Product Design Technical Group Newsletter

Human Factors and Ergonomics Society
Product Design Technical Group

Summer 2008

Challenging Your Current Thinking About Usability

By Stan Caplan

Stan is President/Principal at Usability Associates where he serves clients with usability research, design, and evaluation of products as well as organizational benchmarking studies, and Human Factors staff recruiting.

This article, written for product developers that typify "clients" of usability professionals, was submitted to Appliance Design magazine and published in the September 2007 issue under the title "Understand the User".

Digital technology gives designers the opportunity to incorporate all kinds of new features into today's appliances. But that's a double edged sword. Because they can, designers often make snazzy multifunction devices with bells and whistles galore to try to appeal to customers. But users are typically frustrated by the resultant complexity of operation. In other words, companies are trying to market makeable appliances when they should be making marketable appliances. The latter means using the technology to give customers the functionality they need and bringing that functionality to them in a way that is easy to use. This may be more challenging for the designer to do than simply designing something because s/he can.

The challenge can be met by letting user focus be an integral part of your product development process and incorporating user-centered design (UCD). UCD recognizes that the intended output of a product can't be achieved without the actions of a person. The product is a sub system of the larger system that also includes the user and the usage environment.

Committing to UCD requires designers to elevate the importance of users to the success of the system and to change some of their perceptions about the users.

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Challenging Your Current Thinking About Usability, continued

Committing to UCD requires designers to elevate the importance of users to the success of the system and to change some of their perceptions about the users. I say this because over the years as I have worked with design engineers, I have heard statements that indicate an attitude that trapped them into a dysfunctional design mode. Maybe you have heard your colleagues say these kinds of things.

	DESIGN ENGINEER TRAPS	ISSUES
1	"Users will always do what they should do"	User behavior predictability
2	"They'll only do that once"	Expectations for user memory
3	"Usage complexities are a low priority because they can be explained in operating instructions"	Reliance on instructional material
4	"No complaints were received from the field about usability so it must be OK" (i.e., no news is good news)	Passive data collection
5	"We can take care of usability issues later after we have made the important design decisions"	Timeliness of usability considerations
6	"It works for me, it will be OK for users"	Human diversity
7	"I gave it to some family members and friends to try and they liked it"	Usability testing
8	"Operators will be trained to use the product so usability is a low priority"	Operator training

The design engineer can escape from each of these traps by adopting a more flexible approach to the issues behind the traps.

1. User Behavior Predictability: Human behavior is more variable than machine or software behavior. That is one reason it is the weak link in the product-person-environment system. Designers need to anticipate erroneous actions of users and either (1) prevent them from happening or (2) mitigate the consequences and provide for a graceful recovery.

> ***Example*:** For safety reasons, opening an access door on a machine disengages an interlock switch that is located at the bottom of the door. Closing the door is supposed to re-engage the switch so the machine can be restarted. The user closes the door by pushing on the top part of it and the door shuts leaving the bottom part slightly, but not noticeably, ajar because of the door's springiness. The switch isn't made and the machine won't start. Realizing the users will not do what you want them to (i.e., push on the door at the position of the switch), a designer would most likely put the switch at the top of the door or make the door more rigid. That creates a forgiving design that prevents user action from being an "error".

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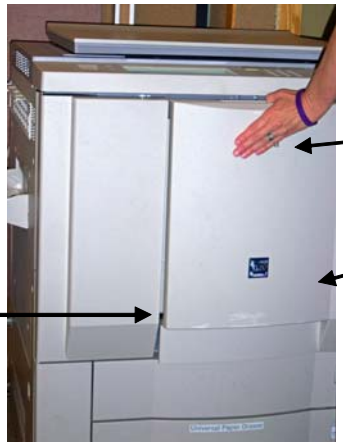
Challenging Your Current Thinking About Usability, continued

Figure 1.
Interlock switch is far from the point where force is applied to close door



2. Expectations for User Memory: "They'll only do that once" is a response when asked about a situation where the user forgets to take an action and the unintended outcome is serious. People may not repeat an erroneous action if the opportunity for the same error presents itself shortly after the first error occurrence and if the opportunity continues to arise frequently. However, when a significant amount of time passes most people will not be able to remember how to do the task correctly again. Besides the time factor, interference from another experience can cause the memory to be faulty. For instance, the erroneous action on product B may have been the correct action for a similar task recently performed on product A.

