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This issue contains articles on the following subjects:1.Situation Awareness: The Buzzword of the '90s; 2.Naturalistic Decision Making: Implications for Design; 3.Human Factors program for Intelligent Vehicle-Highway Systems; 4.The OCS TOOLS: Efficient Event Analysis Through Multimedia Integration

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VOLUME V: NUMBER 1 (1994)

CSERIAC GATEWAY

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CSERIAC is a United States Department of Defense Information Analysis Center administered by the Defense Technical Information Center, Alexandria, VA, managed by the Human Engineering Division, Armstrong Laboratory, Wright-Patterson Air Force Base, OH, and operated by the University of Dayton Research Institute, Dayton, OH.

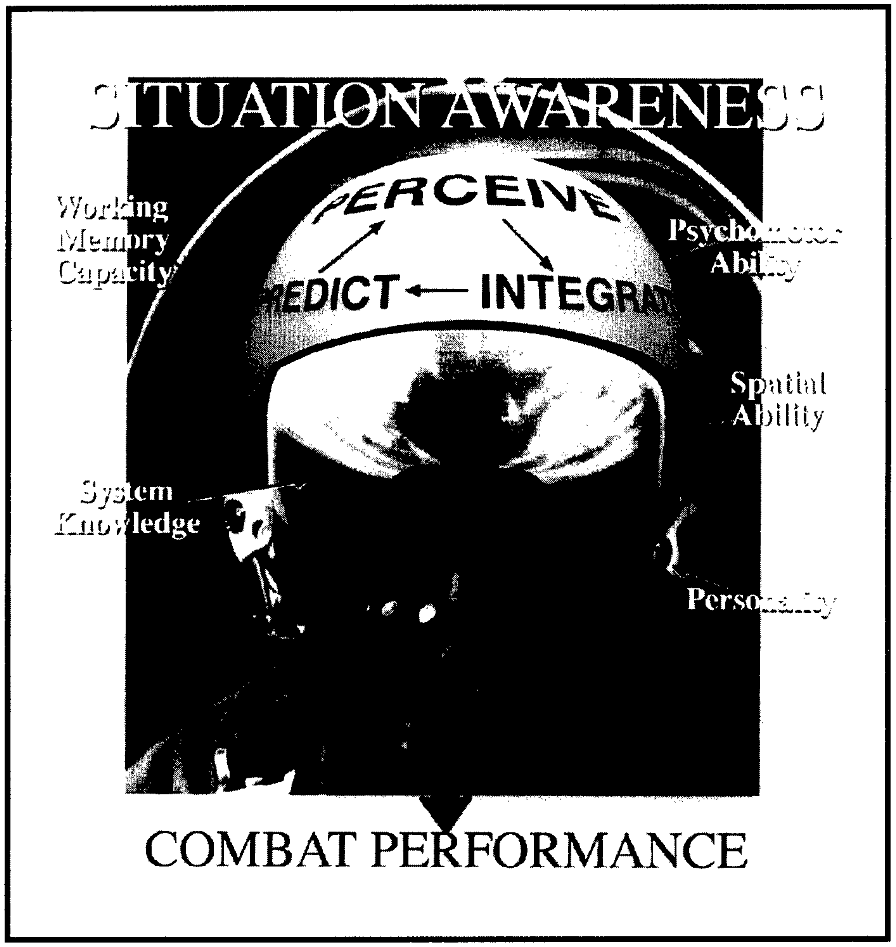

Figure 1. Situation awareness encompasses more than data about the environment; it includes how those data are interpreted and predictions are made by the human. Some of the variables influencing these processes are depicted above. Photo courtesy of Tanya Ellifritt, Human Engineering Division, Armstrong Laboratory.

Situation Awareness: The Buzzword of the '90s

Richard W. Pew

It was my pleasure to discuss *situation awareness* (SA) as part of the Human Engineering Division, Armstrong Laboratory Colloquium Series last June. While my colleagues and I have been working on this topic for a couple of years, we have tried to maintain a healthy skepticism about exactly what we should mean by it. Indeed, I often wonder even whether we should try to

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work with it as an overarching concept at all, one that is anything more than what we think about in the traditional assessment of human performance requirements in any particular system. Nevertheless, it has replaced *workload* as the buzzword of the '90s. In many analysts' eyes, achieving situation awareness has become a design criterion along with more traditional performance measures. Organizations are concerned about whether it is an individual difference variable - whether we can think of some individuals as having more of it than others - something we could test for. Still others are asking whether it is something specific that can be trained. However, using SA in any of these ways requires more than an everyday understanding of the term. It requires a more formal definition and in this article I would like to share with you some of the thoughts of our group at Bolt, Beranek, and Newman, Inc., (BBN) concerning possible elements of a definition.

If pressed for a one-sentence definition, I opt for Endsley's (1988) version:

> *The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and projection of their status in the near future.* (p. 97)

This definition captures the notion of spatial awareness that is important to piloting examples, but also leaves room for awareness of system states for non-moving systems, such as are produced by a nuclear power plant safety parameter display system. It acknowledges the fact that it is not just data from the environment that matter, but also the interpretation of those data, utilizing the crew members' knowledge and experience (see Fig. 1). Finally, it includes the notion that effective SA is useful for anticipating what is likely to happen in the future as well as knowledge of the immediate present.

However, measuring SA requires more than a one-sentence definition. For me, the definition must include the characterization of what we mean by a "situation." Then, given an adequate definition of a situation, we need to know what we must be aware of about situations. My colleagues at BBN and I adopt the following as a working definition of a situation:

> *A situation is a set of environmental conditions and system states with which the participant is interacting that can be characterized uniquely by its priority goals and response options.*

This definition was arrived at, at least in part, because we were trying to figure out when one situation ended and another began. This is important because a coherent definition of SA means that awareness requirements must change when situations change. Otherwise we need to be aware of all things at all times, and the concept of SA has little value. Our current view is that in complex decision-making situations an individual has multiple goals in the priority stack. At any one time, one or two of those goals are paramount and those goals, and the response options associated with them provide the basis for defining situation-awareness requirements. It is to this part of the definition that we turn next.

