Human Factors and Ergonomics Society

Bulletin

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RENEW YOUR HFES MEMBERSHIP BY JANUARY 31!

Improving Voting Systems

By John M. O'Hara, Chair HFES Voting System Task Force

"I hope my vote counted. I don't know. Hanging Megabyte?"

"If they took out something that wasn't working, why did they put in something that works even worse."

–Voters using new touch screen voting machines in primary elections in Florida (*The New York Times*, September 11, 2002)

The United States began using the Australian-type ballot in the late 1800s. This is a ballot produced at public expense on which all candidates are listed and voters mark their selection. It was considered an advance over voting by role call, write-in, or privately produced ballots listing only certain candidates, and it brought fairness to the election process.

Over the years, the technology used in the voting process has changed quite a bit, and today a wide range of technologies are employed, including paper ballots, punch cards, mechanical lever machines, and optical scanning devices. More recently, computer-based voting machines, called *direct recording electronic* (DRE) devices, have been introduced.

The U.S. national election of 2000 spotlighted potential problems voters might have in accurately indicating their selections on the various voting devices. The human factors issues associated with the butterfly ballot used in Florida's Palm Beach County captured international attention. In part as a response to these issues, the Help America Vote Act of 2002 (H.R.3295) was recently passed and will significantly change the voting technology used in many areas of the United States (see http://www.electionline.org/site/docs/pdf/hr3295.final.pdf). Among other things, it will provide funds to replace older technology with new technology: mainly optical scan and DRE technology.

DRE Voting Machine
(Photo courtesy of Sequoia Voting Systems)

However, voting system usability issues were again highlighted during primary elections in Florida when voting equipment employing advanced technology was used. Thus, as we enter an era in which voting technology will rapidly change, it will be important to address the human factors aspects of these devices in order to ensure that they are easy to use and as error free as possible. In this article, I describe some of the issues and the development of a new standard in which HFES is participating that, it is hoped, will help to ensure that technology-based voting systems operate as intended.

National Voting System Standards

In the early 1990s, the Federal Election Commission (FEC, http://www.fec.gov) published the first National Voting System Standards (VSS). Although the VSS is voluntary, it was adopted by the majority of states. In 1997, the FEC began the process of updating the VSS, and the update was published in May 2002 (http://www.fec.gov/pages/vss/vss.html). The purpose of the VSS is to ensure the reliability of certified election equipment used in local, state, and federal elections by enabling state and local election officials to assure the public of the integrity of computer-based election systems and by providing a common set of requirements across all voting technologies.

The commission has acknowledged that the standard does not fully address everything that is needed. Two areas identified are usability and accessibility. The VSS contains some information on usability and accessibility, but more complete guidance is needed.

HF/E Challenges

Although the overall goal of human factors is to design systems that are easy to use and that minimize human error, this is a real challenge given the diversity of users of voting systems.

The new DRE voting equipment is intended to make voting easier and more accessible, but a look at recent history provides a lesson in what can happen when the interfaces between voters and relatively simple voting systems are not well designed.

It is tempting to address existing problems by throwing technology at them. Some of the voting problems experienced in Florida were associated with punch card technology. Therefore, many people feel that if punch cards are replaced with computer-based systems, the problems will disappear. New technology has a halo effect – it's new, it's high-tech, and therefore it must be better. However, technology in and of itself does not enhance or detract from human performance. Old problems are often solved, but new problems may be created. This type of approach fails to recognize that overall system performance is a function of the integrated performance of all system components and that failure is often the result of the interaction of system elements.

But does it make sense to think of a voting system as a *system* in this sense of the word? I think it does. The voting system is the integration of all the elements that support the election and voting

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It's a Fair Question: What Is an HF/E Professional?

By Barry H. Beith, HFES President

In the August Bulletin, HFES President David Post and I co-wrote an article on the revised HFES Strategic Plan. A week or so later, we received an e-mail from an HFES Fellow pointing out that on several occasions in the article we had referred to "HF/E professionals." He observed that although he and many other colleagues are familiar with HF/E researchers, HF/E scientists, HF/E practitioners, and HF/E engineers, he was not at all familiar with what we meant by HF/E professionals. It is a fair question, and I'm glad he asked it because it affords me the opportunity to respond with my own views about what constitutes an HF/E professional. Some readers may roll their eyes and sigh heavily, but there is little doubt from recent events that such discussions are not passé and should be a part of, as Mortimer Adler would say, our own "great conversation."