> ***Example:*** Consider these relatively infrequent scenarios - changing the time on a VCR, advancing the date on your watch, modifying a preference setting in a software application. They are examples of procedures that must be done a particular way. Human memory may not recall the exact procedure because there are many ways for an error to occur – incorrectly performing a step, omission of a step, addition of a step, or transposition of steps. The design point here is to make an operational procedure forgiving and provide timely feedback so correct performance doesn't excessively tax long-term memory.

3. Reliance on Instructional Material: Finding a procedure or a particular answer in a manual or online help takes time and most users will not want to invest "extra" time to use a product. They will do trial and error first and read instructional material only out of necessity. Even that may not happen if the written manuals are not readily available as is so often the case. Finally, the instructions won't help if they aren't written in an understandable way. Like the product itself, the instructions need to be designed for readability and understandability.

4. Passive Data Collection: This stance says "if I don't see it or don't hear about it, then it didn't happen". Rather than using words, people may choose to convey their displeasure by actions such as giving their business to someone else. One of the several ways to employ an active approach to discovering field problems and perceptions is simple observation. Visit customers and watch them work. Look for workarounds they may have devised. Walk around and look for artifacts that indicate usability problems.

> ***Example:*** When I was on the team for developing Kodak Ektaprint copiers, we made frequent visits to customer sites to watch behavior such as how they approached the copier, how they handled the original documents, and what they did when things didn't go the way they wanted. We often saw ad hoc instructions taped to the wall behind the copiers and/or an instruction written in marker on the copier cabinetry. These observations told us a lot about what we should pay attention to in the design of the next copier model.

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HFES 52nd Annual Meeting — Schedule

The *Product Design Technical Group* has what promises to be a very strong program for this year's annual meeting. Take a look at the various paper and poster abstracts, and I think you'll agree that there will be something for everyone. Many thanks to everyone who submitted and reviewed proposals for this year's annual meeting.

Tuesday, September 23, 2008 10:30 am — 12:00 pm

Ecological Aesthetics Design: Presenting a Framework for Product Aesthetics
By Moin Rahman and Ira Jhangiani (Motorola)

We have utilized the principles of ecological psychology in general, and its concept of "direct perception" (Gibson, 1966) in particular, to develop the Ecological Aesthetics Design (EAD) framework to explain how the ecology of a consumer influences his aesthetic judgment of a product. In the EAD framework, we have identified three ecologies (physical, socio-cultural and experience), which together, inform and influence a consumer's aesthetic judgment. Furthermore, based on findings from affective sciences, we show that aesthetic judgment itself is a form of direct perception, which actually is a nonconscious mode of gleaning a product's attributes (quality, function, etc.) through its appearance. The EAD approach provides a much needed framework for product designers to systematically determine the aesthetic requirements of a product for a specific group of consumers whose tastes, dispositions and attitudes are shaped by their ecology.

Perception of Information Security and Its Implications for Mobile Phone
By Dinglong Huang, Pei-Luen Rau, Gavriel Salvendy (Tsinghua University) Ying Liu, Xia Wang (Nokia Research Center), and Xiaoli Shang (Tsinghua University)

Information security is of great concern to IT users, who may hesitate or refuse to adopt IT appliances because of worries about security problems. The objective of this study was to investigate the antecedences and consequences of people's perception of information security. This study included three phases. In phase 1, a six-factor structure modeling people's perception of information security was developed through a survey study and exploratory factor analysis. In phase 2, the relations between people's perception of information security and their intention to adopt IT appliances were tested through a laboratory experiment and path analysis. Significant effects were found and a path model was developed. In phase 3, the implications of people's perception of information security for mobile phone were discussed through focus group. Mobile users' perception of mobile security in seven scenarios was summarized. Three personas of mobile security were developed.

A Multivariate Evaluation Method for Representative Human Model Generation Methods: Application to Grid Method
By Kihyo Jung (POSTECH), Ochae Kwon (Samsung Electronic), and Heecheon You (POSTECH)

A small number of representative human models (RHMs) are used for efficient product design and evaluation in digital environments; however, multivariate performance evaluation on existing RHM generation methods has not been made. The present study developed a multivariate accommodation evaluation method, and then applied the proposed method to evaluation of grid method, which generates RHMs at scattered grids over the population distribution. The measure multivariate accommodation performance quantifies the proportion of the population within representative grids that are formed to accommodate a designated percentage of the target population. Twelve RHMs generated by the grid method to accommodate 95% of the 1988 US Army anthropometric database, it was found that the accommodation performance of the RHMs decreased dramatically as the number of anthropometric dimensions increased (accommodation percentage: 99% for 1 dimension and 10% for 10 dimensions). Multiple regression analysis identified that three factors (overlap area of representative grids, adjusted R2 between key dimensions and other body dimensions, and sum of body size ranges) significantly affect the accommodation percentage of grid method. The proposed evaluation method is applicable for evaluation of other RHM generation methods.