The SA requirements are the essential elements of information and knowledge needed to cope with each unique situation. Since virtually all measurements in human factors are relative, we argue that measuring SA implies having a standard, a set of SA requirements, if you will, against which to compare human performance. Such a standard must encompass an *abstract ideal*, a *physically realizable ideal*, and a *practically realizable ideal*. The abstract ideal includes the full set of information and knowledge that would make a contribution to accomplishing a particular goal. This is an abstract ideal because it is unconstrained by the design of the crew station and the information that is actually available to the crew member. Definition of the physically realizable ideal introduces the constraint of a real crew station. It is the information and knowledge that a crew member could obtain, given the current information resources in the workplace, that is, the current suite of displays and controls. It places no constraints on the information processing capacities and limitations of the crew member. Finally, we think in terms of a practically realizable ideal, what any real individual might be able to achieve under the best circumstances, taking into account typical human performance capacities and limitations. It sets the standard against which to evaluate how well an individual performed given the system he or she had to work with.

The definition of the abstract ideal helps us to understand what might be accomplished with better design and implementation. The physically realizable ideal and the practical ideal provide a basis for addressing the potential for training and selection. They also might help us decide on format and layout to get the most from human performance.

When discussing SA we make a distinction between the process of achieving it, sometimes called situation assessment, and the product or awareness that results. The process is defined in terms of the demands for assessing the relevance, procedural implications, and urgency of incoming data as well as initiating goal-oriented information-seeking behavior. The process involves active association between knowledge stored in memory and currently arriving information, and it leaves traces in memory at varying levels of accessibility. The skilled performer has learned what information to keep in the most readily accessible stores and how to change these priorities dynamically as a function of the changing situation.

Endsley (1988) argues that the product can be represented at three different levels. The *information level* reflects the literal data or state information that is utilized for decision making. The *interpretation level* is concerned with understanding the implications of the data. The *prediction level* is concerned with anticipating likely future states.

The distinction between process and product is important because we might be tempted to just measure the product when we are assessing SA; however, improving SA is more likely to involve influencing the process, either through design, selection, or training. We had better find ways to measure it as well.

Perhaps many of us are leaping on the bandwagon prematurely. There is still a need for fundamental demonstrations that SA may be regarded as a general concept or capacity that can be differentiated from operational human performance itself. Let me suggest three ways that this could be accomplished:

(1) It would be nice to conduct a study in which subjects were pretested on a battery of tests selected specifically because the measured sensory, perceptual, and cognitive characteristics are thought to contribute to SA. For this to be a fair test, it would also be necessary to assess characteristics which, although equally important to overall performance, were specifically not considered a part of SA. This latter selection is the hard part. Then select a practical task for which SA is considered particularly important. If the individual differences associated with SA significantly contributed to performance variance in the practical task, while the others did not, then I would consider such findings to be supporting evidence for the concept of SA. The Armstrong Laboratory has been attempting at least the first half of this demonstration over the past year using air-to-air combat as the criterion task. However, even if successful, with-

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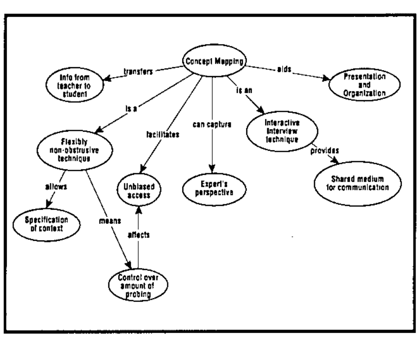
TAKE A LOOK!

New Concepts in Human Factors Coming this Spring

Tools for Automated Knowledge (TAKE) from the Human Engineering Division, Armstrong Laboratory



A concept map derived from TAKE

Concept Mapping software for use during system specification and development, user requirement identification, function identification, and task analysis. TAKE is designed to help you map, organize, categorize, and retrieve the volumes of information provided by subject-matter experts and end-users during knowledge elicitation. TAKE runs on a Macintosh Computer System 7.0.

Look for the article in the next issue of Gateway. TAKE will be available this Spring. For further information, contact the CSERIAC Technology Transfer Analyst at (513) 255-4842.

COTR Speaks

Reuben L. Hann

Situation awareness has become a "hot" area in human factors and ergonomics. While everyone seems to be using the term, few have attempted to develop a standard definition. In our feature article, Dr. Dick Pew of BBN offers us a definition and delineates the essential elements of situation awareness. In addition, he suggests several ways in which the concept of situation awareness can be distinguished from operational human performance. This informative article is based on Dick's lecture last summer as the seventh and final speaker in the 1993 Human Engineering Division, Armstrong Laboratory Colloquium Series: The Human-Computer Interface.

Dr. Gary Klein of Klein Associates was the fourth speaker in the 1993 Colloquium Series, where he presented the latest information on *naturalistic decision making*. Dr. Mike McNeese from the Design Technology Branch in our division, summarizes the lecture in this issue. I had the chance to meet with Dr. Klein for an extended interview. An edited transcript of my conversation with Gary follows Mike's summary.

On the topic of naturalistic decision making, Klein Associates and CSERIAC have joined forces to present the *Second Conference on Naturalistic Decision Making* at the Dayton Marriott Hotel June 13-15, 1994. A full-page announcement providing details of the conference appears on p. 10 of this issue of *Gateway*.

Intelligent Vehicle-Highway Systems (IVHS) are the road to the future, quite literally! The Federal Highway Administration (FHWA) has been hard at work to ensure that human factors are considered in their design. Elizabeth Alicandri of the FHWA's IVHS Human Factors Group examines four of the IVHS projects under study.

Triangle Research Collaborative (TRC) has developed a set of computer tools to assist in collecting observational data that reduce the time involved and number of errors. These tools are called the OSC Tools, and Dave Randle and Ted Szostak from TRC have prepared a report on them for *Gateway* readers.

If you have never had the chance to meet any of our CSERIAC staff members, we offer you the next best thing: The back cover of the *1994 Human Factors and Ergonomics Society Directory and Yearbook* will have a photo of the whole crew. At least you will be able to put a face with the voice the next time you have any contact with us. It's a fine group of dedicated people; we hope you'll let them help by contacting CSERIAC to discuss your ergonomics problems. ●

Reuben "Lew" Hann, Ph.D., is the Contracting Officer's Technical Representative (COTR) who serves as the Government Manager for the CSERIAC Program.

Situation Awareness from page 3

out addressing the second (non-SA) half, it will be hard to argue that they have done any more than predicted individual differences associated with air-to-air combat.

(2) Second, a similar demonstration should be made that generic training for SA, with training for non-SA features of a task as a control condition, can make a differential contribution to the performance of a practical task.

