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This issue contains articles on the following subjects:1.Non-Technical Influences on Human Factors; 2.The Influence of Complex Systems on Motion Sickness; 3.Medical Devices: A new Frontier For Human Factors; 4.Down-Sizing Reaches the MIL-STD-1472; 5.Human Factors and the Technology Assessment of Medical Computer Systems

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VOLUME IV: NUMBER 1 (1993)

CSERIAC GATEWAY

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In this issue:

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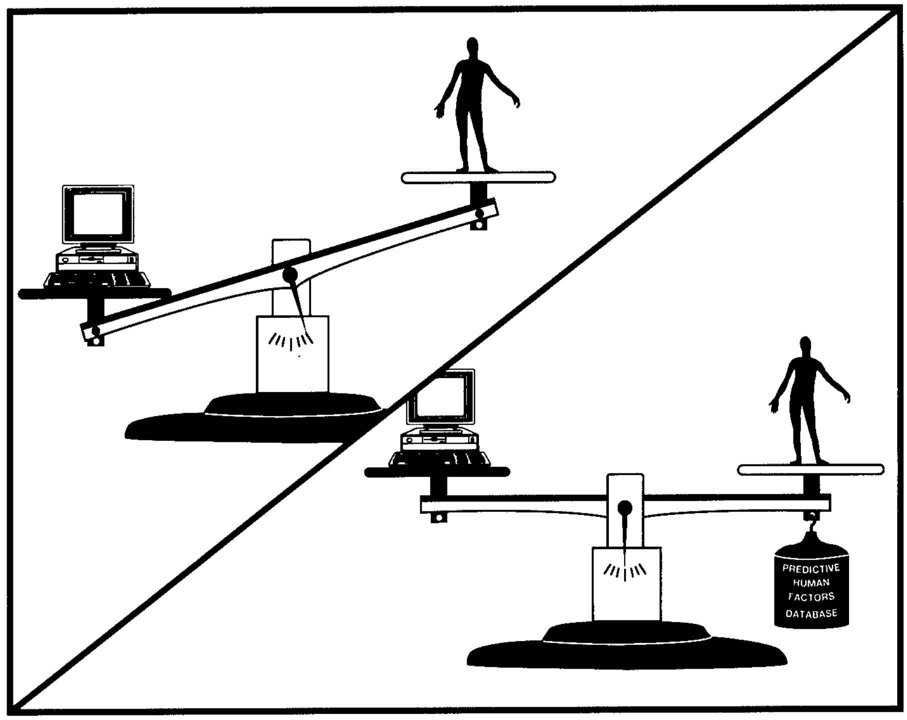
CSERIAC is a United States Department of Defense Information Analysis Center administered by the Defense Technical Information Center, Alexandria, VA, managed by the Armstrong Laboratory, Wright-Patterson Air Force Base, OH, and operated by the University of Dayton Research Institute, Dayton, OH.



A predictive human factors database could serve as a counterweight for the "weak" human when interacting with the "superior" machine. Illustration by Ronald T. Acklin.

Non-Technical Influences on Human Factors

David Meister

Viewed as a specialized branch of engineering, the practice of human factors (as contrasted with its research) has two aspects: technical and non-technical. The technical is what we do and how we do it: analytic and design guidelines and techniques, and test procedures. The non-technical aspect is the context in which we practice. It includes a wide variety of factors, such as the type of organization in which we work, its size, and the availability of money for design.

Often the non-technical factors are even more important than the technical ones. We are affected, like everyone else, by forces over which we have no control, such as the present recession, the size of the military and civilian budget, what people will and will not buy, and what Congress and the Pentagon will provide money for. These vary over time, and we can look forward to periods of greater or less professional prosperity. Beyond all these, however, there is one non-technical factor that is at least as important as the others and over which we *do* have some control. That is the non-human factors specialist's

Continued on page 2

attitude toward our discipline.

It is proverbial that most acquisition and equipment engineers are at best neutral to human factors or at worst actively hostile. There may be many reasons for this; I prefer to believe that engineers developing highly sophisticated machines view the human, as compared with the machine, as weak, prone to error, likely to cause the machine to fail, lacking response speed and the memory that sophisticated computers possess. The practice of a profession linked to the weak human becomes then by generalization somewhat questionable, even discreditable. Since the human is considered a negative element in the human-machine relationship, engineers ask whether a human factors specialist can eliminate this weakness. Their attitude (crudely expressed, which most of them are too sophisticated to manifest directly) is "Prove you can do this or go away and don't bother us."

Even in the professionally rosy days of the 1950's, the human factors specialists working in industry faced many difficulties, the most important of which was that, even if we were included on the design team, our recommendations were often ignored.

Over the years what human factors people have tried to do is to proselytize the engineer, to convert him or her (in a very religious sense) to an appreciation of the importance of human factors in affecting how well the system will perform. Unfortunately, this process of explanation and exhortation usually does not work unless the president of a company or a commanding general is converted. If the top person believes, the subordinates will believe also; if the top person does not, the subordinates will not believe. MANPRINT, the Army's program of incorporating human factors systematically into acquisition, would never have been initiated except for the push it received from a senior general.

One should not, of course, give up on efforts to convert the heathen, but only rarely do these efforts work very well. One major reason for this failure is, I believe, that in engineering and in science generally everything is done with numbers. This is where the technical and nontechnical aspects of human factors merge. Although there are many numbers in behavioral journal articles, these have not been incorporated in what I call a *predictive* database. We have *descriptive* databases like Boff and Lincoln's *Engineering Data Compendium,* but we lack a database to which the design engineer can relate, because behavioral databases are solely that and not linked to physical aspects of design. With the exception of the design handbooks which human factors specialists have published occasionally (and which guide engineering design very inadequately), our database is largely descriptive, because it is tied to generalizations in qualitative terms, rather than numbers. What we really need (and do not have, perhaps because to develop it would require some time and money, and the incentive to apply both) is a database which would permit us to go to a design engineer and say something like this: "If you design in mode X with such and such characteristics, system performance will be 90% of capacity; if you design in mode Y, performance will be 75% of capacity."

If it were possible to give the engineer data such as this, can one imagine that it would be ignored, particularly if we could demonstrate the validity of our data by reference to experiments? In engineering as in science, knowledge and the database are power.

Given the traditional prejudice of engineers (and most other people as well) against the supposed weakness of the human, it is necessary to provide a counterweight (see the figure on the front cover). If our database were to be sufficiently effective, any time a human-machine system were designed the engineer would insist that the human factors specialist be part of the design team. Whenever contracts were let by funding agencies, the latter would insist in their requests for proposals that the human factors group have more and bigger responsibilities.

What our future will be depends on ourselves. We ourselves must be first convinced of the necessity for developing the tools that will enable us to do what we want to do; then we can look for funding. Most human factors specialists tend, however, to be unduly complacent and optimistic about their capabilities and their techniques. Looked at from a perspective of over 40 years in the profession, not much has changed in our discipline, except possibly for the use of computers. Even with these, however, we input the same tired material and output the same inadequate answers.

Am I being too hard on human factors people? Are the goals I set for us too difficult to accomplish? I hope not, unless we are satisfied by the status quo. Unfortunately, too many of us are.

If it seems impossible to develop a predictive database, I remind you that this is the thirtieth anniversary of the one and only truly predictive database we have possessed ("The Data Store," developed and published by the American Institute for Research, Pittsburgh, PA; see the table on page 3 for an example from it), now unfortunately outmoded by time and new developments. Nevertheless, it demonstrates that the goal can be achieved, if we want that goal badly enough. Space does not, unfortunately, permit a description of the techniques required to develop such a probabilistic predictive database (these have been described in some of my earlier papers), and in any case the first and most fundamental step is for the profession to decide that this is what is needed. Until that happens, we shall continue as a profession to limp along on two cylinders rather than six or eight. ●

David Meister, Ph.D., is a Past President of the Human Factors Society and although retired after 40 years of military and industrial experience, is still active in human factors.

An Example from *An Index of Electronic Equipment Operability: Data Store*

Time required and probability of correctly reading circular scales.

