BOOK REVIEW

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User Centered System Design: New Perspectives on Human-Computer Interaction, edited by D. A. Norman and S. W. Draper, Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1985. 526 pp. including glossary, subject-author index.

This is a seminal and provocative book, focusing on people and how interactive systems can aid their mental work, alone and together. Emerging out of collaborative work by the UCSD group on Human-Machine Interaction and colleagues, it defines anew the map of central issues, questions, and complex tradeoffs facing designers, creators, and users of interactive systems. As the editors emphasize, it is not a how-to book for designers but a guide to new ways of thinking about user-centered system design "from which to derive the new directions in which we must move" (p. 2). The tactic for exposition throughout is primarily one of offering speculative, prescriptive essays that are empirically-informed by introspection, observation, and occasionally, experiments with specific systems. Chapters on related overarching themes are collected in topical sections, with a helpful introductory essay by the editors organizing their commonalities and distinctive points. The six sections escalate in analytic scale from micro to macro, from concerns with individual actions and system understandings to questions of

"proactive" societal impact made possible by thoughtful design of links between people, systems, and society.

There is a productive cohabitation of tensions in approach represented in the twenty-two chapters. Some chapters offer traditional examinations of information processing considerations for guiding interface design, others phenomenological treatments of "direct engagement" experiences users have with some interactive systems, and many address social context issues, asking how interfaces can redesign work, jobs, offices, human interactions and even society. There is unusually successful "cross-talk" here for an edited volume, and a manifesto "feel" to the book as a whole.

All the same, some central thrusts of the group as a whole are apparent, since many generative themes cycle throughout. The importance of the system image model, what the user sees, is repeatedly treated as key to driving users' expectations for what can be done with the system, how it works, and how to recover from error. Other emphases include the need to better exploit the adaptive mechanisms which natural language conversation has evolved for repairing misunderstanding, and for managing multi-tasking. A central outcome of this approach is a shift toward defining human-computer interaction as a *collaborative* process between persons and machines. Many chapters are devoted to extending the design problem definition to include social structures and related contextual factors, and they emphasize the focal nature of collaboration not only in mental work with machines, but in getting help in learning how to use systems and recover from errors with grace.

Section I is a survey section on *User-centered System Design*. Hooper provides a sensitive treatment of parallels between architectural and interface design, and concludes that user input on purposes for design artifacts is central to their success. Even though rapid system prototyping makes possible some exploratory evaluative analyses of systems, difficult issues remain in establishing evaluative criteria and selecting aspects of the system for formative evaluation. Continuing this parallel, Bannon discusses potential negative impacts of architectural design on society, which might be avoided if designers take greater responsibility in assessing users' values and needs. Each chapter insists on linking values of user communities to system design; processes and mechanisms for doing so are not described but present challenges for the future. Norman provides a comprehensive guide to critical phenomena in the field of Cognitive Engineering, defined as cognitive science applied to design, construction, and use of machines. It is a field concerned with showing how to make better choices within a complex space of tradeoffs, such as that of functionality/learnability, or supportive/interruptive system-based reminding activities. His goal is to develop an approximate theory of action that may be used to analyze systems and guide design. The psychogeography he provides, with landmarks such as the Gulf of Execution (from user's goals to the physical system mechanisms and states that allow their achievement) and the Gulf of Evaluation (from physical system states to goal monitoring) provides a powerful grid for situating user-centered system design issues. The aim of such design is to facilitate bridging this gap, moving either system or user closer to one another.

Section II highlights phenomenological aspects of "the interface experience." Building on Aristotle's Poetics, Laurel asks that we imagine interfaces as stages

for experiencing a world in which we participate as agents. She proposes some principles for achieving such first-personness in design. Hutchins, Hollan and Norman offer the deepest analysis to date of highly-touted "direct manipulation interfaces," such as the Xerox Star and Apple Macintosh. They elaborate a psychological theory for why such designs effectively present the illusion of direct engagement, and they critically evaluate the alleged advantages of such designs. DiSessa thoughtfully analyzes the future of programming, and argues for a shift from the dominant goal of breaking the "complexity barrier" (to make easier creating and maintaining huge programs) to overcoming the "utility barrier" (making less effort in programming yield greater value, even for novice users). He illuminates how the Boxer language he has been developing at MIT approaches this goal. His triadic scheme for analyzing dimensions of change in programming in terms of presentation-manipulation, structure, and context (what one does) deserves close attention, as does his critique of direct manipulation.

