PREFACE

Special Issue on Cognitive Engineering

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Computer-based systems have changed the nature of the work undertaken at the human–machine interface. More than ever before, operators of complex sociotechnological systems are working in a multidimensional information space. Within aviation, the development of the *glass cockpit* was the forerunner of things to come. Glass interfaces now pervade all areas of aviation systems. Computerization has substantive benefits in that it has introduced enormous flexibility to the interface and is based on a reliable, compact, and inexpensive technology. There is, however, a concern that it has introduced new human performance problems (Sarter & Woods, 1994) that might be classified generically as problems of navigating through an information space.

It would be inappropriate to view this new class of human performance problems as an inevitable consequence of increasing computerization. It has emerged in part because a rational design philosophy (Lintern, 1995) has been employed to determine what information should be provided at the interface and how systems should be operated. The result, possibly nowhere more evident than with many current implementations of automation, has been efficient but brittle systems (Lintern, 1995; Perrow, 1983).

Our rapidly developing computer technologies offer new opportunities as they offer new challenges. The promise put forward here is that there is a way to exploit the power and flexibility of modern computers in the design of interfaces that re-

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duce cognitive effort and support robust performance. To do so will, however, require a new approach to design.

It has been common in many areas to rely for new capabilities on the artisan–practitioner who is also an accomplished designer. Almost from its inception, the technological complexity of aviation has required different models of design (Lintern, 1995). Evolutionary design has been effective for complex, large-scale systems constructed from a slow-changing technological base, and participatory design (Bodker, 1991) is an option for small-scale systems constructed from a rapidly changing technological base. Development of aviation systems has exploited elements of both. However, we are now faced with the challenges of design for complex, large-scale systems with a rapidly developing technological base. Cognitive systems engineering is presented here as a methodology that can cope with the new challenges posed by the task of interface design in this new environment.

Cognitive systems engineering constitutes a set of methodologies for acquisition and representation of the domain and subject matter knowledge essential to interface design. It is a systematic process that assembles and organizes information about a work domain and the work force as a means of designing the modes of human–system interaction. Embedded in cognitive systems engineering is the assumption that knowledge about the work domain, about operator skills and strategies, and about social organization in the workplace is crucial to the development of new systems (Vicente, 1999). Essentially, this approach to design relies on an extensive analysis of the potential modes of human–system interaction within a work domain.

Jens Rasmussen has, for two decades, been at the forefront of developing this approach to interface design. It has been his vision to see the need and his energy and purpose that have stimulated this enterprise. It is fitting that he has the opportunity in the lead article of this special issue to outline the need, the challenge, and the current status of the proposed solution. The methods of cognitive systems engineering have, however, been developed outside the context of aviation. One unfilled need is to demonstrate relevance to our concerns. In the second article, with my colleagues, Tyler Waite and Donald A. Talleur, I do that in a general way, whereas in the third article, Nick Dinadis and Kim J. Vicente apply these methods to a specific problem in aviation. In the fourth article, Neelam Naikar and Penelope M. Sanderson explain their use of the methods to analyze the requirements for an aviation-based training system. Finally, as a reprise, Dal Vernon C. Reising offers an essay review of the text that brought these ideas together, the book titled *Cognitive Systems Engineering* by Jens Rasmussen, Annelise Mark Pejtersen, and L. P. Goodstein.

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