(3) Finally, perhaps it comes down to the bottom line. Identify a design change that can produce a quantifiable improvement in SA per se. If SA is really important, then we would expect the staff responsible for design decisions to be willing to invest resources to make that change. To the extent that we have convinced the client that SA is important, we should no longer have to prove each time that it makes a difference in overall performance.

As usual, the ultimate test is in the market place. ●

Richard W. Pew, Ph.D., is a Principal Scientist and the Manager of the Experimental Psychology Department at BBN Systems and Technologies, Division of Bolt, Beranek, and Newman, Inc., Cambridge, MA.

References

Endsley, M.R. (1988). Design and evaluation for situation awareness enhancement. *Proceedings of the 32nd Annual Meeting of the Human Factors Society, 1*, 97-101.

GATEWAY

Announcements

Human Factors and Ergonomics Society Placement Service

Human Factors and Ergonomics Society (HFES) offers an opportunity for employers seeking human factors/ergonomics expertise to tap into the tremendous knowledge base and range of experience of HFES members and other professionals in related fields.

The HFES Placement Service can help in filling full-time, part-time, or consulting positions. Both members and nonmembers may use the service for renewable four-month terms. Anonymity will be maintained if requested by the user.

Call HFES at (310) 394-1811 or fax (310) 394-2410 to obtain rates and application forms.

BCPE Certification Requirements Revised

The Board of Certification in Professional Ergonomics (BCPE) has revised its certification requirements for ergonomists and human factors professionals. Starting January 1, 1994, certification criteria are (1) a master's degree in ergonomics/human factors or equivalent educational background; (2) four years of full-time professional practice in ergonomics with an emphasis on ergonomic design; (3) submission of a work product demonstrating the application of ergonomics to a product, process, or environment; and (4) a passing score on a written certification examination administered by the BCPE.

Applications are available for $10 and the application processing fee is $200 (to which the $10 application fee may be applied), and the annual renewal fee is $75. For further information or an application, please contact:

BCPE
Office of the Executive Director
P.O. Box 2811
Bellingham, WA 98227-2811
Telephone (206) 671-7601, fax (206) 671-7681

Calendar

April 19-22, 1994
University of Warwick, UK
Ergonomics Society Annual Conference. Contact Conference Manager, Devonshire House, Devonshire Sq., Loughborough, Leichestershire LE11 3DW, UK; (44) 509-234904.

April 24-28, 1994
Boston, MA, USA
CHI '94: Association for Computing Machinery on Human Factors in Computing Systems. Contact Thomas Hewett, Drexel University, Dept. of Psychology/Sociology/Anthropology, Central Receiving, 33rd & Ludlow Sts., Philadelphia, PA 19104; (215) 590-8616.

May 2-5, 1994
Oklahoma City, OK, USA
32nd Meeting of the Department of Defense Human Factors Engineering Technical Group. Contact Louida D. Murray, Program Coordinator, 4476 W. Ponds View Dr., Littleton, CO 80123; (303) 798-2617, fax (303) 798-2617.

May 8-12, 1994
San Antonio, TX, USA
Aerospace Medical Association 65th Annual Scientific Meeting. Contact Pamela Day, Aerospace Medical Association, 320 S. Henry St., Alexandria, VA 22314; (703) 739-2240.

May 21-25, 1994
Washington, DC, USA
Association for the Advancement of Medical Instrumentation 29th Annual Meeting and Exposition. Contact AAMI Education Department, 2220 Washington Blvd., Suite 400, Arlington, VA 22201-4598; (703) 525-4890, fax (703) 276-0793.

May 23-25, 1994
Ann Arbor, MI, USA
Principles and Techniques for User Interface Design Short Course. Contact: Engineering Conferences, 800 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109-2092; (313) 764-8490.

May 23-26, 1994
Utica, NY, USA
Fourth Annual IEEE Dual-Use Technologies and Applications Conference. Contact: College Relations Office, State University of New York at Utica/Rome, P.O. Box 3050, Utica, NY 13503-3050; (315) 792-7113, fax (315) 792-7222, email: smls1@SUNYIT.edu.

May 23-27, 1994
Dayton, OH, USA
NAECON '94, National Aerospace and Electronics Conference. Contact NAECON '94, P.O. Box 31341, Dayton, OH 45431-0341, or call Thomas J. Gaudian, (513) 427-4267, fax (513) 427-4675.

June 6-10, 1994
Ann Arbor, MI, USA
Occupational Ergonomics Short Course. Contact: Engineering Conferences, 800 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109-2092; (313) 764-8490.

June 7-10, 1994
San Antonio, TX, USA
Industrial Ergonomics and Safety Conference. Contact F. Aghazadeh, IMSE Department, Louisiana State University, Baton Rouge, LA 70803; (504) 388-5367, fax (504) 388-5990.

June 12-17, 1994
San Jose, CA, USA
SID '94, Society for Information Display International Symposium, Seminar, and Exhibition. Contact Joyce E. Farrell, SID '94 Conference Chair, Hewlett-Packard Labs, P.O. Box 10490, Palo Alto, CA 94303-0969; (415) 857-2807, fax (415) 857-4320.

June 13-15, 1994
Dayton, OH, USA
Second Conference on Naturalistic Decision Making. Sponsored by Klein Associates and administered by CSERIAC. Contact: Wes Grooms, CSERIAC Program Offices, AL/CFH/CSERIAC Bldg 248, 2255 H Street, Wright-Patterson AFB OH 45433-7022; (513) 255-4842, fax (513) 255-4823.

Notices for the calendar should be sent at least four months in advance to:
CSERIAC Gateway Calendar, AL/CFH/CSERIAC Bldg 248, 2255 H Street, Wright-Patterson AFB OH 45433-7022

Human Engineering Division, Armstrong Laboratory Colloquium Series

Naturalistic Decision Making: Implications for Design

Gary Klein
Synopsis by Michael D. McNeese

Editor's Note: Following is a synopsis of a presentation by Dr. Gary Klein, Klein Associates, as the fourth speaker in the 1993 Human Engineering Division, Armstrong Laboratory Colloquium Series: The Human-Computer Interface. This synopsis was prepared by Dr. Michael D. McNeese, Research Psychologist with the Design Technology Branch, Human Engineering Division, Armstrong Laboratory. JAL

How do people make good decisions under bad circumstances? As Gary Klein posed this basic-level question, the audience was led to consider what *naturalistic decision making* (NDM) is, what it is not, and how it can inform design. While making decisions in real-world situations, people often encounter time pressure, ill-defined goals, changing conditions, impoverished information, learned cues, and mutual coordination with others. These features were identified as representative of NDM and have been found to be *recognition-primed.* This means an expert rapidly recognizes a familiar situation, through experience and pattern-matching abilities, and primes a first option without comparing a large set of alternatives. Options are generated one at a time until an expert finds one that satisfices. The satisficing option immediately evokes a prototypical set of goals, expectations, and actions for use.