R. Buckminster Fuller observed that the strongest natural structure in the universe is the tetrahedron. Perhaps, then, it is only fitting – or a vain attempt to add credence to my opinions – that my model for an HF/E professional is also represented by such a tetrahedral structure.

The Model of the HF/E Professional

Knowledge and perspective. The base of our professional model consists of three elements. The first is that of knowledge and perspective. We have long debated whether HF/E is a science, a discipline, or a field in its own right, or whether we represent the intersection of a myriad of other, more established sciences or disciplines. I believe that the time for such debate is over and that we must declare human factors/ergonomics to be a science and to be a discipline, unique in its combination of behaviorism and engineering, even if others doubt or argue otherwise (as some always will). HF/E must be a science and a discipline if the perspective that human beings are at the center (and are the point) of all design and that "fitting the task to the person" is a mantra that will fade if HF/E and its proponents such as the Society's members are not there to repeat it. HF/E is a science and a discipline because it *must* be and we *must* therefore strive to make it so.

We have also spent a nontrivial amount of effort trying to define the boundaries of our discipline, albeit with very little progress. I believe this is because we continue to look at the boundaries of our work instead of at the core for such a definition. Pursuing this perspective has only led us to frustration because the boundaries as defined by applications and work domains continue to change with technology and social evolution and refuse to remain fixed. We would do better to define ourselves by looking at the core of our discipline, where we discover the two knowledge bases that allow us to work and contribute to virtually any domain and to improve virtually any application. Those knowledge bases are (a) knowledge of human beings relating to such concepts as characteristics, capabilities, limitations, behaviors, cognition, perception, emotion, motivation, and performance, and (b) knowledge about scientific and engineering methods, including experimental designs, measurement, data analysis and interpretation, engineering tools and techniques, simulation and prototyping, and the ability to translate such data in order to affect (and improve) engineering and design.

The combination of these two knowledge bases allows us to bring a unique perspective and set of skills to enhance the performance and quality of life in an almost boundless set of domains and applications. I emphasize that data are the key to raising our recommendations and initiatives above the cacophony and ubiquity of opinion and give us a strong ability to add value to both engineering and design. Thus I conclude that one must have the core knowledge bases, the ability to derive knowledge through science, and the desire to apply it to engineering and design in order to be an HF/E professional.

Identification and investment. Those who consider themselves HF/E professionals must identify with the science, field, and discipline and make this unique perspective their own. This is not to say that being a professional requires that HF/E become the dominant or only focus of one's life. We must identify ourselves as HF/E and be willing to present that to the world. This means that we must be prepared to carry the banner, to proselytize to those who cannot or will not hear the message, and fight back the fatigue that comes from hearing too many times that "it is only common sense" or "it's only junk science" or "what's human factors?"

I have met many people in HF/E over the years. They often seem to fall into one of two camps. The first are those who work for an organization and just happen to be in the human factors, ergonomics, or usability department right now. In contrast, there are HF/E professionals who just happen to work for a particular organization right now. That is my oversimplified and dichotomous view of identification and investment. Without identification and investment, the individual is not a professional but an organizational functionary and usually will not or cannot carry the message because it is not his or her own. For this reason, I believe identification and investment is the second element in the base of the HF/E professional model.

