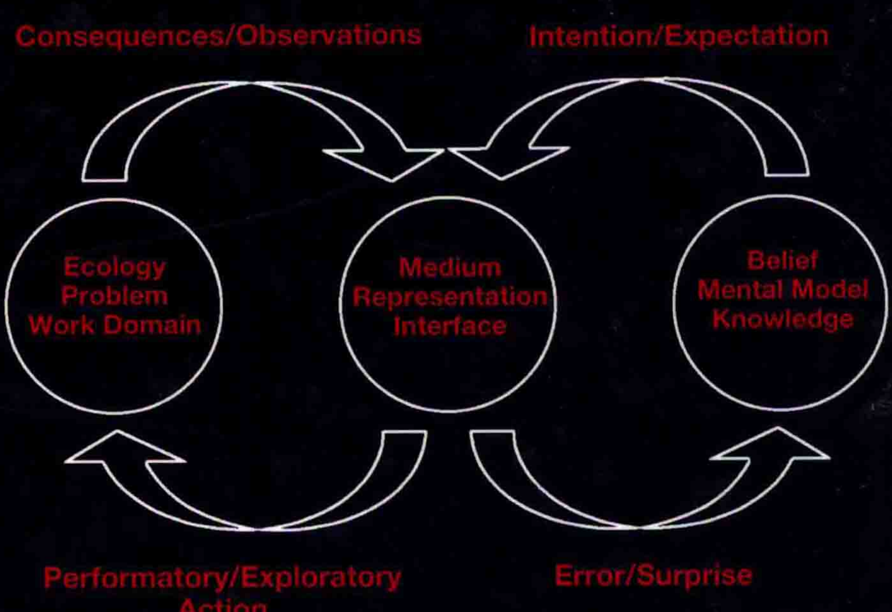
Kevin B. Bennett
John M. Flach

Display and Interface Design

Subtle Science, Exact Art



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To Jens Rasmussen for his inspiration and guidance.

Preface

This book is about display and interface design. It is the product of over 60 years of combined experience studying, implementing, and teaching about performance in human–technology systems. Great strides have been made in interface design since the early 1980s, when we first began thinking about the associated challenges. Technological advances in hardware and software now provide the potential to design interfaces that are both powerful and easy to use. Yet, the frustrations and convoluted "work-arounds" that are often still encountered make it clear that there is substantial room for improvement. Over the years, we have acquired a deep appreciation for the complexity and difficulty of building effective interfaces; it is reflected in the content of this book. As a result, you are likely to find it to be decidedly different from most books on the topic.

We view the interface as a tool that will help an individual accomplish his or her work efficiently and pleasurably; it is a form of decision-making and problem-solving support. As such, a recurring question concerns the relation between the structure of problem representations and the quality of performance. A change in how a problem is represented can have a marked effect on the quality of performance. This relation is interesting to us as cognitive psychologists and as cognitive systems engineers.

As cognitive psychologists, we believe that the relationship between the structure of representations and the quality of performance has important implications for understanding the basic dynamics of cognition. It suggests that there is an intimate, circular coupling between perception–action and between situation–awareness that contrasts with conventional approaches to cognition (where performance is viewed as a series of effectively independent stages of general, context-independent information processes). We believe that the coupling between perception and action (i.e., the ability to "see" the world in relation to constraints on action) and between situation and awareness (i.e., the ability to make sense of complex situations) depend critically on the structure of representations. Thus, in exploring the nature of representations, we believe that we are gaining important insight into human cognition.

As cognitive engineers, we believe that the relation between representations and the quality of performance have obvious implications for the design of interfaces to support human work. The design challenge is to enhance perspicuity and awareness so that action and situation constraints are well-specified relative to the demands of a work ecology. The approach is to design representations so that there is an explicit mapping between the patterns in the representation and the action and situation constraints. Of course, this implies an analysis of work domain situations to identify these constraints, as well as an understanding of awareness to know what patterns are likely to be salient. We believe that the quality of representing the work domain constraints will ultimately determine effectivity and efficiency; that is, it will determine the quality of performance and the level of effort required.