HFES 52nd Annual Meeting — Schedule, continued

Tuesday, September 23, 2008 10:30 am-12:00 pm, continued

Analysis of Human Information Acquisition Behavior for Natural Gaze-Based Wheelchair Control
By Meike Jipp, Christian Bartolein and Essameddin Badreddin (University of Heidelberg)

Especially for severely disabled people, a powered wheelchair is an important means to participate in societal life and live as far as possible independently. To achieve this goal for users, who cannot operate their wheelchair with the traditional joystick or specialty controls, methods have been developed to enable steering the wheelchair on the basis of the user's gaze behavior. While existing approaches require the user to adapt his/her gaze behavior to match the characteristics of the human-technology interaction and/or only provide reasoning about the desired motion direction of the user, the conducted study gives crucial input about the relationship between the gaze behavior of wheelchair users and the - from the user - desired goal position as well as his/her anticipated mission. Implications for a natural gaze-based assistance system for electrically powered wheelchairs are drawn, which allows reasoning on the user's behavioral goal position and his/her current mission.

Developing a Framework for Intuitive Human-Computer Interaction
By Marita O'Brien, Wendy Rogers and Arthur Fisk (Georgia Tech)

Many technology marketing materials tout the intuitive nature of products, but current human-computer interaction (HCI) guidelines provide limited methods to help designers create this experience beyond making them easy to use. This paper proposes a definition for intuitive interaction with specific attributes to allow designers to create products that elicit the target experience. Review of relevant literatures provides empirical evidence for the suggested working definition of intuitive HCI: interactions between humans and high technology in lenient learning environments that allow the human to use a combination of prior experience and feedforward methods to achieve an individual's functional and abstract goals. Core concepts supporting this definition were compiled into an organizational framework that includes: seeking user goals, performing well-learned behavior, determining what to do next, metacognition, knowledge in the head, and knowledge in the world. This paper describes these concepts and proposes design approaches that could facilitate intuitive behavior and suggests areas for further research.

Tuesday, September 23, 2008 3:30 pm – 5:00pm

7th Annual User-Centered Product Design Award
Moderated by Dianne McMullin

Don't miss this presentation of awards to the winners of the Seventh Annual User-Centered Product Design Award. The winners will be announced, and they will provide presentations about the design of their winning product.

Tuesday, September 23, 2008 5:30 pm – 7:00pm

PDTG 2008 Business Meeting

The status and future plans of the PDTG will be discussed at this meeting. All PDTG members and non-members are welcome to participate in this discussion. Your presence and opinions are extremely valuable to the success of the PDTG. Refreshments and appetizers will be served.

HFES 52nd Annual Meeting — Schedule, continued

Wednesday, September 24, 2008 8:30 am-10:00 am

The Boeing 787 Dreamliner --- A Case Study in Large-Scale Design Integration
By Dianne McMullin, Alan Jacobsen, Dwaine Carvan, Richard Gardner, Janice Goegan and Michael Koehn (The Boeing Company)

The development of an all-new commercial transport airplane presents a unique opportunity for the practical application of human factors and ergonomics skills and methods in a large-scale engineering program. From satisfying the needs and desires of a widely diverse global user population that includes passengers, pilots, flight attendants, maintenance workers, ground service personnel, and factory workers; to ensuring that the human interface is appropriately addressed across the whole airplane, including a vast array of systems; the integration of human factors into the overall design process represents a significant challenge to the human factors' community. Successfully balancing key human interface parameters such as safety, usability, producibility, maintainability, and training along with other design parameters such as economic viability, airplane mission requirements, and physical design constraints like weight, drag, and volume is the goal of human system integration.

Wednesday, September 24, 2008 1:30 pm — 3:00 pm

Improving Neutron Detection: Usability Analysis of Control Mechanisms and Control Orientations for Use in Hand-Held Devices
By Scarlett Herring, Pamela Castillejos and M. Hallbeck (U. of Nebraska-Lincoln)

This study was conducted to determine the best control mechanism for a hand-held neutron detector testing three control mechanisms (blister buttons, push-buttons and a single-axis rocker) and two control mechanism orientations (vertical and horizontal). A simple menu-selection task, based on the current neutron detector, was conducted to evaluate the prototypes and determine the most efficient combination of control mechanisms and handle shapes. The most efficient combination was based on the lowest error rate and movement time. The results of this investigation found support for the horizontally oriented controls. In addition, blister buttons were found to be the best control mechanism (lowest error) out of the three control mechanisms tested. Blister buttons should have a diameter of at least 1.3 cm and provide tactile feedback to the first responder in order to enhance user performance.