Base Time—0.50 min

Time Added	Human Reliability	Circular Scales
		1. Scale diameter
1.03	0.9996	a. 1 in.
0	0.9997	b. 1.6-1.75 in.
0.03	0.9993	c. 2.75 in.
		2. Scale style
		a. Quantitative reading to determine a specific value
1.50	0.9966	(1) Moving pointer
1.50	0.9967	(2) Moving scale
		b. Qualitative reading and checking to determine whether indication is within a certain range
0.25	0.9965	(1) Moving scale
0.25	0.9975	(2) Moving pointer
0	0.9999	(3) Color coded
		3. Pointer style
0	0.9990	a. Conventional, horizontal bar, 0 at base
1.40	0.9987	b. Triangle or vertical bar at base (Pointer base—short end of pointer)
3.50	0.9900	4. Parallax factor
		5. Distance between scale marks
2.70	0.9975	a. Less than 1/20 inch
1.10	0.9986	b. More than 1/20-1/4 inch
0	0.9996	c. More than 1/4-2 inch
		6. Number of graduation marks per unit of required resolution (1. Define required resolution, e.g., must read to 5 deg 2. Determine number of graduation marks used for each five degrees represented on the scale)
0	0.9996	a. Every one or two units
2.56	0.9985	b. Every 5th unit
2.78	0.9975	c. Every 10th unit or log scales
		7. Proportion of graduation marks numbered
0	0.9999	a. 1:1
0.50	0.9991	b. 1:5
2.00	0.9980	c. 1:10
		8. Number of units represented
0	0.9996	a. 50-100
0.50	0.9984	b. 200
1.50	0.9962	c. 400
2.50	0.9952	d. 600
		9. Scale brightness
2.50	0.9965	a. Imperceptible from normal viewing position
1.75	0.9955	b. Minimally perceptible from normal position
0	0.9995	c. Easily perceptible from normal position
		10. Alignment position of pointer (Position assumed by pointer when condition is neutral or normal)
		a. All dials uniform (identical markings)
0.75	0.9985	(1) 3 o'clock
0.35	0.9992	(2) 6 or 12 o'clock
0	0.9994	(3) 9 o'clock
		b. Mixed dials (dissimilar markings)
0.43	0.9990	(1) 3 o'clock
0.35	0.9985	(2) 9 or 12 o'clock
		11. Number of scales and arrangement
0	0.9999	a. 1 or 2 x 1
1.10	0.9997	b. 2 x 2, 2 x 4, 4 x 4
3.85	0.9990	c. 4 x 10, 6 x 4
5.10	0.9975	d. 8 x 4, 9 x 5
		12. Scale increase
0.55	0.9996	a. Right to left
0	0.9999	b. Left to right
		13. Exposure (viewing) time
0	0.9997	a. Indefinite
0.20	0.9996	b. 0.08-0.15 sec
0.06	0.9966	c. 0.30-0.70 sec
0.04	0.9977	d. 1.0-1.40 sec

References

Meister, D. (1964, September). Methods of Predicting Human Reliability. *Man-Machine Systems: Human Factors*, 621-646.

Meister, D. (1993, January). Human Reliability Database and Future Systems. *Proceedings of the Annual Reliability and Maintainability Symposium*, 276-280.

Meister, D., & Mills, R.G. (1971, June). Development of a Human Performance Reliability Data System. *Annals, Reliability and Maintainability - 1971*, 425-439.

Munger, S.J., Smith, R.W., & Payne, D. (1962, January). *An Index of Electronic Equipment Operability: Data Store* [AIR-C43-1/62-RP(1)]. Pittsburgh, PA: American Institute for Research. (DTIC No. AD607161)

Request for Topics For State-of-the-Art Reports (SOARS)

CSERIAC makes every effort to be sensitive to the needs of its users. Therefore, we are asking you to suggest possible topics for future SOARS that would be of value to the Human Factors/Ergonomics community. Previous SOARs have included *Hypertext: Prospects and Problems for Crew System Design* by Robert J. Glushko, and *Three Dimensional Displays: Perception, Implication, Applications* by Christopher D. Wickens, Steven Todd, & Karen Seidler. Your input would be greatly appreciated. We are also looking for sponsors of future SOARs. CSERIAC is a contractually convenient, cost effective means to produce rapid authoritative reports.

Send your suggestions and other replies to:
CSERIAC Program Office
AL/CFH/CSERIAC Bldg 248
ATTN: Dr. Lawrence Howell, Associate Director
2255 H Street
Wright-Patterson AFB, OH 45433-7022

GATEWAY

THE COTR SPEAKS

Reuben L. Hann

Have you ever considered how "attitudes" might influence the practice of human factors? In this issue's feature article, "Non-Technical Influences on Human Factors," veteran human factors specialist Dr. David Meister considers the effects of negative attitudes and makes some suggestions on how they can be changed.

We received an interesting letter about the *Gateway* feature article on certification of ergonomists (Vol III, No. 4). We reproduce the letter from Dr. Michael McCauley (Monterey Technologies), as well as a response from the original author, Mr. Dieter Jahns (Board of Certification in Professional Ergonomics).

As part of the continuing colloquium series, The Human-Computer Interface, sponsored by the Human Engineering Division of Armstrong Laboratory, we were pleased to have Dr. Michael Griffin of Southampton University, UK. Dr. Griffin's subject was "The Influence of Complex Systems on Motion Sickness," which is summarized by Dr. Maxwell Wells of Logicon Technical Services, Inc.

The featured Government program in this issue is "Medical Devices: A New Frontier for Human Factors." The author is Dr. Marilyn Sue Bogner (Food and Drug Administration), a

Calendar

March 17-20, 1993
Los Angeles, CA, USA
Technology and Persons with Disabilities, sponsored by California State University, Northridge, Office of Disabled Student Services, at the Los Angeles Airport Marriott Hotel. Contact Harry J. Murphy, Office of Disabled Student Services, CSUN, 18111 Nordhoff St. - DVSS, Northridge, CA 91330; (818) 885-2578, fax (818) 885-4929, Email: HMURPHY@VAX.CSUN.EDU.

March 31- April 4, 1993
Chicago, IL, USA
EDRA 24, 24th Annual Meeting of the Environmental Design Research Association, "Power by Design," at the Allerton Hotel. Contact EDRA Business Office, P.O. Box 24083, Oklahoma City, OK 73124; (405) 843-4863.

April 13-16, 1993
Edinburgh, UK
Ergonomics Society Annual Conference "Ergonomics and Energy" at Heriot Watt University. Contact Conference Manager, Ergonomics Society, Devonshire House, Devonshire Square, Loughborough, Leichester LE11 3DW, UK; (44) 509-234904.

April 18-21, 1993
Oak Ridge, TN, USA
American Nuclear Society meeting, "Nuclear Plant Instrumentation, Control, and Man-Machine Interface Technologies," cosponsored by the Human Factors Division of the ANS, the HFS Smoky Mountain Chapter, and others. Contact Bill Knee or Jim White, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831-6360; (615) 574-6163 (Knee), (615) 574-5592 (White), fax (615) 574-9619.

April 24-29, 1993
Amsterdam, Netherlands
INTERCHI '93, The 1993 Conference on Human Factors in Computing Systems, combining CHI '93 (ACM SIGCHI) with INTERACT (the triannual conference of the IFIP TC 13). Contact Carol Klyver, INTERCHI '93 North America Office, P.O. Box 1279, 1355 Redwood Way, Pacifica, CA 94044; (415) 738-1200, fax (415) 738-1280, Email: ic93-office-na.chi@xerox.com.

April 26-29, 1993
Columbus, OH, USA
Seventh International Symposium on Aviation Psychology, sponsored by The Ohio State University Department of Aviation and the International Journal of Aviation Psychology. Contact Dr. Richard S. Jensen, Department of Aviation, 164 West 19th Ave., Columbus, OH 43210; (614) 292-8378, fax (614) 292-1014.

April 26-29, 1993
Knoxville, TN, USA
5th Topical Meeting on Robotics and Remote Handling, sponsored by the American Nuclear Society, Oak Ridge/Knoxville Section, and the ANS Remote Systems Technology Division, at the Holiday Inn World's Fair and Exhibition Center. Contact the Topical Meeting on Robotics and Remote Handling, P.O. Box 200001, Oak Ridge, TN 37831, or Norbert Grant, (615) 574-4530, fax (615) 574-4624.

May 5-8, 1993
Raleigh, NC, USA
Interface '93, "Humanizing Technology," sponsored by the HFS Consumer Products Technical Group, hosted by the HFS North Carolina State University Student Chapter and the HFS Carolina Chapter, at the North Raleigh Hilton. Contact Sharolyn A. Converse, Dept. of Psychology, North Carolina State University, Box 7801, Raleigh, NC 27695-7801; (919) 515-2252.

May 11-14, 1993
Dayton, OH, USA
Department of Defense Human Factors Engineering Technical Group (DoD-HFE-TG) Meeting at the Dayton Marriott Hotel. Contact Louida Murray, Meeting Administrator, 4476 Ponds View Dr., Littleton, CO 80123; (303) 798-2617, fax (303) 932-1608.

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

well known expert in human error.

Mr. Rick Davids (Lockheed Missile and Space Co.) headed an effort to convert the MIL-STD-1472D into a transportable checklist that would be usable in places with limited space. His report on the outcome, "Down-Sizing Reaches the MIL-STD-1472," appears in this issue. CSERIAC is proud to be the sole distributor of this checklist.

Paula Sind's article, "Human Factors in Medicine: Quo Vadis?" (Vol III, No. 3), prompted John Gosbee (Michigan State University Kalamazoo Center for Medical Studies) to write our concluding article on "Human Factors and the Technology Assessment of Medical Computer Systems."