In contrast, classical analytical approaches to decision making (e.g., Multi-Attribute Utility Analysis) fail to answer the question posed to the audience. These approaches may work when several preconditions are established (e.g., having a very good knowledge base, reliable data, and ample time to perform analysis). But typically, real-world situations fail to meet such assumptions. Klein noted that many decision-support systems predicated upon classical approaches result in user rejection or even catastrophic failure.

To assist users involved in NDM, designers must consider new ways to allow users to seek more information, re-assess situations, and be more sensitive to cues. When a situation is unfamiliar and expectancies are violated, complications may occur. To the extent possible, an interface must afford hypothesis formation, storybuilding, or simply must allow a user to understand "what's happening." In the words of Klein's model, user assistance could be provided in the form of facilitating mental simulation or progressive deepening of knowledge intrinsic to the situation at

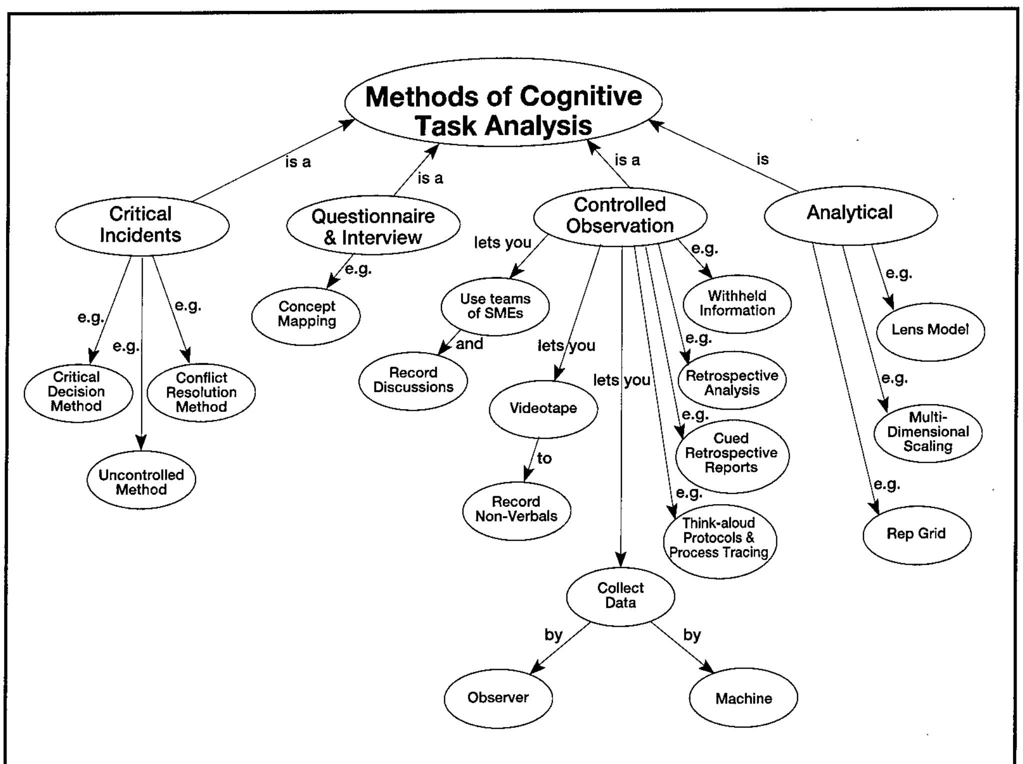


Figure 1. A concept map showing methods of cognitive task analysis.

hand. Hence, the evaluation and improvement of an option are enhanced by an interface.

One difficulty in design is ascertaining "What are the tough decisions people make?" Interface design may proceed through *cognitive systems engineering*, an approach that allows designers to be informed by what we know from cognitive science, new technologies, and cognitive task analysis. Cognitive task analysis, an important component of the approach, provides a rich understanding of how people make decisions and in turn supplies a means for evaluating systems design. It is based on cognitive considerations, goes deeper yet is more selective about knowledge used, requires moderate resources, describes strategies people actually use, and is easy to communicate but difficult to perform. By comparison, traditional task analysis is more behavior-oriented, tends to capture shallow knowledge, requires extensive resources, acquires "recipe-like" responses, points to algorithmic interpretations of human performance, and is hard to communicate but easy to perform. Klein identified several tools of cognitive task analysis including critical incidents, questionnaires, controlled observation, protocol analysis, repertory grids, and concept mapping (see Fig. 1). He mentioned his use of cognitive systems engineering on several applied projects (e.g., a case-based reasoning system to support bidding estimates and manufacturing plans for aircraft parts, new human-computer interfaces for work stations on AEGIS-class cruisers, and the Joint Surveillance Target Attack Radar System [JSTARS]).

After summarizing NDM and cognitive systems engineering, Klein presented the redesign of the Airborne Warning and Control Systems (AWACS) weapon director's station as an example which reflected implications of these approaches for design. ●

Gary Klein, Ph.D., is the Chief Scientist of Klein Associates, Inc., Fairborn, OH.

Scenes from the Human Engineering Division, Armstrong Laboratory Colloquium Series:

Dr. Klein addressed attendees from Wright-Patterson Air Force Base, Wright State University, and the University of Dayton on the topic of naturalistic decision making.

Mr. Ken Klauer, CSERIAC Technical Analyst, asked Dr. Klein for further information on naturalistic decision making.

Human Engineering Division, Armstrong Laboratory Colloquium Series

A Conversation with Gary Klein

Reuben L. Hann

Editors Note: Following is an edited transcript of a conversation with Dr. Gary Klein, Klein Associates, who had just made a presentation as the fourth speaker in the 1993 Human Engineering Division, Armstrong Laboratory Colloquium Series: The Human-Computer Interface. The interviewer was Dr. Lew Hann, CSERIAC COTR. JAL

CSERIAC: How did you first get interested in the area of naturalistic decision making?