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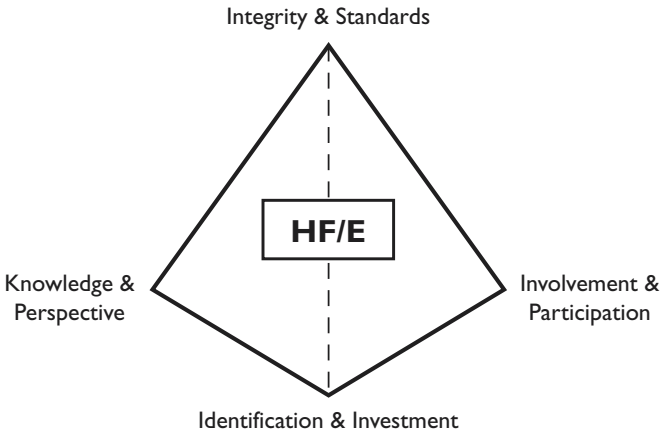
Involvement and participation. This represents the third element in the base of our tetrahedral structure and is the characteristic that most people find difficult to appreciate. Yes, I am talking about actively supporting professional activities. I was told once that 70% of any organization represents the audience rather than the leadership. Though we may strive for something different, the fact is that the audience at any "show" is vital to the success of the show, so by this reasoning, I can hardly be upset that this applies as well to HFES, and I am pleased that we have an attentive audience. We have many who claim to be in the field who are not even part of the audience but still view themselves as HF/E professionals. I'm afraid I must disagree. "Professional involvement" need not mean attending the HFES Annual Meeting or participating in the Society's leadership through its committees, local chapters, or technical groups. Involvement may be attending a regional conference, participating in community activities, sending letters to an editor, donating time to support the HF/E needs of a local organization, or any number of other actions.

The bottom line is that involvement and participation are vital and central to being an HF/E professional, and I strongly believe that HFES membership is one demonstration of that. Not to belong is not to support the organization that represents the discipline, promotes the science, and facilitates the application of that science to engineering and design. If the Society were to cease existence because individuals who otherwise considered themselves to be HF/E professionals didn't support it, then how could one consider that behavior to be consistent with professionalism? It is for this reason that I consider involvement and participation to be a critical third element in the base of this model.



Integrity and standards. Every pyramid must have the identifiable signature shape capped by its apex. In our model, I believe that apex is represented by integrity and standards. It has become evident over the past year that integrity is in short supply in many areas of business and society. Even as courage, dedication, and bravery were on the rise in some situations, integrity and ethics were screaming toward the bottom in others. Without integrity and standards (and I am referring to high ones), an HF/E professional lowers, not elevates respect for the field in anyone's eyes. Integrity and ethics are fundamental to our ability to add rather than detract from the science, discipline, field, practice, and profession of HF/E. It is integrity and ethics that allow us to recognize that colleagues who *are* professional and provide reputable, solid, good HF/E also make for good competitors who open doors, whereas those who are not close them.

High integrity and ethics also demand an accounting in our interactions that recognizes and removes conflicts of interest and misrepresentation. Those of us in leadership roles in the Society, in companies, in universities, and in government must be as sensitive and cautious about the perception of impropriety as the reality of it. We must take active steps to ensure that such conflicts do not taint our decisions and actions or reflect poorly on our commitment to high standards and unwavering integrity. In the back of the HFES *Directory and Yearbook*, we have a Code of Ethics as guidance for the membership. Although putting teeth into an enforcement mechanism is fraught with problems, perhaps it is time to remind ourselves that such a code does indeed have a point and is worth highlighting and remembering. Perhaps each new member should be asked to sign an affidavit of acknowledgment and adherence to that code. HFES has long placed an emphasis on this issue through its Professionalism Subcouncil, but more is clearly needed.

High standards are also an issue in the model of an HF/E professional. It is for this reason that our standards should be driven by a renewed emphasis on the accreditation of programs through which all of these characteristics of HF/E professionalism are passed on to each successive generation. Standards that are imposed from without can never be as strong as those grown from within an individual, but guidance and reinforcement come by teaching and example. Our future lies in the strengthening and growth of our program to accredit institutions that are preparing HF/E professionals for a career in the field by instilling, encouraging, and facilitating the integrity, ethics, and standards that we must have to survive in a world running low on these qualities. Without high standards and integrity, the model loses its strength and misses the point.

This is my personal perspective on a fair and important question with far-reaching implications for our Society and our discipline: What is an HF/E professional? Understanding what it takes to raise our level of professionalism is vital at a time when our attention is being drawn constantly to the lack of integrity all around us. I believe that to the extent that the core membership of the Society reflects a model of professionalism such as this, HFES will grow stronger as the premier organization representing human factors and ergonomics in the United States and around the world. An HF/E professional is an important unifying concept for a Society that draws together such a diverse group from so many areas of engineering, behavioral sciences, design, and technology. It takes just such a group of HF/E professionals to fulfill our slogan, "Human Factors and Ergonomics: People-Friendly Design through Science and Engineering."

As for me, I will continue to strive for professionalism on my way to a higher goal – that is, to become the person my dogs already think I am.