Gateway is now being sent to nearly 8,000 readers throughout the world. If you know of someone who would like to receive this publication, please let us know. We would very much like to hear from you about ideas for new articles, or your thoughts about articles which have already appeared. We need your help to make *Gateway* even more interesting and informative. ●

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

SOARS AVAILABLE FROM CSERIAC

Human Factors Issues in Head-Up Displays: The Book of HUD **(Weintraub & Ensing, 1992)**

Hypertext: Prospects and Problems for Crew System Design **(Glushko, 1990)**

Strategic Workload and the Cognitive Management of Advanced Multi-task Systems **(Adams, Tenney, & Pew, 1991)**

Three-Dimensional Displays: Perception, Implementation, Applications **(Wickens, Todd, & Seidler, 1989)**

May 16-21, 1993
Seattle, WA, USA
SID '93: Society for Information Display International Symposium, Seminar, and Exhibition. Contact Louis D. Silverstein, VCD Sciences, Inc., 9795 E. Pershing Ave., Scottsdale, AZ 85260; (602) 391-1326.

May 23-27, 1993
Toronto, Canada
Aerospace Medical Association 64th Annual Scientific Meeting. Contact AMA, 320 S. Henry St., Alexandria, VA 22314; (703) 739-2240.

May 24-27, 1993
Utica, NY, USA
3rd Annual "DUAL-USE Technologies and Applications Conference," hosted by the SUNY Institute of Technology at Utica/Rome and sponsored by the IEEE Mohawk Valley Section. Contact John Salerno, College Relations Office, SUNY Institute of Technology at Utica/Rome, P.O. Box 3050, Utica, NY 13504-3050; (315) 792-7113, fax (315) 792-7143.

May 24-28, 1993
Dayton, OH, USA
NAECON '93, the National Aerospace and Electronics Conference, sponsored by IEEE, HFS, and others, at the Dayton Convention Center. Contact William Dungey, ASC/XRF, Wright-Patterson AFB, OH 45433.

June 7-10, 1993
Copenhagen, Denmark
Annual International Industrial Ergonomics and Safety Conference. Contact Ruth Nielsen, Technical University of Denmark, Laboratory of Heating and Air Conditioning, Bldg. 402, DK-2800 Lyngby, Denmark; (45) 459-31-199, fax (45) 459-32-166.

June 13-16, 1993
Ann Arbor, MI, USA
Computer-Based Medical Systems Conference sponsored by the IEEE Computer Society and others. Contact Deborah S. Highfield, Diversified Conference Management, P.O. Box 2508, Ann Arbor, MI 48106; (313) 665-2535.

June 14-18, 1993
Warsaw, Poland
International Ergonomics Association World Conference '93, "Ergonomics of Materials Handling," organized by the IEA Industrial Ergonomics Technical Group of the Science and Technology Committee. Contact W. Karwowski, General Conference Chair, Center for Industrial Ergonomics, University of Louisville, Louisville, KY 40292; (502) 588-7173, fax (502) 588-7397, Email: wokarwo@ulkyvm.bitnet.

October 11-15, 1993
Seattle, WA, USA
Human Factors and Ergonomics Society 37th Annual Meeting. Contact HFES, P.O. Box 1369, Santa Monica, CA 90406-1369; (310) 394-1811, fax (310) 394-2410.

October 19-22, 1993
Montgomery, AL, USA
First Annual Quality Air Force Symposium '93 sponsored by the U.S. Air Force Quality Center. Contact Major Zak, AFQC/RS, Bldg. 1400A, 825 Chennault Circle, Maxwell AFB, AL 36112-6425; (205) 953-3306, fax (205) 953-3132, or Wes Grooms, Conference Coordinator, AL/CFH/CSERIAC, Bldg. 248, 2255 H Street, Wright Patterson AFB, OH 45433-7022; (513) 255-4842, DSN 785-4842, fax (513) 255-4823, DSN fax 785-4823.

Letters to the Editor

Editor's Note: The following letter from Dr. Michael McCauley was sent to Mr. Deiter Jahns, with courtesy copies sent to the Human Factors and Ergonomics Society(HFES) and myself. I believe that Gateway can provide an appropriate forum for debating such timely and important topics as certification of ergonomists. Hence, I am reprinting Dr. McCauley's letter and the reply from Mr. Jahns. I invite other readers to express their thoughts on this topic, as well as others. JAL

Dear Mr. Jahns:

I enjoyed reading your article, "Credentials, Criteria, and Certification of Ergonomists" in the recent issue of CSERIAC *Gateway* (Vol. III, No. 4). You provided an excellent review of the field and the difficulties involved in specifying criteria for a multi-disciplinary profession. However, I feel strongly that certification should be done under the auspices of the reigning professional society, in this case the Human Factors Society, rather than by an ad-hoc, self-appointed group, no matter how good their credentials or intentions.

Despite my regard for your reputation and the contributions to human factors made by your BCPE colleagues such as Chapanis and Meister, I feel that in the long run BCPE will do a disservice to our field. The establishment of a maverick, unchartered, unsponsored group to provide "certification" in human factors and ergonomics is more likely to promote divisiveness and confusion rather than professional development. The intentions of BCPE may be good, but they should be debated (again) within the structure and framework of the HFS and, if approved by the membership, implemented with the full support and sponsorship of the Society.

Sincerely,
Michael E. McCauley, Ph.D.
Vice President
Monterey Technologies

Dear Dr. McCauley:

Thank you for your letter of December 16, 1992. I have copied it for potential comments by my BCPE colleagues. Up until 1989 I would have agreed with your position that HFES should be the innovator of professional certification. Did you know that Paul Fitts already proposed that in 1960? That Harry Snyder pushed for certification during his term as HFS President in 1979? Thirty-two years of debate, lots of starts and stops, many studies, and countless hours of volunteer work and no way to get out of the iterative loop because it was research-driven, not design-driven.

Others are eager to fill the vacuum created by HFES vacillation; for example occupational therapists, safety professionals, industrial hygienists are poised to move on ergonomics as one of their subspecialties. The "maverick" BCPE beat them to the punch. We would welcome full support and sponsorship by HFES, but for now we don't have to count on it.

Sincerely,
Dieter W. Jahns, CPE
Executive Director
Board of Certification in Professional Ergonomics (BCPE)

Announcements

Certification for Ergonomists and Human Factors Professionals

The Board of Certification in Professional Ergonomics is now accepting applications for professional certification of ergonomics and human factors practitioners. Applicants should have a mastery of ergonomics knowledge and methods, as well as expertise in the analysis, design, and evaluation of products, systems, and environments for human use. Qualified applicants may choose to be certified as either Certified Professional Ergonomists (CPE) or as Certified Human Factors Professionals (CHFP). Applications are available from Board of Certification in Professional Ergonomics, Office of the Executive Director, P. O. Box 2811, Bellingham, WA 98227-2811, USA, phone: (206) 671-7601 fax: (206) 671-7681.

Minimum qualifications are an MA/MS or equivalent in ergonomics or a closely related field and 7 years of demonstrable experience in the practice of ergonomics. Applications are open to ergonomists internationally.

Certification will be based on an evaluation of work samples and supporting documentation through December 31, 1993. The application processing fee is US$200 (nonrefundable) with an annual renewal fee of $75. After December 31, 1993, applicants will be required to pass a written examination.

The Board of Certification in Professional Ergonomics was formed as a nonprofit corporation in 1990. Although the Board was established with support from the Human Factors Society, it is independent of any professional, scientific, or trade association.

Current members of the Board are Alphonse Chapanis, Ph.D; David Meister, Ph.D.; Melvin H. Rudov, Ph.D.; Hal W. Hendrick, Ph.D.; George A. Peters, J. D.; H. Harvey Cohen, Ph.D.; David J. Cochran, Ph.D.; Jerry R. Duncan, Ph.D.; Steven M. Casey, Ph.D. The Executive Director is Dieter W. Jahns, M.S.

The DTIC Thesaurus on Diskette

For anyone conducting research in a scientific or technical field, knowledge of the vocabulary used to index and retrieve documents is essential. Without such knowledge, it would be difficult to develop search strategies, or to assign cataloging terms to your own documents. Recognizing this, the Defense Technical Information Center (DTIC) has offered a thesaurus in paper copy for years. This excellent reference tool provides researchers with a complete listing of the terms used to catalog DTIC-stored documents. The subject areas covered are broad, and special emphasis is placed on both physical sciences and engineering. As a result, the DTIC Thesaurus can be extremely useful when developing search strategies for almost any scientific or technical database.

DTIC is the central point within the Department of Defense (DoD) for acquiring, storing, retrieving, and disseminating scientific and technical information. The Center maintains databases of over 20 years of both completed and ongoing defense-related research. As each report is entered into the collection, a bibliographic record containing the specific posting terms assigned to the document is created. These terms may then be used to retrieve the bibliographic record and report at a later date. The DTIC Thesaurus lists the posting terms DTIC uses, as well as the hierarchical relationships between them. For example, the following displays the search hierarchy for the posting term *Light.*

- Light
  - Air Glow
  - Cerenkov Radiation
  - Daylight
    - Sunlight
  - Light Pulses
  - Low Light Levels
    - Moonlight
    - Starlight
    - Twilight

The farther to the right the term appears, the narrower the subject becomes. These results may then be used to design more sophisticated search strategies.