Dr. Klein: I left academia to work at Wright-Patterson Air Force Base. At the university I had been working in the area of information processing and memory, and this was a wonderful opportunity to see how the research I had been doing related to the practical issues they were dealing with at the Human Resources Laboratory. We were working in developing simulators for aircrews, and we had people who were being asked to trade actual flying for simulator flying. It was really a question of having them bet the lives of the people they were training.

That raised a lot of questions such as, just what is expertise? What does it mean to develop it? These were questions that were not asked at that time in academia; they were not a part of the information-processing approach to studying behavior. A real influence on me during this time was a book by Bert Dreyfus, *What Computers Can't Do*, which was a critique of artificial intelligence. To me it was also a critique of the information processing approaches to try to break expertise down into components, into context-free elements which can work in well controlled tasks, but don't apply in real-world settings. As a result, I felt we needed to understand what makes people proficient and highly competent in naturalistic settings. That began my disenchantment with the traditional information-processing framework and my eagerness to explore other approaches. It really "de-centered" me. The classical decision view centered around teaching people to use prescriptive methods. In contrast, we were interested in decisions people have to make in operational settings, about what makes those decisions hard, and how to support them.

"Expertise is more than the knowledge in the expert's head; the expert sees a different world than others do."

CSERIAC: Is there a "father" of NDM, or did it just evolve?

Dr. Klein: It evolved in the mid-eighties. We had our first conference in 1989, when we had been working on our own approach, and had completed our initial studies, then we discovered the work of Jens Rasmussen. Also there were people like Marvin Cohen, David Woods, and David Noble and other European researchers. They were all following the parallel idea of how people actually make decisions—or as Ed Salas calls it, decision-making in *situ*. That is, rather than follow prescriptive methods, it was felt we should adopt a spirit of inquiry where we try to find out what people really do, before we try to help them. So, I think it started in several places at the same time. That's why we held the conference in '89, to bring those researchers together. The expression *naturalistic decision making* was coined at about the time of the conference.

CSERIAC: The notion of *time pressure* seems to be an important part of NDM's appeal. The traditional approaches seem to break down when time pressure increases, which is a fact of life in real-world settings.

Dr. Klein: Right. Zakay and Wooler found that, although you try to teach people to use multi-attribute utility analysis, as the time pressure increases, you find no impact of that training. One interpretation is that, with time pressure, you revert to old habits. But I draw a different conclusion—that it is physically impossible to perform a rigorous analysis under time pressure. Interestingly, we saw the same naturalistic strategies when we studied design engineers, involved in a project extending over several months. Even with the low time pressure, we found little evidence of decision analysis or multi-attribute utility analysis. That surprised us. We found they liked to know some of the options, but they used a lot of analogical reasoning, where they would employ ideas that worked before. They took advantage of their experience. Where they had no experience, they would try to get it by making little mockups and collecting the reactions of colleagues.

CSERIAC: Are you still grappling with the concept of *expertise*?

Dr. Klein: For the past ten years or so researchers have become interested in what expertise means, and how that affects situational assessment—the ability to size up what is happening. Experts do this well. Also, we see that an important part of expertise is that experts can see what *isn't* there. They know what to expect and can detect when something is missing. David Noble calls these *negative cues*. Novices do not have any expectations, so they cannot say something did not happen. Furthermore, experts can make discriminations that go unnoticed by novices. A horse-show judge can "see" things which are invisible to most of us. Expertise is more than the knowledge in the expert's head; the expert sees a different world than others do.

CSERIAC: Expertise is more than just experience, then?

Dr. Klein: Oh yes. In our studies of firefighters, we found that someone coming from a rural area, where they had been exposed to a limited number of fire situations—even though they had ten years experience—did not have the same level of expertise as somebody, say, from Cleveland with only a couple of years experience, had. The latter group had seen a wide range of situations. They knew what was typical and could detect when something was not behaving as it should.

The *development* of expertise is extremely important. The information processing tradition geared us to think that expertise was just accumulating more declarative knowledge—more rules—and increasing access to those rules; it missed the perceptual aspect of the process. The rules always sound straightforward when you find out what they are, but the difficult part is being able to specify the antecedent condition.

CSERIAC: An area which has always been of considerable interest to the operational world, especially—but not limited to—the Department of Defense, is *decision aiding*. I assume principles from NDM can be useful in designing these tools.

Dr. Klein: Very much so. We have been engaged in this, and so have others. David Noble has a software package, the Recognition-Primed Decision tool, which is a very elegant way of using feature matching to help people develop situation assessment and to compare different hypotheses about what is happening in a situation.

CSERIAC: Situation assessment is a hot area in itself, and of course it's a precursor to making any decision.

Dr. Klein: Exactly. From our findings, that's where the action is. Usually, once experts know what's going on in a situation it's pretty clear what to do. They don't have to wrestle with alternatives, and that's why classical prescriptive strategies are not interesting. They are not relevant to experts. The game is really: *What's going on?*

CSERIAC: Once you know the situation, the answer jumps out at you.

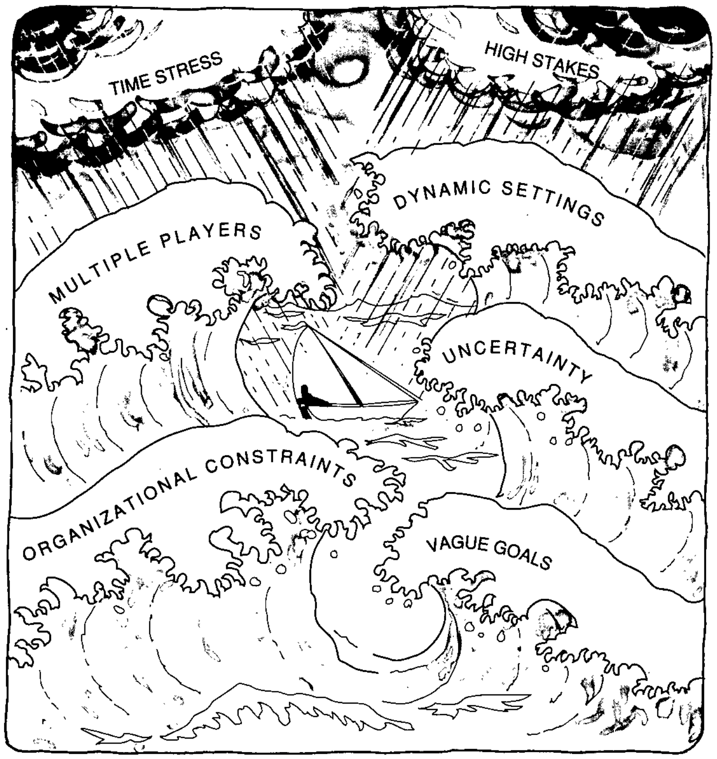
Dr. Klein: Precisely—*if* you have expertise. Now, in terms of building decision aids, I think this illustrates the differences between naturalistic and classical approaches. Classical approaches were looking at a very tough problem: How do people compare options? They developed prescriptive strategies for doing that as rigorously as possible, such as multi-attribute utility analysis. They created computer-based aids which flowed naturally from the theories. The idea was that they would be general, because the same issues would appear time after time. This approach has had some success. It has been useful in situations where we don't have sufficient expertise, and we need to puzzle it out ourselves. However, to me it is still a solution searching for a problem. The naturalistic approach would be to identify the decision requirements in a task and to say that these are going to drive the design of the system and the interface. We don't come in with a set of solutions ready to implement. We of course have the experience of what we have used before, but we are more focused on what the decision requirements are for *this* arena, and to use them to define the specifications for the system. It doesn't completely close the gap; there still is a requirement for creativity on the part of the designer. But it gives the designer the basis for using that creativity.