Preliminary Call for Proposals
Human Factors and Ergonomics Society 47th Annual Meeting

Denver, Colorado • October 13–17, 2003

Mark Scerbo, Chair, Technical Program Committee

The 47th Annual Meeting of the Human Factors and Ergonomics Society offers opportunities for participants to submit creative proposals for program materials of all kinds. Proposals are welcome from HFES members and nonmembers. New formats for presenting human factors efforts are strongly encouraged. Participants are invited to present proposals that describe either research or applications; examples include case studies, debates, demonstrations, competitive product designs, new methodologies, on-site experiments, and posters.

The meeting will be held at the Adam's Mark Hotel in Denver. The Call for Proposals will be mailed to members in December and posted on the HFES Web site (http://hfes.org).

Proposals of all presentation types (lecture, panel, symposium, demonstration, workshop, seminar, alternative format, debate, poster, etc.) are due **MARCH 4, 2003.** (Note that this is later than the date published in the 2002 Annual Meeting Program.) Acceptance notification will be sent in April. Proposals must represent original work not previously presented or published elsewhere.

Workshops

Workshops emphasize how-to, hands-on instruction and may be offered for continuing education credit in three- or six-hour sessions. Of particular interest are advanced-level workshops dealing with applications of human factors to design, state-of-the-art multimedia (hands-on) hardware and software, training techniques (including team training, visual performance, and/or display techniques), the use of theories and models in human factors, adaptive design for special populations, psychophysiology, and mathematical modeling techniques.

Decisions on final acceptance will be made after receipt of all course materials in acceptable and presentable form by the Workshops chair. Underenrolled workshops are subject to cancellation at the sole discretion of HFES.

An honorarium of $500 is paid for each three-hour workshop and $1,000 for full-day workshops, to be divided among the instructors. Continuing Education Units are provided to attendees by North Carolina State University. The Society supplies copies of handouts required for the workshop.

Posters

Poster sessions are intended for presenters who desire a more intimate and interactive relationship with the audience and/or wish to give a more detailed presentation than can be accommodated in conventional lecture sessions. Posters are on display for half a day and provide the entire 1-1/2-hour period for your presentation. Proposals for work that has not been completed by the proposal due date will not be considered.

Student Forum Sessions

HFES encourages proposals geared toward students. Past sessions include presentations on skills for transitioning from school to work or to an HF/E career from another field, employment trends in the HF/E field, and improving interviewing and résumé-writing techniques. HFES encourages students to submit work for a "Student Work Only" lecture session. Submission of completed work is desirable; however, work in progress will also be accepted.

The format of the session will be such that feedback on work in progress can be freely given. There will be at least one student reviewer for each submission.

Special Sessions (Demonstrations, Colloquia etc.)

You are invited to submit proposals for demonstrations, colloquia, on-site experiments, competitive product designs, new methodologies, case studies, or any other presentations that are not appropriate for traditional formats. We particularly encourage innovative ideas about alternative format sessions that will enhance the value of attendance at the annual meeting.

Proceedings Publication and HFES Copyright

Authors of accepted proposals will be invited to submit a paper (maximum five pages) for publication in the proceedings CD-ROM. Instructions and requirements will be described in the instruction kit mailed to authors in May. It is the Society's policy to obtain copyright for all papers published in the annual meeting proceedings (except for work performed by government employees or under government contract, which may be in the public domain). However, the author and/or author's employer may reuse the material for any purpose without restriction or fee. Contact the Communications Department (see below) for more information.

Nonmembers Are Welcome to Submit Proposals

Participation in the 47th Annual Meeting is open to both members and nonmembers of the Society. All speakers are required to pay the registration fee. If you know of nonmembers who would like to receive a copy of the Call for Proposals, have them contact the HFES central office at P.O. Box 1369, Santa Monica, CA 90406-1369 USA; 310/394-1811, fax 310/394-2410, lois@hfes.org. The Call for Proposals will also be available at the HFES Web site, http://hfes.org.

process. It consists of a complex interaction of hardware, software, and human resources that, together with policies and procedures, achieve the overall mission of conducting elections. In systems engineering terms, it is a loosely coupled distributed system, but it is a system nevertheless. For example, even with good voting machines, if ballots are poorly designed, if the equipment is improperly set up, or if the voters are not given adequate instructions and familiarization, the system will fail.