Like many organizations, DTIC recognizes the need to take advantage of evolving technology to streamline work functions and save resources. For example, the Center is now not only accepting documents in the Technical Report (TR) system in nonprint formats, but also distributing them in those same formats. In addition, DTIC is beginning to provide its own products in nonprint formats. One such example is the **DTIC Thesaurus on Diskette**.

The **DTIC Thesaurus on Diskette** is easy to use, menu driven, and provides access to four different search/display options. These options include *Single Word Search, Truncation Search, Thesaurus Display,* and *Hierarchy Display.* For each posting term entered, the *Thesaurus Display* will provide a listing of all related terms. For example, the posting term *Aeronautics* is related to *All Weather Aviation, Army Aviation, Civil Aviation,* and *Naval Aviation.* Knowing this, a researcher will be better able to pinpoint documents relating to a specific subject.

The diskette version of the DTIC Thesaurus also offers the search hierarchy form. As with the DTIC Thesaurus in paper copy, you may view the full relationship between broad and narrow terms. When developing a hierarchical search strategy, however, you may want to begin by browsing the exact vocabulary used. This may be accomplished with a *Single Word Search.* This feature allows you to scan subject areas with a common term, but does not consider where the term appears in a particular phrase. For example, by entering the word *Technology,* you will retrieve both *Stealth Technology* and *Technology Forecasting.*

The last search option, *Truncation,* allows you to retrieve and display an alphabetical listing of subjects. Using *Truncation* it is possible to enter only the beginning of a word to execute a search. In the case of the prefix *Tech,* the system would display *Technical Writing* as well as *Technology Forecasting.* In addition, the truncation display helps you to identify the correct spelling of a posting term. If you enter a word incorrectly, the system will bring you to where it would have appeared alphabetically.

The cost for the **DTIC Thesaurus on Diskette** is only $49.00 per set and includes installation and use instructions directly on the diskettes. Use of the **DTIC Thesaurus on Diskette** requires:

- An IBM compatible micro-computer
- dBASE IV Version 1.1 (or dBASE IV Runtime Version 1.1)
- 8MB of hard disk storage for the Thesaurus alone (Runtime requires an additional 1.4 MB)

The **DTIC Thesaurus on Diskette** is available in the following formats:

- AD-M000 125 3 1/2" Format (without Runtime) one disk
- AD-M000 126 3 1/2" Format (with Runtime) two disks
- AD-M000 127 3 1/2" ASCII Format one disk
- AD-M000 128 5 1/4" Format (without Runtime) four disks
- AD-M000 129 5 1/4" Format (with Runtime) nine disks

For additional information, or to order the **DTIC Thesaurus on Diskette**, please contact Ms. Judy Pickeral, DTIC Product Management Branch on (703) 274-6434 or DSN 284-6434.

Industrial Ergonomics Bibliography

The Human Factors and Ergonomics Society has revised its guide to the literature on industrial ergonomics, "Industrial Ergonomics Bibliography." The new brochure is free of charge and lists publications that contain data useful for the design of jobs in industry.

The bibliography is divided into six sections, in addition to lists of periodicals and proceedings: *General* lists texts and handbooks; *Worker Characteristics* covers size, strength, age, and gender; *Job Design* addresses productivity, human error, fatigue, and accidents; *Equipment Design* concerns displays, controls, and tools; *Workplace Design* includes information on chairs, benches, floors, and stairs; and *Environmental Design* covers heat, noise, vibration, and illumination.

The bibliography is designed for human factors practitioners, industrial engineers, safety professionals, occupational physicians and nurses, industrial hygienists, personnel specialists, managers, labor union officials, and workers.

To obtain a free copy of the "Industrial Ergonomics Bibliography," contact the Human Factors and Ergonomics Society, P.O. Box 1369, Santa Monica, CA 90406-1369; (310) 394-1811, fax (310) 394-2410.

Liveware Survey & Database Progress

A number of interesting new Human Systems Integration (HSI) technologies have been added to the Liveware database since last reported. We keep finding additional technologies that are important to include in a comprehensive HSI technology database. For this reason, the sponsor, Mr. Mike Pearce of OASD(FM&P)/R&R(TFM) HSI office, and program manager, Dr. Mona Crissey, request that owners, developers, and major users of HSI technologies participate by April 15, 1993. It now appears that we will be able to include in the Liveware catalog all those who have their survey to us by that date. The catalog will include all United States inputs, plus those of the other member nations of NATO Liveware Research Study Group (RSG.21). Technologies received after that date will be added to the Liveware database, but may not be printed in the Liveware catalog.

Liveware survey participation as of February 3, 1993 is summarized in the table. The Training domain has had the greatest number (227) of programs listed. The Manpower and Human Factors Engineering domains have the next largest participation, with 142 and 140 programs, respectively. The lowest participation is in the Safety and Health Hazards domains, but they still have achieved 82 and 60 "hits" respectively. Participation by DoD Service shows the U.S. Army with 86 technologies and the Air Force with 64 technologies, while the Navy/Marine Corps grouping has 32 technologies listed. The showing from Industry is quite good, with 82 technologies listed. One hundred technologies indicated they helped achieve integration in some way, whether with integration of two or more domains, or with vertical integration from a lower level of design to a more aggregate level.

LIVEWARE SURVEY PARTICIPATION
BY SERVICE/INDUSTRY (As of February 3, 1993)

LIVEWARE DOMAIN	UNITED STATES AIR FORCE	ARMY	NAVY MARINES	OTHER GOV'T	INDUSTRY	UNIVERSITIES & OTHER	TOTAL BY DOMAIN
MANPOWER	44	28	8	6	46	10	142
PERSONNEL	36	29	5	6	43	14	133
TRAINING	55	39	24	14	69	26	227
SAFETY	27	11	7	2	31	4	82
HEALTH HAZARDS	20	12	5	0	22	1	60
HUMAN FACTORS ENGINEERING	40	27	7	5	48	13	140
INTEGRATION (2 or more)	29	10	9	4	34	14	100
Number Programs in Database	64	86	32	21	82	74	359

Note: Each technology can impact more than one domain

To obtain a survey or further information, contact Dr. Mona Crissey at Department of the Army, Chief, ARL-HRED-STRICOM Field Element, ATTN: AMSRL-HR-MT (Dr. Mona Crissey), 12350 Research Parkway, Orlando, FL 32826-3276; (407) 380-4356, DSN: 960-4356, FAX: (407) 381-4201, E-mail: CrisseyM@Orlando-EMH3.Army.MIL. She is the Liveware Program Manager.

Or contact Frank C. Gentner or Dave Kancler at AL/CFH/CSERIAC Bldg 248, 2255 H Street, Wright-Patterson AFB, OH 45433-7022, (513) 255-4842, DSN: 785-4842, FAX: (513) 255-4823, E-mail: FGentner@FALCON.AAMRL.AF.MIL. They are the CSERIAC technical analysts assisting Dr. Crissey with the Liveware program.

Armstrong Laboratory Colloquium Series
The Influence of Complex Systems on Motion Sickness

Michael Griffin
Reviewed by Maxwell Wells

Editor's Note: Following is a review of a presentation by Dr. Michael Griffin as the sixth and final speaker in the 1992 Armstrong Laboratory Colloquium Series: The Human Computer Interface. This review was prepared by Dr. Maxwell Wells, a Research Scientist with Logicon Technical Industries, Inc., Dayton, OH.

Question - What do the common cold and motion sickness have in common? Answer - everyone has a remedy, but no one has a cure. Furthermore, despite the fact that most people have suffered both afflictions, on the whole, we show very little sympathy towards the afflicted. This is evidenced by our amusement at, for example, someone asking for "doze drops," or the (w)retched regret of someone who has made a hasty visit to the windward side of the boat. Perhaps this lack of sympathy contributes to one of the anomalies of motion sickness: despite its ancient role in human existence (the word 'nausea' is derived from the Greek word *naus*, meaning boat) there is still an incomplete understanding of its causes.

With this as a backdrop, Professor Michael Griffin provided a review of some of what is known about motion sickness. Beginning with the conclusion, "Motion sickness is caused by motions which allow erroneous perceptions of body movements," he went on to elucidate some of the factors which, from the literature, can or can't be identified as contributing to motion sickness.

The review was comprehensive and included consideration of the axis, frequency, duration, and magnitude of motion, along with other factors, such as the presence or absence of visual information, and the phenomenon of visually induced motion sickness. The results of the reanalysis of earlier data were presented, as was the derivation of the shape of the motion sickness dose curves used in British Standard 6841 (see Fig. 1).

Continued on page 10

MOTION SICKNESS DOSE VALUES

$$MSDV_z = a_{rms}\, t^{1/2}$$

where:

a_{rms} = r.m.s. frequency-weighted acceleration (ms^{-2})

t = exposure time (s)

OR:

$$MSDV_z = \left[\int a^2(t)\, dt \right]^{1/2}$$

PREDICTING VOMITING PERCENTAGE

percentage who may vomit = 1/3 $MSDV_z$

for unadapted adults.

Based on 20 min to 6 h exposures & vomiting up to 70%.

