# Introduction to Humans in HCI

Mary Czerwinski
Microsoft Research
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We are fortunate to be alive at a time when research and invention in the computing domain flourishes, and many industrial, government and research institutions are aggressively funding creative research in the field of HCI. There exists today a deep level of understanding that HCI is a multidisciplinary field, incorporating research and theories from Computer Science, Psychology, Anthropology, Education, Design, Engineering, Math and even Physics. Partly driven by a flourishing economy and certainly aided by a relatively stable global political situation, much innovation has occurred in HCI since the last edited volume on this topic. In particular, our understanding of how our knowledge about the user, the user's context and culture all fit together to determine optimal performance and satisfaction during HCI tasks has grown immensely. Rapid advancements in our understanding of the laws governing input devices (e.g., Accot & Zhai, 2001; Chua, Weeks and Goodman, Chapter 1, this volume), the mapping of perceptual codes to display design (e.g., Proctor & Vu, Chapter 2, this volume; Ware, 2000), a deeper understanding of how humans process information to the point of automating various aspects in computer simulations (e.g., Byrne, Chapter 5 this volume, Pirolli, Card & Van Der Wege, 2001), and a much better understanding of the emotional and social aspects of HCI (e.g., Brave & Nass, Chapter 4, this volume; Picard, 1997) have occurred. In addition, the artificial intelligence community's collaboration with HCI researchers has produced some fascinating examples of how to capture information about a user's context in order to make better decisions about how to interact with that user (e.g., Horvitz, 1999).

Given these rich opportunities for research and exploration, it would seem fit for any book entitled "Handbook of Human-Computer Interaction to cover in depth the recent progress surrounding the human aspects of interacting with computers. It would be impractical to assemble such a book without addressing those human aspects relevant to computing in the foremost section of the book, much as the editors have done for this volume. The chapters chosen to comprise this section of the book cover most of the human characteristics necessary for optimal HCI design, including perceptual, cognitive, emotional, motoric and social aspects of computing. Issues related to socio-cultural influences on cognition (e.g., Hutchins, 1995) are addressed in various other chapters in this volume. In addition, the authors of the following chapters cover a myriad of research techniques and methods to provide guidance by way of example to the reader, whether a practitioner, scientist or student. Methodologies such as chronometric methods and subtraction logic from psychology's early history are covered, in addition to more advanced modeling techniques, physiological recording approaches and computer simulation efforts.

All of the authors of this section emphasize the need to study the human's perceptual and cognitive processing capabilities in order to design systems that are more natural, less error-prone and generally more satisfying to use. Psychologists who work in the software industry typically find themselves designing and evaluating complex software systems to aid humans in a wide range of problem domains, like word processing, interpersonal communications, information access, finance, remote meeting support, air traffic control, or even gaming situations. In these domains, the technologies and the users' tasks are in a constant state of flux, evolution and co-evolution. Cognitive psychologists working in human-computer interaction design may try to start from first principles developing these systems, but they often encounter novel usage scenarios for which no guidance is available. It was encouraging to see the authors of this section describe applications of their theories, models, and specific findings from basic psychological research to user interface (UI) design. Of special interest to the reader should be the various analysis techniques and guidelines generated presented throughout the chapters. The chapter authors outline some efforts in human-computer interaction (HCI) research from their own applied research experience, demonstrating at what points in the design cycle HCI practitioners typically draw from the psychological literature. This is especially valuable to students and current practitioners in HCI.

To begin the section, Chua, Weeks and Goodman introduce two basic theoretical and analytical frameworks as part of their approach to studying perceptual-motor interaction. Integrating aspects of information processing theory and the use of analytical tools to investigate both static and dynamic interactions, the group presents a series of elegant arguments about the limitations of Fitts' Law in predicting movement time for input devices in HCI. Specifically, the authors argue that simply basing estimations of movement time on distance and target size ignores factors such as the number/type of distractor items (as often accompany a target in any display or GUI), in addition to "top-down" or cognitive decision processes that might influence the selection of a target, and hence, movement to that target. The authors detail the "movement process" approach (Kelso, 1982), which supplements chronometric techniques in the study of dynamic, perceptual-motor interaction. In addition, they discuss the phenomena of compatibility and some recent data from their laboratory to push their framework further. Given the emphasis on Fitts' Law in most HCI publications and studies, this chapter provides an excellent alternative view and focus in the area of perception and motoric behavior and HCI.