When one thinks of voting systems, the voter immediately comes to mind. However, other user groups are essential to reliable voting systems. Election officials must design ballots and test that the ballots correctly record votes prior to Election Day. On Election Day, poll workers – often volunteers – must set up the voting machines and verify voter registration. With DRE equipment, poll workers may give voters key cards or some other technology, which the voter uses to start the voting process and to access the correct ballot for local elections. When voting is completed, election officials must tally the votes. Somehow, votes from individual machines must be sent to centralized locations.

The success of any complex system is based on systems engineering and defense-in-depth design, including high design standards, redundancy of and diversity for key system elements, analysis of likely failures and design for recovery from them, and preparation of personnel for normal and abnormal conditions through training and procedures.

One of the human factors contributions to system design is to ensure that the system enables voters to give their complete attention to the task at hand: voting for the candidates and issues of their choice. To do this, the voting system interface should be almost transparent to the voter and should guide appropriate behavior. A poor design may confuse the voter or may cause the voter to shift attention away from voting to trying to understand the interface itself. At best, this is distracting and can lead to frustration. At worst, it can lead to errors.

At a minimum, designing effective and usable interfaces involves three activities. First, human-centered requirements should be identified for all user groups. These requirements reflect the ways users interact with a system to accomplish their tasks and vary depending on the voting technology. For example, the way a vote is cast is different for a paper ballot than for a computer-based voting system. The requirements for these tasks need to be carefully analyzed.

Second, human factors design guidelines should be used to help specify the characteristics and functions of the voting system interface and its supporting infrastructure. These guidelines have evolved from scientific research on human performance and from many years of application in the design of other types of systems. Their use can help to ensure that the final design of a voting system is consistent and compatible with the characteristics of the voting public.

Third, tests and evaluations should be conducted to ensure that the voting system has achieved human factors design goals. The results from these evaluations can be used to correct any design deficiencies before the systems are actually used for voting.

DRE voting will likely come to a polling place near you in the not-too-distant future. The national interest in improving the voting process and the new legislation that supports this objective will lead to novel approaches to voting. For example, it may not be long before people vote over the Internet. As these developments occur, it will be important to ensure that the needs of the users of voting systems are foremost in the minds of voting system developers. This will help ensure that the technology is properly implemented and that events like those that occurred in Florida are a distant memory. HFES has been given the opportunity to help make this vision a reality.

Addressing the Problems

In response to the need for better and more comprehensive standards for the new voting systems that are and will be emerging, the Institute of Electrical and Electronics Engineers (IEEE) initiated an effort in 2002 to develop a standard (IEEE P1583) that is complementary with the FEC VSS. (For information on the IEEE voting system standard, see http://grouper.ieee.org/groups/scc38/1583/.) The purpose of the project is to develop requirements and evaluation methods for election voting equipment. The standard will provide technical specifications for electronic, mechanical, and human factors that can be used by manufacturers of voting machines or by those purchasing such machines. The tests and criteria developed will ensure equipment usability, accessibility, accuracy, confidentiality, reliability, and security.

HFES is working with the IEEE on the standard (see http://standards.ieee.org/announcements/1583hfes.html) by establishing a task force that is responsible for developing the sections of the standard that address usability and accessibility. Those of us on the task force are now working on two main sections: one addressing voting system requirements and the other dealing with testing. Topics addressed in the draft requirements section include the following: General Principles, Overall Design and Layout of the Voting Location, Voter Identification and Authentication, Ballot and Information Presentation, Voter Input and Response, Navigation and Interaction with Ballots, Preventing and Minimizing Voter Errors, Help and System Failure, and Voter Familiarization and Training. The evaluation section will address verification against the requirements and usability testing.

The schedule for the standard is aggressive. Our work began over the summer, and we hope to have a completed standard by early 2003. This includes preparation of the draft, balloting and comment resolution, and final publication. Such a schedule is needed in order to support the voting device manufacturers and the states in procuring new equipment prior to the 2004 presidential election.

John O'Hara is a scientist at Brookhaven National Laboratory in New York. In addition to voting systems, he is interested in human performance and safety in complex systems. For more information about the HFES Voting System Task Force, please contact him at ohara@bnl.gov.

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