Cognitive Prostheses

Kenneth M. Ford
Institute for Human & Machine Cognition
University of West Florida

ABSTRACT

This emerging concept of human-centered computing represents a significant shift in thinking about intelligent machines, and indeed about information technology in general. It embodies a "systems view," in which human thought and action and technological systems are seen as inextricably linked and equally important aspects of analysis, design, and evaluation. This framework focuses less on stand-alone exemplars of mechanical cognitive talent and is concerned more with computational aids designed to amplify human cognitive and perceptual abilities. Essentially these are *cognitive prostheses*, computational systems that leverage and extend human intellectual capacities, just as the steam-shovel was a sort of muscular prosthesis. The prosthesis metaphor implies the importance of designing systems that *fit* the human and machine components together in ways that synergistically exploit their respective strengths. The design and fit of these computational prostheses require a broader interdisciplinary range than has traditionally been associated with AI work, including computer scientists, cognitive scientists, physicians, and social scientists of various stripes. This shift in perspective places human/machine interaction issues at the center of focus. The "system" in question isn't "the computer" but instead includes cognitive and social systems, computational tools, and the physical facilities and environment. Thus, human-centered computing provides a new research outlook, with new research agendas and goals. Building cognitive prostheses is fundamentally different from AI's traditional Turing Test ambitions — it doesn't set out to *imitate* human abilities, but to *extend* them. As humans contemplate journeys to Mars and beyond, research requirements clearly exist for developing a wide range of performance support systems for both astronauts and ground operations personnel.

Cognitive Prosthesis
Notes by Doug Cooke

Cognitive Prothesis information was gleaned from discussions with Ken Ford from the University of West Florida and from an article in Computer Magazine by Scott Hamilton. This was published in the January 2001 edition. The title of the article is "Thinking Outside the Box at the IHMC".

Although Ken was not able to attend this workshop, I thought it was important to relay some of the key points and strategies that he would have discussed. Our discussions tend to revolve around humans versus robots and humans collaborating with robots. The ideas incuded here take this discussion into a different dimension.

Cognitive Prosthesis involves the study of human cognition, studying the human being as a system. Based on this knowledge, the focus of this activity is to augment the capabilities of the human and overcome his limitations. The idea is not to replicate a human being through robotics, but to augment his capabilities.

In looking at human capabilities "humans are wonderful analog computers that process huge quantities of data, often without conscious awareness." The human brain is able to react instantaneously to stimuli, based on all its memory and experience, without any apparent logical search. On the other hand, computers have tremendous logical capabilities and computational skills. If there is a close and carefully designed interchange between them, the combination can be made more powerful.

Examples of prostheses are:

- Eyeglasses, which augment the eye, but don't replace them.
- A steam shovel run by a person greatly enhances his ability to dig.
- The pathfinder rover was an extension of the scientists on earth.

Examples such as these can all be made more effective by designing the human and machine as a system. "Build a total system that includes the user. Fit the human and machine components together in ways that synergistically exploit their respective strengths."

Ken recommends a "shift from making artificial super humans who replace us to making superhumanly intelligent artifacts that can amplify and support our own cognitive abilities."

Our current EVA suits are designed to minimize their debilitating effects on the humans who use them, yet they are still debilitating. Imagine an EVA suit that is designed to enhance the astronauts' abilities in terms of information and computational augmentation available; and in terms of enhanced strength, mobility, and sensory inputs. It could have miniaturized sensors built into the gloves that can make the appropriate scientific measurements that aid in sample selection. There could be additional sensors that provide data that address other scientific investigations. This data could all be computationally integrated and provided to the astronaut real time in the suit, as well as being transmitted back to Earth.

In our thinking about what can be achieved on exploration missions, we should begin to look forward and conceptualize how our capabilities to perform with humans could be advanced well beyond today's capabilities and experience. In our thinking of future designs, these concepts should be employed to maximize performance and achievement. The discussion of robotics and human interaction should begin to include the idea of merged humans and machines.