In Section II on *Users' Understandings*, five chapters invoke central issues in cognitive science, dealing with the complexities of defining, assessing, and promoting "understanding." Collectively, the authors focus on the substantive details and origins of the mental models users construct for how computational systems work. They hope that with better knowledge about how users come progressively to understand a system, we may be able to build better learning support into it. Riley discusses three criteria for establishing user understanding of an interactive system: internal coherence, validity, and integration of available and new knowledge. Lewis asks how users understand what is happening in system interactions. His account of explanation-building as a key encoding structure when learning to use systems is the richest chapter for educators and developmentalists, and has important implications for training models. Owen discusses some examples of user interactions suggesting the existence of naive theories of how computation works which may interfere with system learning. DiSessa differentiates three different models of computation which he believes should be learned simultaneously: structural, functional, and distributed models (aggregations of partial understandings). Mark describes a rigorous knowledge-based design methodology he has developed for ensuring coherence of the system image model presented to users for an office automation system.

Section IV looks at *User Activities*, examining their structure with a particular emphasis on supporting multiple, interleaved activities. Windows as they are today are inadequate, since some of these activities are related, others not. Cypher offers empirical grist for the argument that users need flexibility in grouping their systems activities, since these activities often share contexts in different ways. Miyata and Norman's chapter on psychological constraints on pursuing multiple activities is a complementary treatment, drawing on experimental work in attention, memory, perception, and cognition. This chapter suggests various supports for reminding users of suspended activities, as well as for concurrent activities. Their analysis of "reminding" suggests fertile ground for future experimentation. From research on the success of topic-switching in natural language discourse, Reichman (Adar) takes rich prescriptions for redesigning communication paradigms for window systems. The aim is to attain smoother ballistics of system use.

Section V assesses technical possibilities for developing a more optimal

pragmatics of human-machine communication. Buxton's chapter highlights the mismatch between the range of input devices used and the sensorimotor capacities we have available, including two hands, feet, sound and voice. His important admonitions on matching input device features to task appropriateness recommend less simplistic holistic comparisons of input devices than commonly found. Draper traces design implications of the important unifying I/O concept of a "shared medium": making user input refer to an object in the system's output.

Section VI highlights the need for a unified approach to designing interactive systems for better *information flow*—between people as well as between systems and people. Owen offers insights on conditions when we may need to volunteer information to users before they know how to request it. O'Malley describes types of question formulation supports for helping users help themselves, and persuasively considers how systems can help users help each other. Taking the stance that error is an inevitable aspect of much goal-directed action, Lewis and Norman propose and critically examine methods for minimizing error-proneness (at the level of user system understanding), and for rapid discovery of and graceful recovery from errors. Bannon discusses current tools and future prospects for system-facilitated interpersonal communication.

Section VII is devoted to John Seeley Brown's futuristic synthesis chapter on interactive systems as socio-cognitive technologies. He argues that creative tasks such as designing, communicating, and writing can be better socially constituted with computer supports. He offers a heuristic framework of issues and design strategies for analyzing the challenges of maintaining user understanding and control of interactive systems. Generalizing from natural language discourse, he provides a compelling pragmatic analysis of the central nature of "repair," or trouble management, in systems design and use. Finally, Brown forcefully conveys the need for "mutual intelligibility"—a dynamic in which machines and people can understand one another's moves in an interaction and respond appropriately. Revisiting Bauhaus, he characterizes potentials of interactive technologies as carriers of social change, for example, to create design communities through distributable recorded histories of design development.

I have no doubt that the authors' novel treatments of concerns in user-centered system design will have broad applicability to interactive systems designed for work, learning, and even play. Indeed, many chapters make one impatient to test one's favorite or in-progress designs against the various prescriptions and analyses of the tradeoffs they outline. This volume contributes an excellent new source for teaching graduate courses and for conducting industry workshops.

