis of this unique new science has yet to be developed.

Human factors is indeed based on the very ancient wisdom of accommodating human needs in living environments, but it is mainly driven today by explosive growth and rapid developments in information technologies, which most often than not, are incompatible with the human characteristics.

In my discussion of the ancient and future characteristics of human factors, I will focus on some of the basic issues that need to addressed in order for the human factors/ergonomics, which is deeply rooted in the ancient sciences of psychology and engineering, to be able to break away and develop into the unique new science of the future, ie. the science of (human-system) compatibility, or simply the science of compatibility.

Designing for human use. In view of the ancient wisdom of human factors (E. Grandjean), our discipline was defined as one that aims to fit the task to the human. The lack of fit, or incompatibility between the system and the human (Karwowski, 1991, Casey, 1993), is the ancient evil that we try to overcome. And yet nobody has developed a way to measure the degree of fit between the human and the task that would be context free, and would allow to compare the effect of system redesign on the level of fit . We often claim that this or that will help to improve the fit, but we do not have scientifically rigorous ways of measuring the degree of fit itself. This black box approach does not help to build the scientific basis of ergonomics. Development of a methodology for quantification of the human system-human compatibility, regardless of the application area (context), is paramount to preservation of the ancient qualities of our profession, and to social (political) and peer (among other ancient sciences) recognition and acceptance of our unique field of scientific endeavor.

Complexity vs. simplicity and compatibility. The complexity of our new technology-driven world is continually increasing (Casti, 1994). In our own field, the ancient wisdom tells us to keep things simple, and yet most of the ergonomic improvements lead to some (often significant) increase in the the system (system-human interface) complexity. In order to improve the human-system compatibility we inexplicitly increase its complexity by the way we design the improvements . The notions of complexity and compatibility are inter-related, and, therefore, must always be considered together (Karwowski et al. 1994) . We must also measure and compare the before and after for both complexity and compatibilty when redesigning the system. The social costs of improving system compatibility at the expense of system complexity are obvious if one examines its consequences in view of the revenge of unintended consequences (Tanner, 1996; Casey, 1993).

Entropy vs order in ergonomic systems. We should not be surprised that things are not being designed to fit people in either simple or complex systems. In fact we should expect this to be the case, and be aware that the system under consideration will progress towards greater disorder (i.e. incompatibility) as time goes on. The concept of entropy helps us to understand that natural phenomenon. In ergonomics, we must also realize and accept that there exist a non-reducible level of system-human incompatibility (or ancient lack of fit). This basic level of system incompatibility can be called the ergonomic entropy (Karwowski, 1991).

It is a futile exercise to try to improve the system beyond that level, or from practical point of view, to even come close to this level of ergonomic design quality. The

consequences of doing so will be an increased system complexity and not justifiable economic cost. And yet, we see many such attempts done every day. When one research approach (e.g. biomechanical) fails, we move to another approach (e.g. psychosocial), continuing the black box paradigm in seeking illusory solutions to ergonomic problems. An ancient example of such efforts are naive attempts on the part of some of the recently born ergonomic specialists to solve the problem of work-related musculoskeletal disorders in industry.

Human-system compatibility vs system-human compatibility. We often refer to the human-system interface technology, but the focus of our work is on designing systems to fit people. And since it is the modern technology that must be compatible with the human, perhaps we should be talking about system-human compatibility instead.

System compatibility vs human adaptation. In designing systems to be compatible with humans, we cannot forger that people have ancient abilities of (ecological) adaptation (Conrad, 1983; Flach et al., 1995), and part of the design that preserves human creativity should allow for some level of adaptability to naturally take place. In ancient human factors, this requirement is known as designing to reduce undesirable level of, for example, mental underload or boredom. Hence, it is imperative that in the designing for compatibility we do allow for the compatible level of adaptation between people and systems to take place. Paradoxically, we must also remember that we are dealing with the complex ergonomic systems which are adaptable, and partly because of high complexity of system interactions, these systems learn to adapt and behave in often unpredictable ways. An example of such adaptation process is the system of psychosocial effects which have a strong impact on the perceived success or failure of many ergonomic interventions in industry.

Conclusions. The ancient wisdom of human factors will always be with us, but to built the new science of system-human compatibility, the one that only we can build based on our knowledge and experience, we must change our thinking paradigms and go beyond the ancient world of human factors...

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