CSERIAC: A final question: If you had all the resources you needed, where within this area would you direct your effort?

Dr. Klein: I would invest my efforts in *problem detection*. It's an important area. It's not how some people notice cues that others never even saw. Rather, given that two people have the same information, why does one person say, "Hmm, looks like a problem could be arising. I had better start preparing contingencies," while the other person ignores the information or explains it away until it becomes such a dramatic problem that he or she *must* attend to it, and by then some of the options have been foreclosed and the person is behind the curve. It's a "psychological threshold" question. Why is this problem detection threshold different for different people? We have seen this phenomenon enough to know that this is an important area in which to direct our energies. ●

The Second Conference on NATURALISTIC DECISION MAKING

June 13-15, 1994 **Dayton Marriott, Dayton, Ohio**



Naturalistic Decision Making (NDM) research studies the decision strategies people actually use in bringing their experience to bear under challenging real-world conditions. Some of these conditions are time pressure, high stakes, multiple players, and competing goals. NDM research is emerging as a new paradigm within the field of decision research. Its focus of interest is on real-world situations, where both the context in which decisions are made and also the individual's experience are critical to diagnosing the situation and generating a course of action.

The Second Conference on Naturalistic Decision Making will bring together leading researchers for panel sessions which focus on applying the findings that have emerged from their research. In addition, empirical and theoretical papers will be presented to challenge and push forward our understanding of Naturalistic Decision Making.

The registration fee includes meals and is $170 before May 25, 1994 and $195 after May 25, 1994. Registration is limited to 150. Questions or comments regarding the format or content of this conference should be directed to Klein Associates Inc. at Voice: (513) 873-8166, FAX: (513) 873-8258, or EMAIL: 76360.3035@COMPUSERVE.COM

To register or receive a brochure, contact Wes Grooms at CSERIAC, Voice: (513) 255-5498, or FAX: (513) 255-4823

Federal Highway Administration Human Factors Program for Intelligent Vehicle-Highway Systems

Elizabeth Alicandri

Intelligent Vehicle-Highway Systems (IVHS) are a major U. S. Department of Transportation initiative to improve the safety and efficiency of the nation's highways. The IVHS Program is a cooperative effort by private industry, academia, and the government. Through application of advanced technologies, IVHS will improve highway safety, reduce congestion, protect the environment, and provide increased convenience and mobility to users of the surface transportation system.

Various disciplines are involved in the program to effectively address technical, institutional, legal, and other issues that are of concern in the development and implementation of IVHS. Human factors is one of the emphasis areas requiring early and continual attention throughout IVHS development. The Federal Highway Administration's (FHWA) Office of Research and Development is taking the lead in executing a comprehensive human factors program to provide timely information essential to cost-effective and technically sound IVHS development. IVHS will substantially change the driving task, and appropriate and timely human factors guidance is critical to the success of the program.

Although all IVHS areas are related, they have been divided into six interlocking technology areas. The FHWA's IVHS Human Factors Program has ongoing and planned projects in the first four areas (see Fig. 1).

Advanced Traveler Information Systems (ATIS) provide real-time in-vehicle information to drivers. ATIS comprises four major subsystems. *In-Vehicle Routing and Navigation Systems* determine the best route between an origin and a destination and provide directional guidance at choice points. *In-Vehicle Motorist Services Information Systems* provide in-vehicle access to a variety of information that might be available in a yellow pages directory. *In-Vehicle Signing Information Systems* solve the frequently cited and contradictory problems of "too many signs" or "not enough information" by providing in-vehicle signing adapted to individual driver and trip needs. *In-Vehicle Safety Advisory Warning Systems* provide information regarding fixed or temporary highway hazards out of the driver's line of sight.

Advanced Vehicle Control Systems (AVCS) aid drivers in controlling their vehicles, particularly in emergency situations, and ultimately will take over some or all of the driving tasks. AVCS is made up of three subsystems. *Sensory Enhancement Systems* use specialized sensors to enhance the human visual system and provide an extended line of sight in

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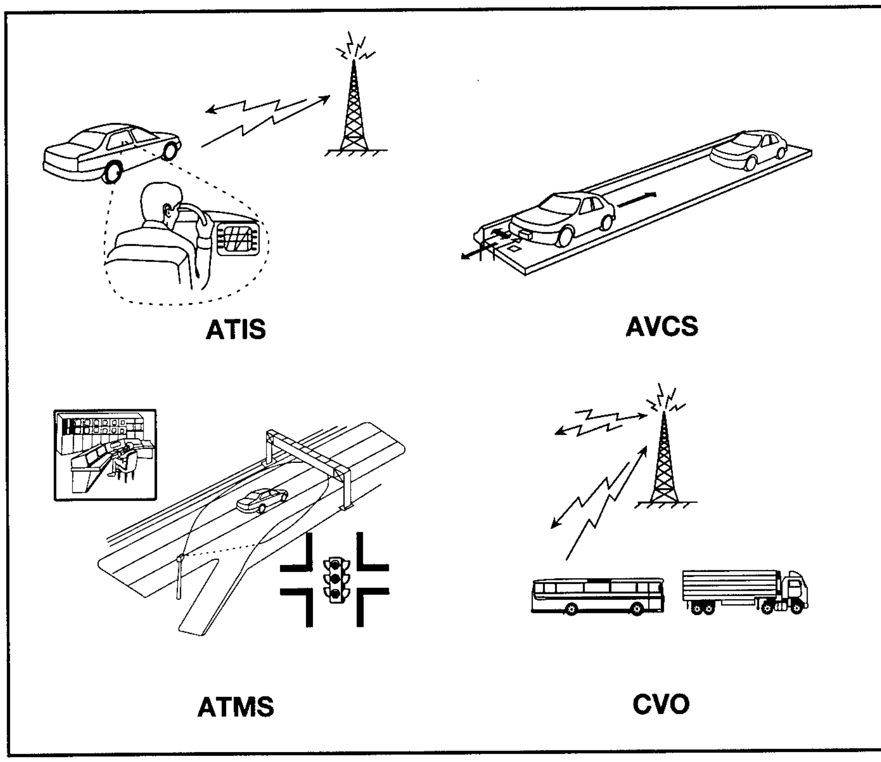