What questions test the limits of the new perspectives contributed by this volume? And what next steps might be profitable? Experimental design work informed by these perspectives is clearly in order. Enlightened by the new issues and methodologies, the how-to-do-it enthusiast will probably run to Card, Moran and Newell's *Psychology of Human-Computer Interaction* for comfort from the difficulties of social, communicative and phenomenological analyses recommended here. But I believe these groundbreaking chapters provide an attractive counterpoint to an isolated experimentalism, giving this field a welcome kinship to literary criticism and social theory. But that leads to its main limitations.

It is an ironic challenge that once the authors have widened their scope to include many divergent perspectives and literatures (e.g., architectural design, Aristotle's poetics), other fields become pressing and their omission more salient. The first is the "logic of inquiry": there is an extensive literature on question formulating and posing, dating from Dewey and colleagues to current studies in erotetic logic by Rescher and others. The section on information flow might be enriched if it built more on this substantial history.

Throughout this book, the fundamental problem haunting the reader concerns the *moral* dimensions of systems design. The authors often confront prescriptive issues. Sometimes prescriptions involve only local principles of interactive systems design, for example, concerning I/O conventions. But once the discourse turns to reshaping society by using interactive systems as carriers of social change, to transforming human attitudes, beliefs and behaviors, the inadequacies of cognitive engineering as moral science are revealed. These struggles are nowhere more apparent than in Hooper and Bannon's introductory chapters comparing user-centered system design to architectural design, and in Brown's treatment of social change potentials of computing. How does the designer get from possibilities to telos?

Unfortunately, the tenor of moral dialectic found in contemporary "postmodernist" exchanges in philosophy and social theory is absent here. Issues treated here are more microsocial (i.e., relating to existing user groups) than macrosocial, pertaining to societal or global changes. Few would dispute the values of sharing and collaboration to which the authors' user-centered systems would aim. But difficulties abound, such as distribution of power and solidarity in access to data and systems. And in the moral realm as in systems design there are tradeoffs, for example, of freedom and equality. The profound possibilities of negative effects of the "reshaping" of society with technologies require more analysis. For example, consider the establishment of new contexts and methods for discrimination, and of invasions of privacy and impositions of social control.

As a responsible consumer of proposed societal changes wrought through new technologies, one must ask: *who* does the reshaping of society with technologies? And in *whose interests*, for what *purposes*? These issues are familiar from continentally-inspired debates on research knowledge and human interests, and debates over third world industrialization. But they resurface here with a vengeance. Until such questions are addressed, we should be cautious of pronouncements that "user"–centered system design should play proactive roles in shaping society. Current "users" are not representative of the social base that defines the society. Poor and unemployed communities are either un- or under-represented in the collection of needs and interests supported by technologies discussed here. Contexts for examples are primarily offices, university mainframe operating systems, accounting, programming, and corporate board rooms. This is understandable, because examples are drawn from research studies funded by related institutions. But there are likely to be incompatibilities of American financial interests competing in a world economy and non-nationalistic moral issues of global freedom, justice, and other social ideals. Any responsible "proactive" shaper of interactive systems needs to monitor these influences.

It is also worth noting that there is a complex history of child-centered approaches to education which share some of these difficulties. But in some sense the UCSD issues are deeper, since they potentially involve the definition of "homo sapiens siliconous": integrations of human mind and interactive technologies not only to support but to reshape what humans do, think about, and feel about themselves and others in their social system. Throughout, the designer faces difficult values issues: what should be done given a field of choices, each with different advantages and costs, individual and social, many of them unknown until tried?

Of course this is already an ambitious book, and we cannot expect the authors to have compiled a moral treatise on top of a psychotechnological one. Nonetheless, the social dimensions of these essays render apparent the need to strike a collaborative mode with the work of social theorists such as Gadamer and Habermas, critical epistemologists such as Bernstein, Putnam and Rorty, and the many communities to be affected by the social changes wrought by future technologies. We need to articulate and experiment with methods for designing, monitoring, and evaluating the social and moral consequences of new interactive systems. Paradoxically, electronic communication media, if universally accessible and usable, might provide the very medium of "user input" on values that would rekindle the possibilities of a democratic ideal. Only then will the humane uses of technology to which the authors clearly aspire emerge from the needs and interests of the evolving communities and societies they should serve.

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