Design Specs for a Cognitive Engineering Textbook

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This discussion panel will consider whether the time is right for a cognitive engineering textbook and what the ideal specifications for such a text would be. Courses in this area are typically taught using either one of various books focused on a particular approach or perspective, or else multiple books or articles that aim at somewhat broader coverage. The panelists are recognized leaders in cognitive engineering research and education at universities and industry. One important focus of the discussion will be whether the field has matured to a point where some of the barriers that have contributed to the difficulty of creating such a book can now be overcome. These include the need for a systematic and coherent integration and orderly presentation of material in the style required for a true textbook, and a shared or convincing definition of the scope of the field.

A COGNITIVE ENGINEERING TEXTBOOK?

This panel brings together a group of leading researchers, educators and professionals from universities and industry to discuss, and perhaps debate, whether the time is right for a cognitive engineering textbook, and what the ideal specifications for such a book would be. At present, courses in this area are typically taught using either one of various books focused on a particular approach or perspective, or else multiple books or articles that aim at somewhat broader coverage. It is not at all obvious, and certainly not agreed, that the literature in cognitive engineering as it currently exists even admits of the type of systematic and coherent integration and orderly presentation that is required of a true textbook. Arguments can be made that such an integrated textbook may be not only premature, but also simply inconsistent with the diversity and rapidly changing pace of cognitive engineering as a profession and area of research.

On the other side of this coin, arguments can also be made that good textbooks play important roles in not only documenting and presenting a field but also in defining it. In this view, textbooks do not necessarily have to be faithful to past or current practice or opinion in scoping and presenting a discipline to be successful. Clearly, there is no requirement for a cognitive engineering textbook to recapitulate the entire history of key ideas, works and creation myths that have played an integral role in providing the initial intellectual and financial footing for the discipline. Instead, or so this argument goes, cognitive engineering has now matured to the point where it has an eager audience and market, and the central task has shifted from one of championing and consciousness raising to one of delivering the goods in the sober and systematic manner characteristic of successful texts in all other mature areas of engineering.

Even the most cursory examination of engineering texts in other areas indicates that doing so requires identifying the foundations of the field and the sequencing of topics in a manner that is ordered by intellectual, rather than historical concerns. Achieving such an ordering requires an ability to define the basic ideas, methods, measures, models, tools and techniques involved in cognitive engineering, and importantly, an

ability use these concepts and constructs reflectively to present problems and their solutions to students in a manner that is ordered from simple to complex. Such an ordering is obviously different than the historical order in which cognitive engineering matured, or any order or structure inherent in the current literature. Yet identifying such an ordering is crucial to creating the type of scaffolding framework required for any textbook equipping students to solve sequentially more complex and difficult problems.

A clear absence of any agreed upon knowledge of how one might identify and define the intellectual rather than historical foundations of cognitive engineering, and sequence material to promote an incremental and scaffolded approach to education is one of the primary motivations for having the discussions that this panel will hopefully promote. Some type of intellectually coherent and educationally effective sequencing of material would seem to be required whether that material is comprised of mathematical equations or case studies. The panelists will be asked to address this issue, and others, including:

1) Level (graduate, undergraduate, both).

2) Required or assumed student preparation.

3) Appropriate content (methods, models, measures, theories, findings, design frameworks, case studies, application domains, examples, etc.

4) Problems and assignments.

5) Pedagogy.

6) Use of electronic resources.

7) Support for student evaluation.

8) Other.

STATEMENTS BY PANELISTS

Cognitive Engineering Education: Many Disciplines and Many Perspectives

Ann Bisantz

As the research and practice base in cognitive engineering has grown, it makes sense to move towards a more formalized and integrative approach to cognitive engineering education. Clearly, many people are teaching excellent, content rich courses in cognitive engineering, but to date, due to the lack of broadly based, integrative texts in the area, instructors must assemble course materials from a variety of sources, or choose to focus the course on the traditions and methods as emphasized in one of the many monographs which support cognitive engineering practice. Additionally, due to the multidisciplinary nature of the material, as well as the often diverse backgrounds of students attracted to the course, instructors often must "fill in" basic background in areas such as knowledge representation, reasoning, decision- making, and problem solving. A text that included such background foundations, along with a broad (and thoughtfully integrated) description of methodologies and case examples, would be a valuable addition to education in this field.

A Cognitive Engineering Textbook: Why WE Can't (Or Shouldn't) Do It

Catharine Burns

An excellent cognitive engineering textbook needs to provide broad coverage of the field. A student in cognitive engineering needs a toolkit of multiple methods, practical examples and guidance on when to use each method most effectively. As cognitive engineering researchers we tend to be experts in one method, relatively naïve in other methods, and often guilty of overusing our specialty method for all problems. The best cognitive engineering textbook will be written by someone not invested in any one methodology, possibly even outside of cognitive engineering. They need to have the perspective of a student and understand the needs of an effective future cognitive engineer. What should the cognitive engineer of the future be able to do?