Evaluation of Input Control Type and Screen View Orientation for a Hand-Held Neutron Detector
By James Crowe, Pamela Castillejos, Scarlett Herring and M. Hallbeck (U. of Nebraska-Lincoln)

Current radiation detectors are unwieldy, heavy, difficult to use and thus are not ergonomically designed. Easily usable control mechanisms are imperative for comfort, usability and accuracy for hand-held tools such as radiation detectors. A study, employing participants, examined the usability, design, and comfort of different handle designs and control mechanisms The purpose was to evaluate the prototypes for the main effects of control mechanism type, control orientation and word orientation on performance time. According to research findings for control type, the fastest performance time was found with vertically oriented push buttons and a vertical word orientation. The subjective results also showed a user preference for the vertical push button control. The results from this study can be used to drive future research and help develop a working prototype for a hand-held neutron detector.

HFES 52nd Annual Meeting — Schedule, continued

Wednesday, September 24, 2008 1:30 pm — 3:00 pm, *continued*

Sensory Quality Evaluation of Clothes Washing Machine Selector Knobs
By James Kleiss (Whirlpool Corporation)

The present study sought to expand upon the traditional role of human factors in assessing the efficiency with which users interact with controls to include the sensory quality of controls, in this case, clothes washing machine rotary selector knobs. Thirty seven participants operated and compared the selector knobs on nine clothes washing machines, providing similarity judgments, pleasantness ratings, and verbal comments regarding most liked and least liked features. A multidimensional scaling analysis revealed that participants perceived differences among knobs along two sensory dimensions: tactile feel (smooth versus distinct detents) and the loudness of the detent. Pleasantness was optimized at a medium value of detent loudness, but was constant across levels of tactile feel. Tactile feel, therefore, defines an ideal dimension along which to perceptually differentiate knobs for branding purposes without negatively impacting perceived pleasantness.

Characterizing and Differentiating the Semantic Qualities of Auditory Tones for Products
By James Kleiss (Whirlpool Corporation)

Traditionally, sounds in user interfaces have served the practical purpose of providing feedback for control operations and informing users of various system states. The purpose of the present study was to explore properties of sounds that are not primarily functional in nature, but might be useful for characterizing and differentiating products based upon semantic qualities. Twenty nine short tonal sequences were created exhibiting a variety of musical properties. Each tonal sequence was evaluated by thirty five participants using a set of twenty three bipolar attribute rating scales intended to capture a range of semantic qualities. Results of a principal components factor analysis revealed four factors: elegance, sturdiness, complexity and activity. These results provide a conceptual framework for describing and differentiating among audio tones based upon their semantic qualities. Physical properties of sounds associated with each factor were also identified providing a design tool for creating new tones to fit a desired semantic profile.

A Study of Firearms Mode Indicators
By Lisa Devlin (San Jose State U.)

This study evaluates a current range of mode indicators (also called "safety mechanisms" or "selector switches") on various firearms. The purpose is to fill a gap in the current knowledge base. There are currently no studies of location or label design for the firearm mode indicator. This study evaluates experienced and novice users. With location, the more the mode indicator is in the user's line of sight, the more quickly it is found. The experienced group located the mode indicators in all locations more quickly than the novice group. In labeling, when the labels are less ambiguous, they are interpreted more correctly and with more confidence. Color needs to be studied further in order to determine which, if any, colors should be used to compliment other labels. Low participant numbers and high variances in the findings dictate that this must be treated as a pilot study; however, there is a trend in the data that indicates further study is warranted.

Challenging Your Current Thinking About Usability, continued

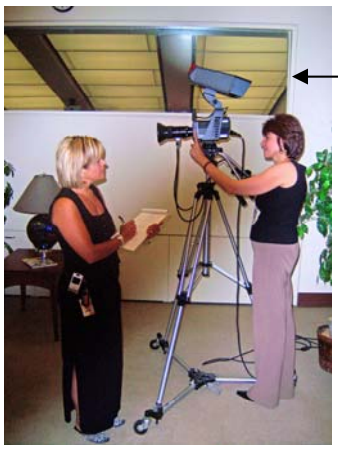
5. Timeliness of usability considerations: When Human Factors specialists are brought onto the team late in the development process, they tend to be perceived as part of the problem rather than part of the solution. They identify usability problems that are costly and disruptive to fix because decisions about product architecture, design configuration, and maybe even tooling have already been made. Early Human Factors involvement with project teams puts usability on an equal footing with other development functions so ease of use considerations can be incorporated into key design implementations.