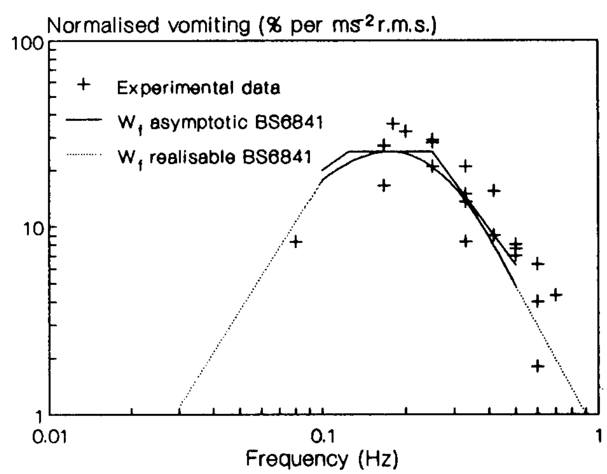


Figure 1. Results of the reanalysis of data from McCauley et al (1976).

Concerning the theories of motion sickness, Professor Griffin pointed out that various theories have been proposed, but none is yet capable of providing quantitative predictions of the degree of motion sickness to be expected from a range of different motion stimuli. He contended that a complete theory of motion sickness would give a method of measuring both the cause and the effect, and would indicate how they are related. Referring to the sensory conflict theory, he asserted that its greatest value appears to be the identification of the relevant sensory systems, their interactions, and the foundation that this provides for the concept of sensory rearrangement. However, the sensory conflict theory does not identify which of several possible conflicts in an environment is most significant; it does not predict the extent of the symptoms, or how they depend on the magnitude, type, or duration of the motion.

Professor Griffin then went on to discuss studies conducted at sea. After some cautionary comments concerning navigation through the literature (many studies were conducted to support previously concocted hypotheses), he presented the results of work conducted with Tony Lawther, one of his past graduate students. In these studies, several sea-going vessels were instrumented to measure motion, and the passengers were surveyed. Over 20,000 responses were collected. The vessels included 6 ships, 2 hovercraft, and a hydrofoil. The data were from 114 voyages, of durations from half an hour to 9 hours, in a variety of sea states. Some of the results are shown in Figure 2. One of the by-products of this research was a wealth of advice offered by passengers, including the supposed prophylactic effect of singing, and of brown paper (clasped firmly to the chest).

Tying together several themes and areas of research, Professor Griffin offered the following advice concerning interface design: Beware of wide fields-of-view, beware of lags in the visual system with wide fields-of-view, beware of head movement in accelerating and oscillating environments, and beware of head movements while wearing magnifying or distorting optics.

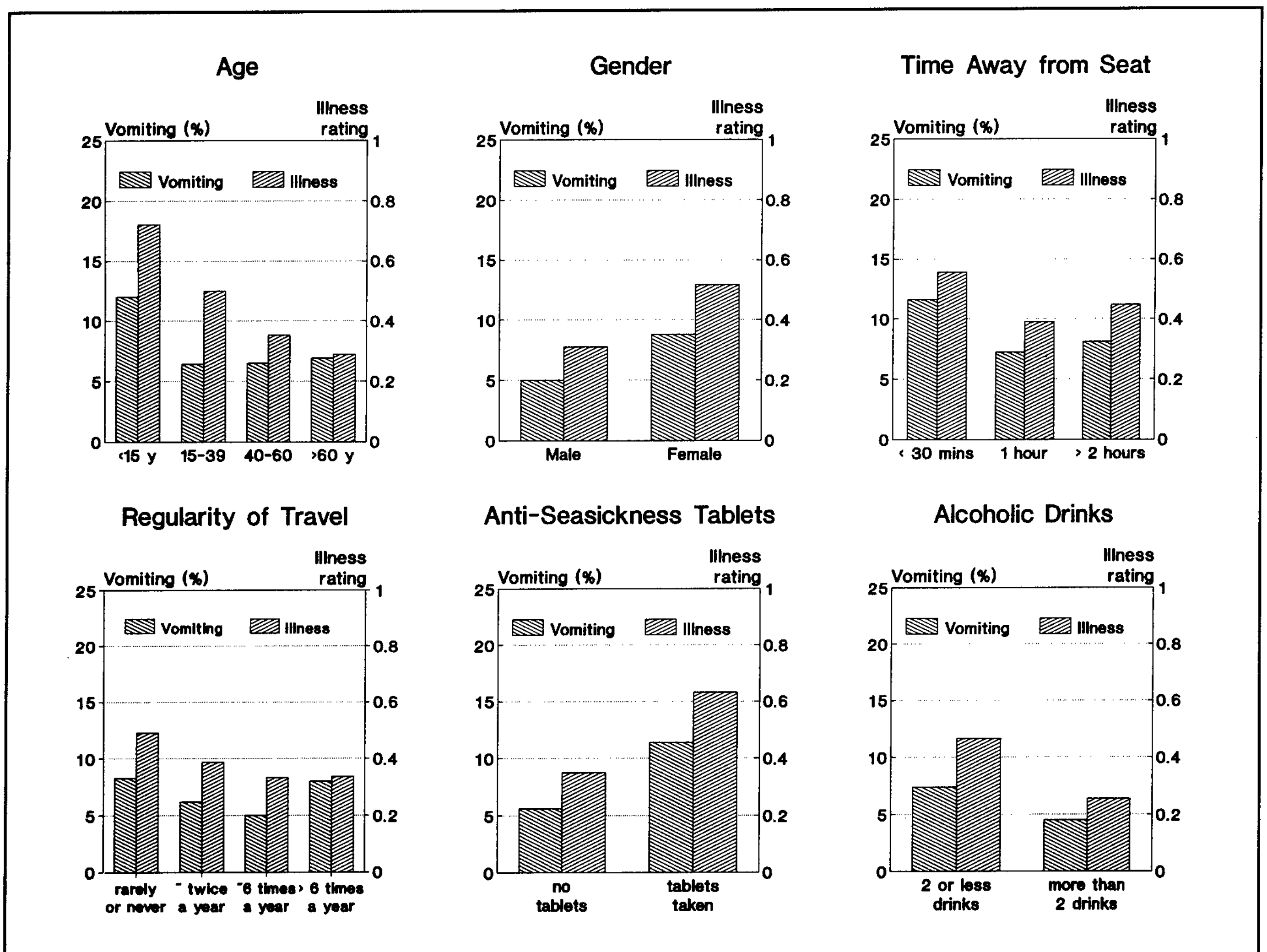


Figure 2. The effects of various factors on illness and vomiting for over 20,000 passengers surveyed at sea.

The final message was the need to continue basic research. This is often the call from academia to the outside world. In this case it rang particularly true, as Professor Griffin's review had made evident the complexity of the issues and the gaps in our understanding. A lot of material was covered, but it was done in a comprehensible and entertaining manner. Some of the material may be found in the references. Also, CSERIAC's video tape of the colloquium is to be recommended to anyone doing work in the area. ●

Michael Griffin, Ph.D., is a Professor of Human Factors at the Institute of Sound and Vibration Research, University of Southampton, UNITED KINGDOM.

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Griffin, M. J. (1991b). Sea sickness. In *Motion Sickness: Significance in Aerospace Operations and Prophylaxis* (AGARD Lecture Series 175, pp. 7-1 - 7-20). Neuilly Sur Seine, FRANCE: Advisory Group for Aerospace Research and Development (AGARD).

Lawther, A., & Griffin, M. J. (1988). A survey of the occurrence of motion sickness amongst passengers at sea. *Aviation, Space and Environmental Medicine, 59*(5), 399 - 406.

McCauley, M. E.,Royal, J. W.,Wylie, C. D.,O'Hanlon, J. F., & Mackie, R. R. (1976). *Motion sickness incidence: Exploratory studies of habituation, pitch and roll and the refinement of a mathematical model* (Report No. AD-A024 709). Goleta, CA: Human Factors Research Inc.

Scenes from the Armstrong Laboratory Colloquium Series:

Dr. Griffin, speaking on the relationship of motion-sickness and complex systems, reviewed the known and supposed causes of motion sickness.

Dr. Griffin advised his audience that when designing interfaces, they should avoid wide fields-of-view as they can lead to nausea.

Medical Devices: A New Frontier For Human Factors

Sue Bogner

Health care, particularly medical care, is an area in which the human factors community can make significant contributions. The Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration (FDA) has the mandate to ensure the safety and effectiveness of medical devices. CDRH recognizes the value of human factors considerations for medical devices in pursuing that mandate. The term medical devices, as used by CDRH and for the purpose of this discussion, refers to any non-drug item used for the diagnosis, treatment, or prevention of a disease, injury, illness, or other condition. Thus, CDRH is concerned with products ranging from condoms and eyeglasses to anesthesia machines, heart valves, and magnetic resonance imaging machines.

Historically, of the deaths or serious injuries associated with medical devices that were reported through CDRH's Medical Device Reporting (MDR) System, approximately 60% have been determined as attributable to user error. Assuming this percentage has not changed, then of the 80,000 MDR reports received in 1992, 48,000 might be attributed to user error. Efforts to reduce such error traditionally have been educational. However, education alone cannot compensate for factors in the device/user/environment interaction which are conducive to the commission of error.