Nancy J. Cooke

Textbooks not only educate, but also help define a field in terms of the topics covered. Therefore, the scope of one of the first textbooks in cognitive engineering is critical and deserving of the attention of the field as a whole. Cognitive engineering or cognitive "systems" engineering can be defined by the people who call themselves cognitive engineers and the work that they do, encompassing different theoretical frameworks, approaches, methods, and applications. One way to survey this breadth is to examine cases in which cognitive engineers have successfully changed cognitive systems for the better. Frank Durso and I recently gathered seven cases of cognitive engineering successes for a forthcoming Taylor and Francis book, *Stories of Modern Technology Failures and Cognitive Engineering Successes*. These seven stories represent a variety of cognitive systems problems, approaches, and

application of methods that can provide input to the design of a cognitive engineering textbook.

Stephanie Guerlain

As a professor of a graduate CSE course for engineering students, most of whom know nothing about psychology, I always start with the basics of human information processing, but proceed directly and often to implications for design, with examples. I have students perform fieldwork leading to a cognitive task/work analysis for a domain unfamiliar to them. I also introduce performance evaluation methods, comparing usability testing to experimental design, and the tradeoff between "controlling everything" and having some external validity and the need for different kinds of statistics depending on the design. We also delve into and practice various performance measures (time, errors, talk aloud, behavioral protocol, WL, SA, etc.) and finish up with example decision support techniques and human-automation interaction examples. I can never find a book that is structured the way I'd like it to be. I've used in the past various combinations of books and readings.

Preparing Practitioners to Address the "Cognitive" and the "Engineering" in Complex Systems

John D. Lee

Cognitive engineering places strenuous demands on its practitioners. To function effectively they must bridge the gap between the considerations of psychology and engineering. A cognitive engineering textbook must also bridge this gap. To achieve this end, a textbook must provide students with a theoretical grounding in cognitive constraints that guide human behavior. The book must also introduce the engineering constraints that define the context of human-system interaction. Such perspectives might be best reconciled using the philosophy of ecological psychology. Although ecological psychology provides a unifying framework that describes how engineering and cognitive factors constraint human behavior, the book must also serve to introduce engineers to the research techniques of behavioral scientists (e.g., ethnographic analysis). It must also introduce behavioral scientists to the analytic techniques of engineers (e.g., Monte Carlo simulation). This information should be presented in support of the analysis, design, and evaluation cycle that underlies system development.

Nadine Sarter

Given the growing number of Cognitive Engineering and Cognitive Ergonomics programs across and beyond the US, the need for a textbook in these areas is increasingly felt by both instructors and students. However, creating such a textbook involves numerous challenges. For example, the field of CE is still rather young, and thus there are fewer agreed upon models, methods, and paradigms than in more established sciences. For the benefit of students, it will be important to provide a balanced and coherent account of the different approaches and schools of thought. Another requirement is the creation of examples and assignments that are sufficiently complex to illustrate the real challenges of conducting CE work. Also, CE programs reside in different departments across universities, and courses in this field tend to attract students from outside those departments. Thus, the knowledge base of students in CE courses varies widely which calls for either an extensive background section or at least a significant number of references to relevant related material.

Daniel Serfaty

As a "consumer" of Cognitive Engineering (CE) talent at Aptima, and a producer of CE-based designs and analyses, I feel their is an urgent and important need for a good textbook/reference in Cognitive Engineering. As CE practitioners, we need a text that blends theories, models, and applications, with an emphasis on design. The text must include approaches to integrate CE with classical/accepted methods of Systems Engineering. This is also an opportunity to revise, update, and streamline accepted CE methods of knowledge elicitation and modeling, such as Cognitive Work Analysis. Only a textbook, at the advanced undergraduate/graduate level, can do this. I would also welcome and encourage a special section on measurement and evaluation. Great advances have been made in systematic, rigorous, quantitative human-systems performance measurements that need to be captured in this textbook. My hope is that this book can contribute to giving CE a place on the bookshelves at the same level that Systems Engineering, Mechanical Engineering, or Software Engineering. I believe the CE field is now mature enough and the community large enough to make such a feat possible.

CONCLUSION

It is hoped that this panel discussion helps to determine if the time is right for a cognitive engineering textbook, and if so, also results in useful ideas about the ideal content and structure of such a book. In addition, it is hoped that this panel prompts continued and constructive dialogue on these issues.