6. Human Diversity: If everyone you expect to use your product is the same as the designer in physical size, perceptual capability, and cognitive ability, then the designer can be a valid benchmark. However, we all know that people vary greatly on these dimensions. Difference factors can relate to age, gender, genetics, and disabilities. Therefore it is important to profile the capabilities and limitations of the target user population and design for the appropriate range of dimensions. Additional factors are at play when the product is to be marketed globally because local cultures and perceptions shape user expectations. For instance, colors and gestures can take on different meanings. The way things work (population stereotypes) can differ from country to country.

> ***Example:*** I encountered a population stereotype issue in the case of a power toggle switch on a product that was being reconfigured from a United States version to one that could be positioned in several European countries. The U.S. model's switch turned on the machine by pressing the up button. That was compatible with the population stereotype for Germany, but not for the United Kingdom. There the lower button is used to turn something on. Since the same product was slated for both countries and we didn't want to violate local custom, we were faced with a dilemma. It was quickly and economically solved by mounting the switch on its side during the product reconfiguration. No strong stereotype exists for either country for the relationship between the left-right action and the on-off result.

7. Usability Testing: This is the most common method used by Human Factors Engineers to evaluate usability of hardware and software. It isn't "rocket science", but it takes thoughtful planning and is more reliable than getting casual comments from family and friends. It uses targeted participants individually doing typical tasks as a basis for collecting performance and perception data. It is not a quality control task just prior to shipment of the product. Usability testing is most valuable when it is applied at appropriate times during the product development cycle to discover interaction problems when they can still be corrected. Often it is conducted in a usability lab with a one-way glass for viewing by design engineers and other interested observers (See Fig. 2).

Figure 2.
Tester documents behavior of participant attempting to operate video camera



One-way glass in front of observation room (shows reflection of test room lights)

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Challenging Your Current Thinking About Usability, continued

Example: As part of client training, we performed a usability test of two defibrillator models already on the market. Among the problems found was that 50% of the users failed to select the correct synchronization setting after each administered shock. The reselection was required because the software logic reverted to the default mode after each shock. The operator control panel did not clearly indicate the change to the user. Usability testing during development of the defibrillator would have discovered this problem. Unfortunately, this exact error occurred during a physician administered defibrillation of a patient at a Missouri hospital. He was using the same defibrillator model we had previously independently tested.

8. Operator Training: It is true that users may get some training in the use of a product, especially if it is a B2B product. The fallacy of the designer trap has to do with the quality of the training and its lasting effect. I have seen "training" that was a walkthrough of the product given by the person who installed it. No script to make sure all the things were addressed that were important to the customer. No opportunity for any of the five potential operators to get their hands on the machine. When operators who were trained get replaced, the succeeding operators are on their own or possibly trained by another operator who has questionable training skills. When a consumer product is purchased, some ‘"training" may be received from the store clerk, but that counts for little when the purchaser shares its usage with others in the family. The point is that assuming the purchaser/user will be trained can lead to easier design decisions, but not necessarily good ones.

Conclusion

Getting a competitive edge in the marketplace may come down to being perceived as the easiest product to use, especially when the product's technology is not particularly advantageous. Incorporating user-centered design into the product development process is the surest way to make products easy to use on a regular basis. UCD focuses on the product-user interaction in the product-user-environment system by:

1. Discovering tasks users do and the requirements for those tasks
2. Designing the performance of those tasks according to usability principles
3. Evaluating usability iteratively throughout the development process

With a positive usability perspective and a user-centered design approach, the result will be a compelling user experience.

Coming Events

HFES 52nd Annual Meeting, September 22-26, 2008. New York, NY.
http://www.hfes.org/web/HFESMeetings/08annualmeeting.html

UPA China — 2008 User Friendly Conference, 24-27 October, 2008. Shenzhen, China.
http://www.upachina.org/userfriendly2008/

World Usability Day 2008 - Transportation, November 13, 2008. http://www.worldusabilityday.org

UPA Europe 2008: Usability and Design: Cultivating Diversity, December 4—6, 2008. Torino, Italy.
http://www.upaeurope2008.org/

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We're on the web!
http://cptg.hfes.org/

Mark your calendar!

The PDTG will be having an informal meet up with the NYC chapter of the *Industrial Designers Society of America*. This is a great chance to talk to designers in a casual setting.

The event is tentatively scheduled for the evening of Tuesday, September 23rd. More details will be released soon!