An example of device/user/environment interaction exacerbating potential for error is provided by the infusion pump, a device that regulates the flow of intravenous (I.V.) solution when attached to the tubing through which the solution flows. A schematic drawing of an infusion pump can be seen in Figure 1. When one removes an infusion pump from I.V. tubing, free flow of the solution into the patient will occur unless a clamp (which may or may not be attached to the device) is used to close the tubing and stop the flow. Infusion pumps are used extensively in the intensive care unit (ICU), where because of the high concentration of devices necessitated by the patients' conditions, there is a great deal of device/user/environment interaction. It is not unusual for an ICU staff person to be called to a crisis situation while in the process of removing an infusion pump from a patient's I.V. Because of the distraction of attending to the crisis, the staff person may not remember to clamp the tubing. This, depending on the drug in solution, could result in death or serious injury.

The importance of user characteristics and the operational environment for a medical device has become particularly salient with the increasing home use of devices originally designed to be used only by health care professionals in a hospital, e.g., infusion pumps and ventilators. People using devices in the home more than likely have no easily comprehensible instructions for the operation and maintenance of the device, and are experiencing a great deal of stress which affects their cognitive and physical functioning. These problems can be compounded by conditions in the home such as the ambient temperature not being in the range for accurate functioning of the device and/or not having electrical outlets compatible to the device in the location appropriate to its use.

To complicate matters, the family care-giver can be attempting to use a device that has switches which are difficult to operate. Difficulty can occur if manual dexterity is compromised by clumsiness resulting from lack of knowledge or physically constraining conditions such as arthritis. Another source of difficulty in home use stems from device dials which are not readily visible under home lighting conditions. In addition, messages from device dials and read-outs may not be easily understood by non-health-care professionals who can vary in age from youth through elderly as well as in a diversity of cultural backgrounds. Clearly these are conditions that invite user error.

As with most systems, medical devices are not without maintenance problems. A good example is provided by blood glucose monitors, hand-held computerized devices that provide a reading of the concentration of glucose in the drop of blood a diabetic places on a test strip in the monitor. Figure 2 presents a schematic drawing of such a blood glucose monitor. Based on those readings, diabetics adjust their dose of insulin and/or determine their diet and exercise regimen. In some models of monitors, the blood can

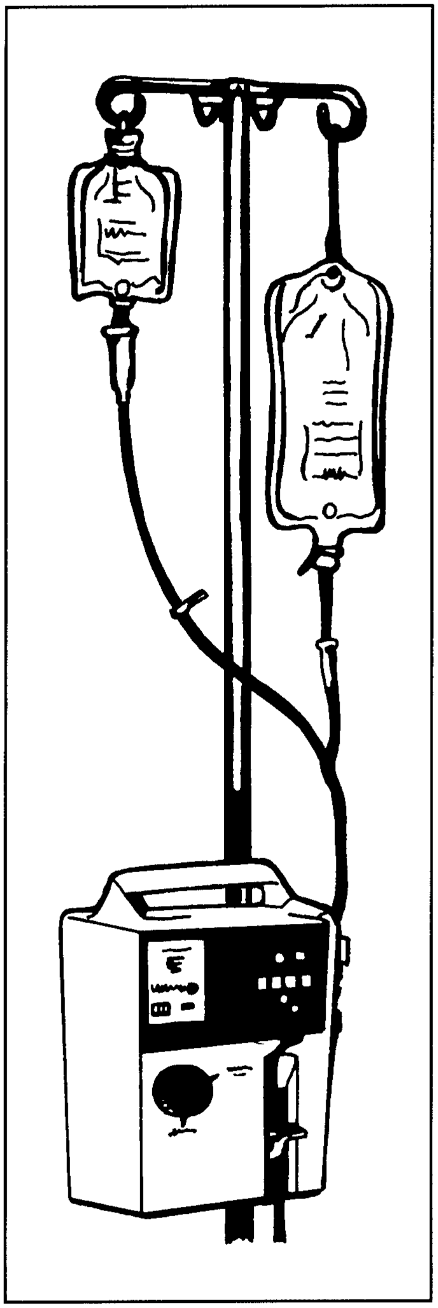

Figure 1. A schematic drawing of an infusion pump.

seep into the sensing area and accumulate over time, which may result in errors in readings. Maintenance of these models of monitors entails taking the monitor apart, washing it, waiting for it to dry, and reassembling it. This multi-step process might readily discourage cleaning by the proportion of the seven million diagnosed diabetics in the U.S. who use those particular models of monitor.

The human factors community has a history of addressing conditions which induce human error in the use of systems, albeit not specifically medical devices. Thus, the human factors community has the potential to make significant contributions to the medical device industry and in turn to the FDA, and ultimately to the overall well-being of the American people. A schematic drawing (Fig. 3, p.14) depicts some of the areas that can be affected by human factors considerations, including the user, the surroundings, and the device. The methodology and experience needed to reduce the likelihood of error in operating and maintaining medical devices are readily available. However, incorporating human factors considerations into the development and approval of medical devices is not easy.

Medical devices, unlike weapon systems or other made-to-contract specifications procurements, do not result from contractual Statements of Work, but are developer-initiated. A device is developed, most often by a "mom and pop" shop, and after its safety and effectiveness are demonstrated in physical terms (e.g., the material with which the device is constructed is not toxic, and the device does what it is purported to do) the device is cleared by the FDA for marketing by industry. The device then is manufactured and sold. Medical devices do indeed constitute a new frontier for the human factors community, a frontier with considerable payoff to all of society. However, to pursue and develop that frontier, the human factors community must employ the ingenuity for which it is known to market and ultimately to demonstrate the potential of its contributions. ●

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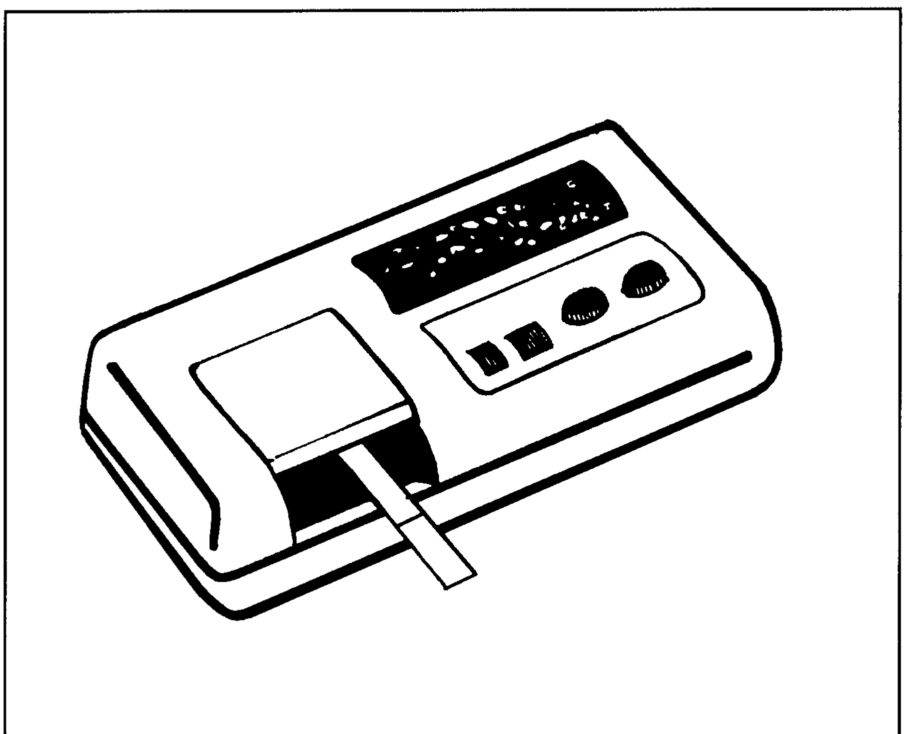
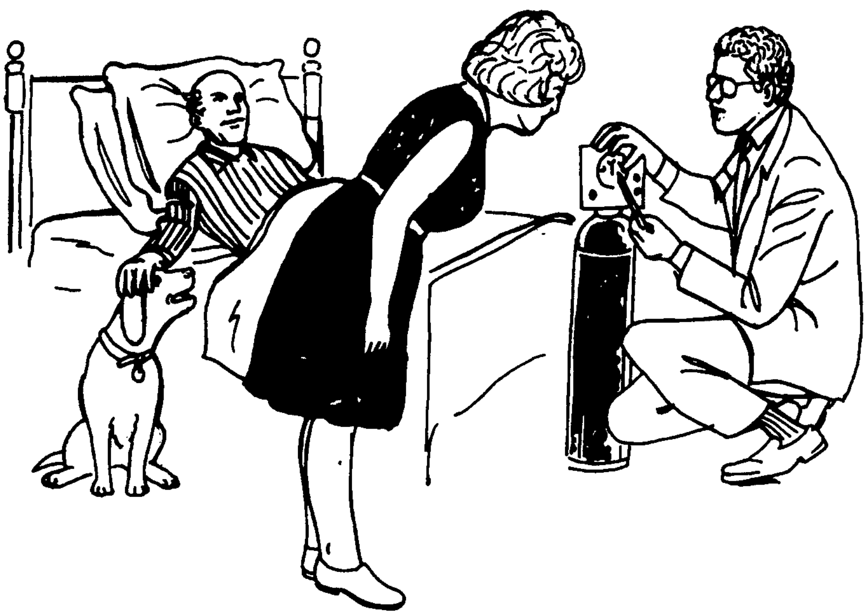


Figure 2. A schematic drawing of a hand-held blood glucose monitor.