Proctor and Vu provide an overview of the human information processing approach that has so long been the mainstay of perceptual, cognitive and human-computer interaction research. The premise of this chapter is that only through understanding the user's information processing capabilities can the user interface to a computing system be optimally designed. Taking a historical approach, the authors walk the reader through many of the prominent approaches and methods over the last 50 years of psychology, and more recently applications of psychology to computing systems. The authors survey methods used to study human information processing and then provide a summarization of the key findings and theories that guide our explanations of those findings. From chronometric methods including the subtractive and additive factors techniques, through electrophysiological measurements and recordings of magnetic fields, Proctor and Vu attempt to inform the reader about the need to distinguish between serial and parallel processing stages, and between local and distributed processing models. In addition, excellent coverage of recent models of attention and memory is provided, including a discussion of the effects of practice, analogy and decision making heuristics. This chapter paves the way for a subsequent discussion of Cognitive Architectures by Byrne.

The chapter by van der Veer and del Carmen Puerta Melguizo is an absolute must read for anyone new to the field of HCI, or who has come to HCI from an intense background of psychology or computer science. The authors not only define the meaning of the term “mental model”, but they cover the modern techniques for capturing users’ system models and provide a practical approach to applying that modeling with an eye toward system design. Any system designer that has had to sit and watch a real end user attempt to understand a novel user interface will appreciate the guidance presented in this chapter!

Brave and Nass cover the definition of emotions, including how they are measured, the course of emotions and their causal basis. They review their concept of the “media equation”, asserting that if the user considers computers as social actors, then the social aspects of computing need to be part of optimal HCI design. This would include capturing the user’s emotional state and responding appropriately, if possible. In their discussion of the effects of emotions during human-computer interaction, they discuss how emotions tend to alter attention and memory, bias judgment, motivate behavior, and can short-circuit cognitive processing and lead to irrationality. In addition, they discuss how emotions can interact with a user’s cognitive style, and that emotional interactions with a computing situation could alter future interactions with a system.

They argue that capturing a user's emotional state can be useful for diffusing user frustration, providing help when needed, or simply making a user feel satisfied while performing a necessary task.

Byrne's chapter defines cognitive architecture to be "a broad theory of human cognition based on a wide selection of human experimental data, implemented as a running computer simulation program". Cognitive architectures are also described as simulating aspects of cognition that are fairly constant over time and task domain. They are an attempt to bring theoretical unification to cognitive psychology via computer simulation. Speaking from experience, the unification effort itself is of fundamental importance to designers, who typically have to rely on their psychology partners to inform them of piecemeal empirical findings that are relevant to a computer system's task domain or target end user. Other benefits of using cognitive simulation models are discussed, including quantitative predictions (e.g., error rates, task times, learning curves) and the identification of alternative strategies, comparative findings and as a provision for some level of automation in design. Byrne covers a brief history of such systems, leading up to current day architectures. The shortcomings of these systems are acknowledged, but the chapter ends with a call for more research and development as the broad importance of these architectures will most likely grow in the future.

The section on humans in HCI closes with a chapter by Yoshikawa, also on modeling human-computer interaction. The motivation for Yoshikawa's model is to generate good system performance while avoiding human error in the complex task domains of process control, education and training. Yoshikawa also discusses the application of findings from human memory, including the various modes of information processing, and what is referred to as the "balance sheet" of human capabilities. Focusing on the problem of human error, and frameworks for minimizing it through good design, the author provides an overview of Rasmussen's skill, rule and knowledge-based modes of human action. An important focus in this chapter is the importance of context in the manner in which a user will interpret the task or procedures to carry out given a set of system input signals. In addition, an overview of the common types of errors made during complex system interaction and their classification is described. Similar to Byrne's chapter, methods for error identification and prevention via modeling are discussed. In addition, Yoshikawa describes the importance of observing and recognizing system and user state information through artificial intelligence techniques. Especially in the aviation and military domains, these are becoming increasingly important techniques for proficiency in our field. The chapter closes with a discussion of application domains.

In all, this section on the human in HCI provides an important overview of many of the methods available to HCI researchers and practitioners as they attempt to understand their users with an eye toward optimal design. A new understanding of motoric behavior, information processing, and user modeling during human-computer interaction has been provided and detailed. The compiled works provide the proper tools and techniques for the next generation of advanced human-computer systems. Now it is up to each of us to put these thoughtful, scholarly principles to good use.

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