Figure 1. The technical areas currently under study by the Federal Highway Administration include Advanced Traveler Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Commercial Vehicle Operations (CVO), and Advanced Traffic Management Systems (ATMS).

reduced visibility conditions. *Obstacle Detection and Avoidance Systems* provide warnings to drivers when they are in danger of colliding with a fixed or moving object, and will eventually take control of the vehicles in situations where driver response times are insufficient to avoid collision. *Automated Control Systems* take over a portion of the driving task. Eventually these systems will achieve the sophistication to become a fully automated highway system (AHS) allowing for "hands and feet off" driving.

Commercial Vehicle Operations (CVO) refer to application of IVHS technologies to the special needs of commercial vehicles and include automated vehicle identification and location, weigh-in-motion, clearance sensing, and record keeping.

Advanced Traffic Management Systems (ATMS) monitor, control, and manage traffic on streets and highways to reduce congestion using vehicle route diversion, automated signal timing, changeable message signs, and priority control systems.

Advanced Rural Transportation Systems (ARTS) apply IVHS technologies to the special needs of rural systems and include emergency signaling, vehicle location, and traveler information.

Advanced Public Transportation Systems (APTS) use IVHS technologies to enhance the effectiveness, availability, attractiveness, and economics of public transportation and include fleet management, automated fare collection and real-time information systems.

The products of the FHWA IVHS Human Factors Program will aid the IVHS community in planning, designing, and implementing an IVHS that will meet the operational objectives and produce the anticipated benefits. Ongoing projects in ATIS, AVCS, CVO, and ATMS are focusing on identification and resolution of critical human factors issues in these areas. Each of these projects incorporates both analytical and empirical research to ensure that all critical areas are covered and that sound human factors guidelines and handbooks are developed for use by IVHS designers.

The ATIS program includes laboratory and field efforts directed at identifying user needs and ensuring that system design accommodates these needs. Critical issues being addressed include display modality (visual vs. auditory), display location (in-dash vs. head-up [HUD]), and information flow. The TRAVTEK project in Orlando, Florida, provided important real-world information on ATIS, and issues raised during that operational test will be further researched in controlled laboratory and simulation environments.

The AVCS program focuses on the development needs of the automated highway system (AHS). FHWA has been congressionally mandated to demonstrate the AHS by 1997, and human factors considerations are being given considerable weight in system design. Critical issues including drivers' abilities to enter, exit, and maneuver in an automated system are being investigated using the Iowa Driving Simulator as the primary test bed. Further investigations will address user acceptance of the short headways envisioned for AHS, methods of transferring control, and the effects of reduced capability AHS on driver performance.

The focus in the CVO program is similar to the ATIS program, but addresses a different user population, different vehicle characteristics, and different information needs. The CVO human factors project examines the information requirements that are necessary for the successful operation of the trucking system.

In the ATMS program, human factors issues associated with the design and operation of traffic management centers (TMC) are of primary importance. Specific human factors questions addressed in this program include investigation of the number and type of staffing required for a TMC under both normal and emergency situations and an analysis of the ergonomics of the TMC to optimize information throughput and user requirements. Another key research area addresses the type of decision aids required for efficient TMC operations. Much of this work will be performed on a human factors research TMC simulator.

IVHS has great potential to significantly increase highway safety and decrease congestion, if it is designed with appropriate consideration for the needs and capability of the diverse driving population. The FHWA IVHS Human Factors Program will ensure that system designers have access to this critical information in both the initial design phases and throughout the evolution of the system development. ●

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The OCS TOOLS: Efficient Event Analysis Through Multimedia Integration

J. David Randle & Thaddeus K. Szostak

Traditional observational research methods are inherently time-consuming and error-prone. A new technology by Triangle Research Collaborative, Inc. (TRC), the OCS TOOLS, integrates observational research methods and computer and video technology into a single multimedia environment. This environment consists of computer and audio/video equipment and the OCS TOOLS which are optimized for the study of live or recorded events. The system offers increased efficiency through time-savings, improved accuracy, and flexibility for a wide range of applications requiring event analysis.

Time-Savings Plus Accuracy

The OCS TOOLS software automatically synchronizes codes with time from the computer's internal clock, or to machine-readable timecode recorded on audio or videotape. This orders codes chronologically and provides data for a number of analyses. Since time does not have to be entered manually, as it would using a stopwatch and data collection sheet, observers are free to focus their attention on the event coding task. In addition to saving time, data collected with the system are accurate to real-time.

Data are stored to disk during data collection in a virtual mode and are immediately ready for analysis. Data transcription is also eliminated; again, time is saved and accuracy is increased.

Flexibility

Hardware modularity, software configurability, and dataset adaptability increase functionality and, therefore, efficiency.

Hardware Modularity

The OCS TOOLS may be integrated with a number of optional multimedia modules to fit a specific application. Modules include but are not limited to a Timecode Reader/Generator (Figure 1a-d), VCR-Controller (Figure 1b-d), Dual Keyboard or Keystroke Capture System (Figure 1c and d), and Video Overlay or Video Windowing System (Figure 1c and d). Modules may be integrated to add functionality and increase usability according to project requirements.