FOOD and DRUG ADMINISTRATION

Human Factors– characteristics that make humans and medical devices work well together.



User
- mental abilities
- physical abilities

Device
- design
- labels, instructions

Surroundings
- physical
- social

Figure 3. The influence of human factors on medical devices includes consideration of the user and the surroundings, as well as the device itself.

MAILING ADDRESS

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CSERIAC has an immediate opening for a key analyst in crew system ergonomics/ human factors. Following are some of the preferred qualifications for the position.

- Ph.D. and 15+ years related experience in engineering or psychology with an emphasis on human factors.
- Experience in analyzing problems, finding information, and synthesizing solutions.
- Good communication skills (both written and oral).
- Flexibility and versatility in response to changeable job duties.
- Military experience and/or knowledge of the DoD and government agencies.
- Good interpersonal skills (the ability to interact productively with people in government and industry, as well as coworkers).

For information about CSERIAC, contact Dr. Larry Howell at (513) 255-4842. Send resumes to Robert Artman, University of Dayton Research Institute, Office of Human Resources, Kettering Laboratory 503, Dayton, OH 45469-0105.

Down-Sizing Reaches the MIL-STD-1472

Rick Davids

Constructing a checklist is like getting a vaccination or cleaning out your attic: you don't look forward to it, it's going to be messy, and you wish there were an easier way. As a rite of passage, it seems that most human factors engineers are required to put together a checklist for field-level tests and evaluations for a proposal effort. Usually the checklist is based on MIL-STD-1472, since it is the recognized source of reliable human factors data and information. If you are fortunate enough to have a hypertext electronic version, formatting the text entries is not painful. However, most of us must word process the entries from scratch; worse yet is to cut and tape paragraphs from second-generation copies.

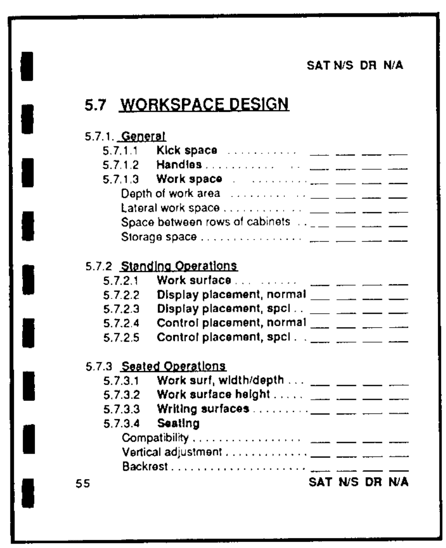
Any way you do it, the checklist still comes out looking the same. The final output is squeezed to fit the US Letter 8-1/2" x 11" format. The checklist has the MIL-STD-1472 entries word-for-word, line-for-line. It includes the paragraph number and title, criteria, and 3 or 4 columns for registering the degree of compliance (N/A, Yes, No, Reject, etc.). After the text is reproduced and reduced, the ubiquitous 1-inch wide "Comments" column is added on the right-hand side. Of course, when you try to use it in a cramped electronic equipment shelter, you're either standing up with an awkward 3-ring notebook folded over upon itself or sitting down with the checklist squashed in your lap. Either way, you wish you had two extra hands to hold all the other paraphernalia.

Based on these experiences, frustrations, and cost-consciousness, the Human Factors Engineering Group at Lockheed Missiles and Space Company decided to "human factor" a checklist based on MIL-STD-1472D. The result is a "pocked-sized" comb-bound booklet measuring 5" (w) x 6" (h) x 3/4" (d). It is a sequential listing by chapter of only the paragraph text headings in a legal display format. Since the criteria were not included, the onus of compliance depends upon the long-term memory, expert judgment, and interpretative skill of the human factors engineer who is conducting the evaluation. Thus, the checklist doubles as an information training and marketing device. It is easier to show the doubting test directors and program managers both the applicable criteria and the full extent of human factors engineering expertise in one easy step.

Figure 1. The MIL-STD-1472D Checklist from Lockheed Missiles and Space Company.

The checklist includes four blank spaces opposite each paragraph heading (see Fig. 2). These blank spaces are for recording the status of compliance. Four compliance categories are offered: (1) satisfactory (SAT), (2) not satisfactory (NS), (3) deficiency report (DR), and (4) not applicable (NA). The booklet includes one or two blank note pages at the end of each chapter for sketches and notes. At the back of the book are ten yellow, color-coded blank deficiency report forms for recording the "who, what, when, where, how" information concerning the violation of the criteria. Spaces are provided for recording the name of the item, model number, date, location, design engineer, method of analysis, description of the deficiency, and a proposed change. The deficiency report form is sized to be reproduced onto a vertical 8-1/2" x 11" piece of paper. The best part of all is that the "down-sized" Checklist is available only through CSERIAC on a cost-recovery basis. The cost for the checklist is $3.25, with descending costs for bulk purchases. ●

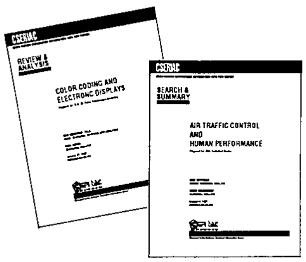
Rick Davids is a Human Factors Staff Engineer at Lockheed Missiles & Space Co., Sunnyvale, CA.



	SAT	N/S	DR	N/A
5.7 WORKSPACE DESIGN				
5.7.1. General				
5.7.1.1 Kick space				
5.7.1.2 Handles				
5.7.1.3 Work space				
Depth of work area				
Lateral work space				
Space between rows of cabinets				
Storage space				
5.7.2 Standing Operations				
5.7.2.1 Work surface				
5.7.2.2 Display placement, normal				
5.7.2.3 Display placement, spcl				
5.7.2.4 Control placement, normal				
5.7.2.5 Control placement, spcl				
5.7.3 Seated Operations				
5.7.3.1 Work surf, width/depth				
5.7.3.2 Work surface height				
5.7.3.3 Writing surfaces				
5.7.3.4 Seating				
Compatibility				
Vertical adjustment				
Backrest				
55	SAT	N/S	DR	N/A

Figure 2. A page from the checklist showing paragraph headings and the spaces for recording compliance.

CSERIAC TECHNICAL SUMMARY AND ANALYSIS SERVICES



What is a Technical Inquiry?

Simply stated, a technical inquiry is a request for ergonomics information. In general, ergonomics information is technical knowledge about human abilities and performance, which can be used to enhance equipment design and development.

CSERIAC's answer to inquiries can take many forms, including customized bibliographic searches, review and analysis of research, recommendations based on analyses, and expert consultation referrals. We have grouped these into three basic categories, based on the kind and amount of ergonomics expertise applied to the problem. The three categories are Search and Summary, Review and Analysis, and Technical Area Tasks. A fixed fee has been established for the first two; Technical Area Tasks must be negotiated on an individual basis.

Search and Summary

Search and Summary consists of a literature search and a printout of relevant abstracts, which are then bound in a booklet. A professional human factors analyst reviews the abstracts and identifies the most pertinent. The human factors analyst also consults references within CSERIAC's immediately accessible resources and provides comments and/or excerpts from these references. The main purpose of this level of response is to provide a very rapid response to requests for technical information.

Review and Analysis

This level of response includes all of the above plus direct contact with subject-matter experts, a 3-to-7 page white paper synthesizing the results of the technical review, complete copies and/or excerpts from relevant documents, and names, addresses, and telephone numbers of subject-matter experts. It also includes the requisite materials for access to databases and personal contact with the subject-matter experts. The main purpose of this level of response is the in-depth synthesis of the literature with the formation of an authoritative "conclusion" or answer regarding the question posed.

Technical Area Tasks

In this category are those inquiries requiring major CSERIAC time and material expenditures, such as preparation of state-of-the-art reports (SOARs), critical reviews, technical assessments, and handbooks, organizing workshops and symposia, or exercising computer models in our technology transfer inventory. The main purpose of this level of response is an extensive customized effort directed at solving the customer's particular needs.