Intended Audience

The primary target audience for this book is students in human factors and related disciplines (including psychology, engineering, computer science, industrial design, and industrial/organizational psychology). This book is an integration of our notes for the courses that we teach in interface design and cognitive systems engineering. Our goal is to train students to appreciate basic theory in cognitive science and to apply that theory in the design of technology and work organizations. We begin by constructing a theoretical foundation for approaching cognitive systems that integrates across situations, representations, and awareness—emphasizing the intimate interactions between them. The initial chapters of the book lay this foundation.

We also hope to foster in our students a healthy appreciation for the value of basic empirical research in addressing questions about human performance. For example, in the middle chapters we provide extensive reviews of the research literature associated with visual attention in relation to the integral, separable, and configural properties of representations. Additionally, we try to prepare our students to immerse themselves in the complexity of practical design problems. Thus, we include several tutorial chapters that recount explorations of design in specific work domains.

Finally, we try to impress on our students the intimate relation between basic and applied science. In fact, we emphasize that basic theory provides the strongest basis for generalization. The practical world and the scientific/academic world move at a very different pace. Designers cannot wait for research programs to provide clear empirical answers to their questions. In order to participate in and influence design, we must be able to extrapolate our research to keep up with the demands of changing technologies and changing work domains. Theory is the most reliable basis for these extrapolations.

Conversely, application can be the ultimate test of theory. It is typically a much stronger test than the laboratory, where the assumptions guiding a theory are often reified in the experimental methodology. Thus, laboratory research often ends up being demonstrations of plausibility, rather than strong tests of a theory.

We believe this work will also be of interest to a much broader audience concerned with applying cognitive science to design technologies that enhance the quality of human work. This broader audience might identify with other labels for this enterprise: ergonomics, human factors engineering, human–computer interaction (HCI), semantic computing, resilience engineering, industrial design, user-experience design, interaction design, etc. Our goals for this audience parallel the goals for our students: We want to provide a theoretical basis, an empirical basis, and a practical basis for framing the design questions.

Note that this is not a "how to" book with recipes in answer to specific design questions (i.e., *Interfaces for Dummies*). Rather, our goal is simply to help people to frame the questions well, with the optimism that a well-framed question is nearly answered. It is important for people to appreciate that we are dealing with complex problems and that there are no easy answers. Our goal is to help people to appreciate this complexity and to provide a theoretical context for parsing this complexity in ways that might lead to productive insights. As suggested by the title, our goal is to enhance the subtlety of the science and to enhance the exactness of the art with respect to designing effective cognitive systems.

Kevin Bennett

John Flach

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The second author wants especially to thank Rich Jagacinski and Dean Owen, two mentors and teachers who set standards for quality far above my reach, who gave me the tools I needed to take the initial steps in that direction, and who gave me the confidence to persist even though the goal remains a distant target. Also, special thanks to Kim Vicente, the student who became my teacher. I also wish to acknowledge interactions with Jens Rasmussen, Max Mulder, Rene van Paassen, Penelope Sanderson, Neville Moray, Alex Kirlik, P. J. Stappers, and Chris Wickens, whose friendship along the journey have challenged me when I tended toward complacency and who have encouraged me when I tended toward despair. Finally, I want to thank my wife and sons, who constantly remind me not to take my ideas or myself too seriously.

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Finally, thanks to the software specialists. Daniel Serfaty and Aptima kindly provided us with their DDD® simulation software and Kevin Gildea helped us use it effectively. Randy Green implemented (and often reimplemented) many of the displays, interfaces, and environments that are described here.

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Drs. Flach and Bennett are co-directors of the Joint Cognitive Systems Laboratory at Wright State University. They share interests in human performance theory and cognitive systems engineering, particularly in relation to ecological display and interface design. Their independent and collaborative efforts in these areas have spanned three decades.

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