Software Configurability

The OCS TOOLS may be configured to code events at various speeds

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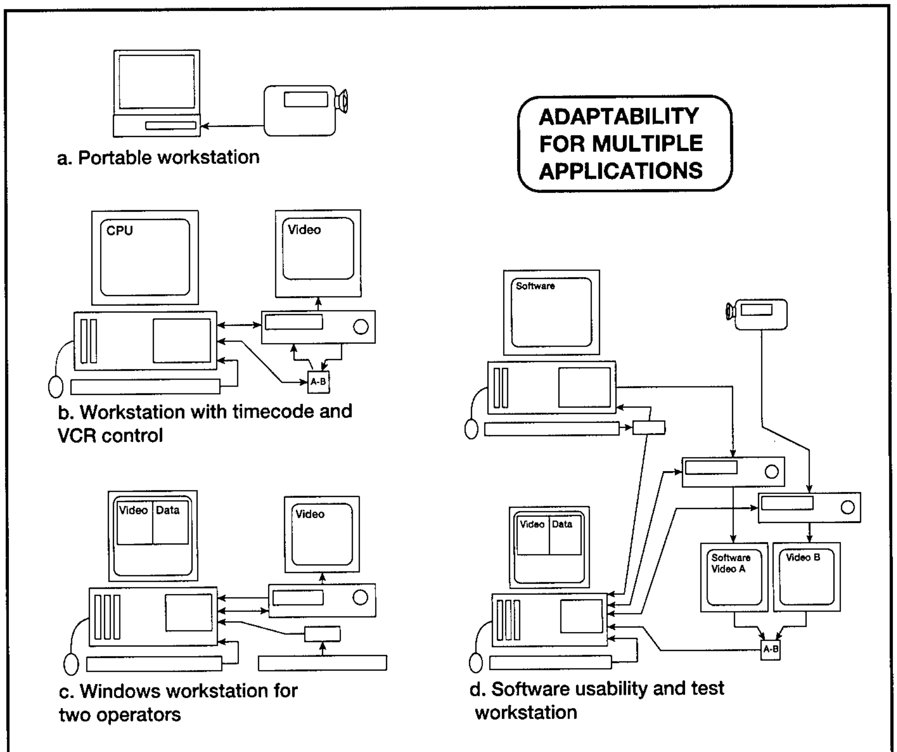

Figure 1. A range of possible configurations from portable to fully integrated workstations.

and degrees of synchronization with audio or videotape. Events may be coded live with no synchronization, at a freeze-frame rate with or without synchronization, and at any speed using machine-readable timecode with full synchronization. The tools offer a variety of analyses including frequency and duration analysis, interval analysis, pattern analysis, time series comparison, and dataset reliability. In addition, datasets and reports can be output in ASCII format for use with other statistical packages. For group projects, managers may assign access rights. The software offers a number of coding options, variety of analyses, and project management features..

Dataset Adaptability

Another advantage of the OCS TOOLS is their adaptable, generic method of defining data and analyses. The observer enters discreet event codes and may enter additional comments for each record. Variable files are used to define the time-ordered data and are composed of discreet or durational events (paired discreet event codes). Variables may be further defined using wildcard characters (?,*) to group events. Variable files allow the redefinition of datasets for many different analyses without changing the original data. In addition, potential dataset errors, according to variable definitions, are automatically located. This allows researchers to make necessary corrections before analysis.

Applicability

The OCS TOOLS are being used in a number of fields. The same tool-set can be used by human factors engineers, industrial engineers, ergonomists, physical therapists, psychiatrists, research psychologists, and other professionals to accurately and efficiently record and analyze events. Some existing applications are shown in Table 1.

Table 1.
Applications of the OCS Tools

Technology Assessment
Product testing, software usability, cash register usability, and medical technology assessment

Work Measurement and Task Analysis
Crew performance in loading and firing howitzers, assembly line measurements, incentive pay measurements, and pilot workload

Communications Research
Communication between multiple helicopter pilots and control tower personnel, management group communication, marital and mother-child communication and interaction, television content analysis, focus group response measurement, and emergency room communication

Medical Studies
Pain studies, carpel tunnel measurements, range of movement and rehabilitation in geriatrics and sports medicine, and fetal movement studies

Other Applications
Sociological interaction, traffic studies, facial action measurement, perception, cognitive development in children, psychology and nursing education, and animal studies

Time and accuracy are important in observational research. The OCS TOOLS integration greatly improves efficiency and can be used in virtually any application requiring observational research.

The OCS TOOLS are a subset of TRC's Multimedia Research Tools (MRT). Other components include the Motion Analysis System Toolset (MAS TOOLS™), future Physiological Data Acquisition Toolset (PDAS TOOLS™), and toolsets to be announced in the future. For additional information on these tools, contact:

Triangle Research Collaborative Inc.
PO Box 12167
100 Park Suite 115
Research Triangle Park NC 27709
(919) 549-9093 or (800) 467-9093

J. David Randle and Thaddeus K. Szostak are respectively Technical Writer and President of Triangle Research Collaborative, Inc.

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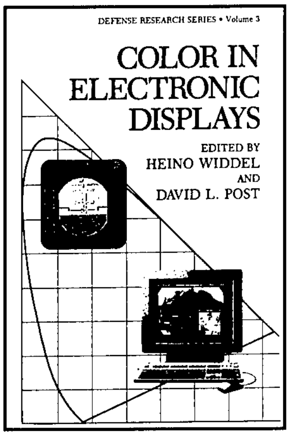
COLOR IN ELECTRONIC DISPLAYS



Color in Electronic Displays edited by Heino Widdel and David L. Post (1992). Published by Plenum Press.

Color in Electronic Displays is a comprehensive collection of information concerning color vision, color perception, colorimetry, and color displays relevant to display design. It comprises 11 chapters, which are divided into four sections devoted to the perception and measurement of color, theoretical and applied color research methodologies, use of color in electronic displays, and electronic color-display technology. Leading international authors contributed to this work.

Through special arrangement with the publisher, Plenum Press, CSERIAC price: $45. To order or obtain further information on Color in Electronic Displays, contact the CSERIAC Program Office at (513) 255-4842.

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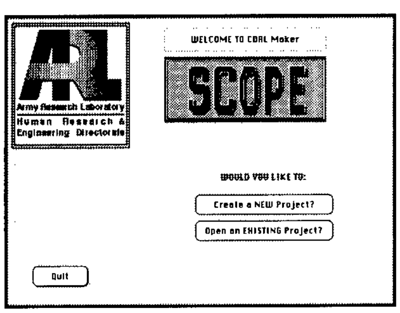

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CDRL Maker - to facilitate the preparation of DD Forms 1423, the Contract Data Requirements List, and the tailoring of the human engineering Data Item Descriptions (DIDs), DD Forms 1664.

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