Previous TOPICS

- Pilot Decision-Making Under Stress
- Speech Synthesis and Recognition
- Human Tolerances to Impact
- Operator Workload Assessment: Subjective Techniques
- Design Guidelines for Human- Computer Interaction
- Cumulative Trauma Disorders in the Workplace
- Shift Work and Sleep Deprivation
- Human Error
- International Anthropometric Data Sources
- Color Coding and Visual Displays

Previous CUSTOMERS

- NASA
- General Motors Corporation
- AT&T Bell Laboratories
- US Army Tank-Automotive Command
- University of Illinois
- Texas Instruments Inc.
- US Consumer Product Safety Commission
- NCR Corporation
- Naval Air Warfare Center
- Ford Motor Company
- FAA Technical Center
- US Nuclear Regulatory Commission

For More Information Contact:
Mike Gravelle
Senior Technical Analyst
CSERIAC Program Office
(513) 255-4842

Human Factors and the Technology Assessment of Medical Computer Systems

John Gosbee

An earlier issue of *CSERIAC Gateway,* Dr. Paula Sind (Vol. III, No. 3) noted the importance of medical technology assessment as part of her article, "Human Factors in Medicine: Quo Vadis?" I would like to expand her discussion of this area, and discuss how the Michigan State University Kalamazoo Center for Medical Studies (MSU/KCMS) is using human factors methods and principles to address assessment of medical computer systems.

Medical Technology Assessment and Human Factors

As I have previously written (Gosbee, 1991), human factors professionals can play an integral role in Medical Technology Assessment (MTA). MTA entails evaluation of medical equipment and systems in terms of safety, effectiveness, patient preferences and quality of life, and cost-benefit trade-off (Fuchs & Garber, 1990). MTA was a term coined to describe an area of research and development that hopes to answer the question: does this new piece of medical equipment (technique) improve diagnostic and treatment capabilities in a tangible and cost-effective way? Insurance companies and the federal government are using MTA to help contain escalating health care costs. For instance, federal funding for research activities like MTA rose from $1.9 million in 1988, to more than $30 million in 1990 (Epstein, 1990).

How can human factors professionals help? In short, the MTA process needs the standardized techniques and principles of human factors applied in a research and development environment. To improve the quality of health care, Berwick (1989) has called for "...modern, technical, and theoretically grounded tools for improving processes." Roper, Winkenwerder, Hackbarth, & Krakauer (1988) noted that MTA (health care evaluation) lacks data acquisition and processing methods that would help improve the safety and effectiveness of technology.

The medical device industry does recognize the need for human factors inputs. The editor of the medical device trade magazine, *Medical Device & Diagnostic Industry,* wrote that quality and user-based design were the two most important industry issues for the 90's (Bethune, 1991). Further, he warned that new legislation and FDA regulatory enforcement will make human factors a "need to have" rather than a "nice to have" for medical device companies.

Medical Technology Assessment of Computer Systems at MSU/KCMS

At the Center for Applied Medical Informatics, we are evaluating medical software and hardware based on experience and knowledge from the field of human factors. MSU/KCMS is developing a state-of-the-art clinical facility that will use advanced information technology. The clinical facility will also function to generate, refine, and evaluate product ideas while in active use. Our Center will promote a user-centered design approach using principles from participatory design, concurrent engineering, and rapid prototyping.

The Center is involved in many aspects of assessing medically related hardware and software. We are identifying and characterizing significant challenges or needs in rural health care and primary care. We will develop this vague need into specifications, so improved information systems can be developed. For our development projects, we are working with researchers, developers, or vendors to produce information systems that are usable and viable. We are using field study methods to take advantage of our access to a generalizable health care population. We are also building a usability laboratory dedicated to studying human-computer interaction with medical information systems. The floor plan of the laboratray is shown in Figure 1. Other academic and industry groups are assisting us in this effort, including the Industrial Engineering Department at Western Michigan University. If we succeed, we will prevent scenarios like the one depicted in Figure 2.

Other Examples

Other universities are using human factors techniques and principles to assess medical technology. Dr. David Gaba, Stanford University, indirectly evaluates anesthesia monitoring equipment through use of simulations and mental workload testing. One reason he supports the application of human factors to MTA is that vendors are claiming new anesthesia devices have superior human-device interaction. Dr. David Woods, The Ohio State University, also applies human factors and cognitive engineering techniques to the evaluation of anesthesia equipment.

I am heartened that these efforts to apply human factors to MTA are broadening. The result will be improved, higher-quality, and more efficient health

Continued on page 18

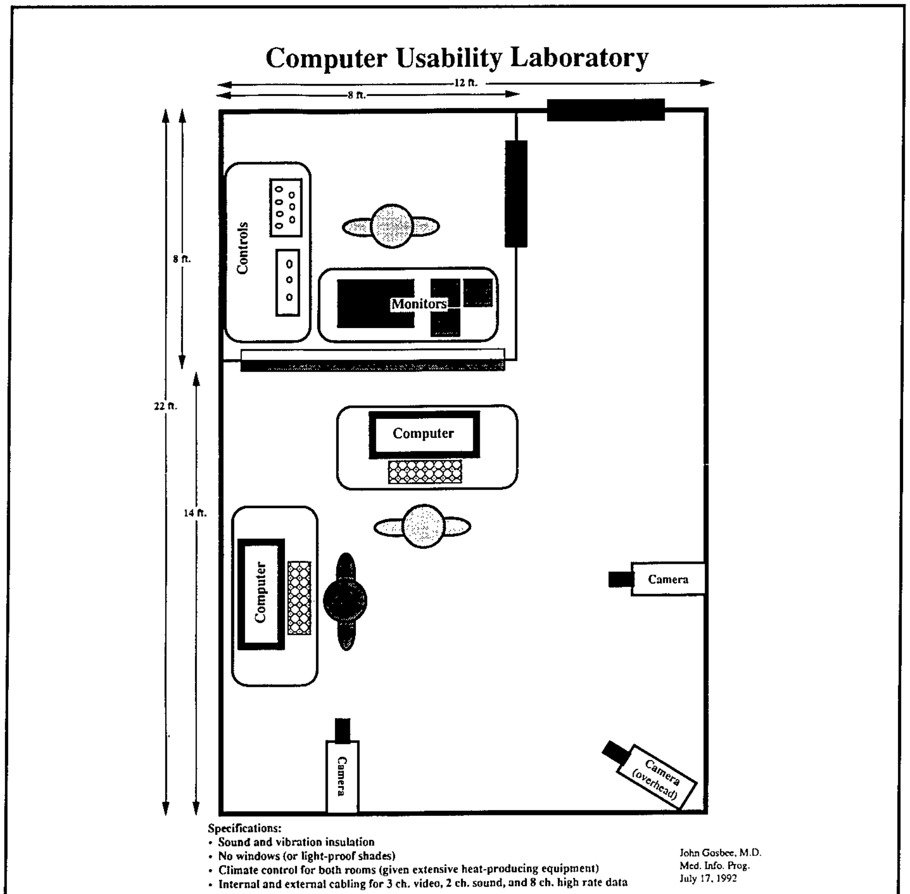


Figure 1. The floor plan of the Computer Usability Laboratory at the Center for Applied Medical Informatics, Michigan State University, Kalamazoo Center for Medical Studies.

care. As the health care technology field wrestles with new legislation and constraints, I think they will be glad to know that the human factors discipline exists.

* The views in this article are not necessarily those of Michigan State University Kalamazoo Center for Medical Studies. ●

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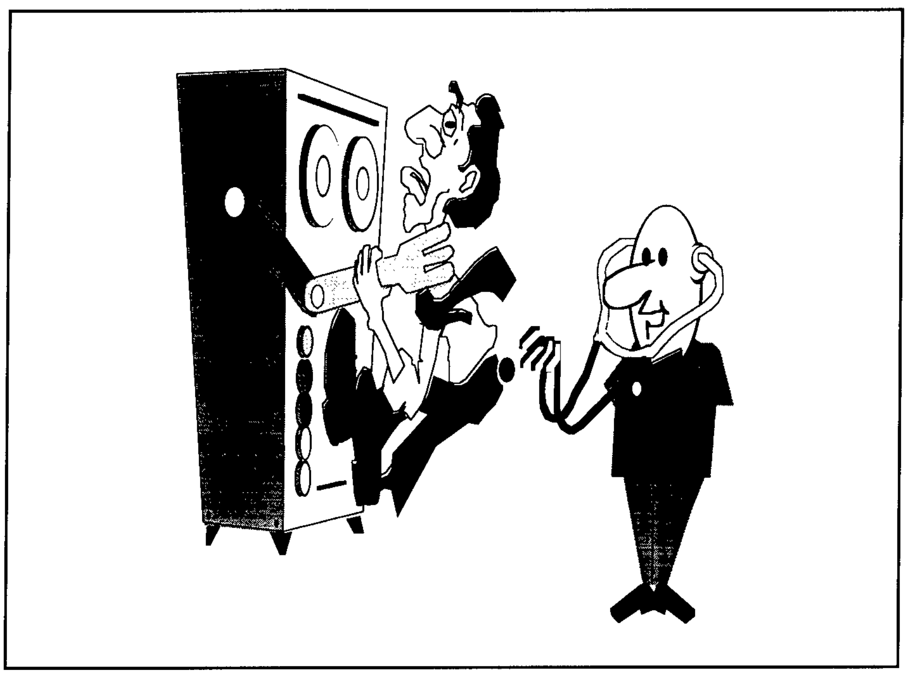

Figure 2. Computer and physician work together to treat their patient? Adapted from "Bit Art" in Power Point Macintosh Program.

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