HUMAN-COMPUTER INTERFACE USABILITY IN A SURVEY ORGANIZATION: GETTING STARTED AT THE CENSUS BUREAU

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1. INTRODUCTION

At the Census Bureau we are starting a program to address usability issues for some of our computer applications such as electronic questionnaires and Internet web sites. This paper addresses the issues pertaining to the start-up of usability research and testing capability at the Census Bureau.

By way of introduction we discuss what we mean by usability, the kinds of products and activities that it can apply to in survey organizations, and how one might evaluate whether usability research, design and testing are worthwhile. Next we focus on the kinds of usability methods to apply at various stages in the development cycle and issues we have encountered when dealing with clients. In the last section we mention some features of the emerging Census Bureau usability capability and areas in which we are currently conducting usability research.

1.1 What is usability?

Let's begin by defining usability.

Have you ever been frustrated at your computer? Maybe you can't figure out how to accomplish something simple? Maybe you 're lost among web pages? Well, these are common experiences probably caused by usability design faults. Stop blaming yourself. It's time to get mad and to do something constructive about it.

A new field of research has emerged to deal with these frustrations called usability engineering, human-computer interaction, or just usability. It is a melding of computer science and psychology, particularly the human factors and cognitive psychology specialties.

Its goals are to understand users, develop good user-oriented design principles, apply them to the design of the human-computer interface, and then to test the product to make sure the interface is usable.

Computer applications generally address some goal of the user. Usually, to accomplish the goal, there are several tasks that a user needs to accomplish. These are called task goals.

The user needs a way of accessing, controlling, and using the wonderful things that computer systems do. So one builds what is called a "user interface," the special devices and displays that operate the product.

On an automobile, the user interface includes the steering wheel and the accelerator pedal. On a cooking stove, the interface includes the knobs to turn on the burners. The user manipulates these interface features and these manipulations are translated into instructions to the system for what to do, how, where and when.

The attributes of a good user interface are that it is understandable, that it empowers the user to achieve task goals, and that it is likable.

The way the interface is designed and implemented can help or hinder the user in accomplishing task goals. The steering wheel and accelerator are well understood and used successfully millions of times a day throughout the world. But somewhere, right now, someone is turning a knob on a stove and igniting the wrong darned burner! (See, for example, Norman, 1988). A good interface will take maximum advantage of the knowledge, abilities, expectations and preferences that users already have, making operations as "intuitive" as possible. It will minimize user errors. Where necessary, it will provide guidance, new information, and training when intuition is not sufficient.

1.2 Application areas in a survey organization

What can usability apply to in a survey organization?

At the Census Bureau, we are suggesting that usability principles and methods can be applied to our Computer Assisted Personal Interviewing (CAPI) and Computer Assisted Telephone Interviewing (CATI) software, the software that interviewers use to conduct interviews over the telephone or by personal visit.

Self-administered, electronic questionnaires are another relevant application area.

There are a number of data processing and data analysis tasks performed by humans on computers. User interfaces for these systems are logical candidates for usability work.

Survey organizations now distribute much of their processed data electronically. CD-ROMs and Internet web sites raise a number of user interface issues for usability professionals to recognize and solve.

And, of course, software used by employees for internal operations often needs usability attention. These include electronic accounting, timekeeping, procurement, travel expense, scheduling, hiring, and payroll systems.

1.3 Can usability produce worthwhile results?

The first question a planner might ask is, "What will usability do for me and how can I tell if it is worthwhile?" When a survey organization contemplates setting up a mechanism for usability testing, it is important to start thinking about how expenditures on making software usable will benefit a survey organization.

Listed below are some areas that might show measurable benefits of more usable computer software.

For example, regardless of whether electronic questionnaires are filled out by respondents or interviewers, more usable interfaces may get higher response rates, better data quality, and fewer calls to the help desk.

Turning to interviewers, the advantages of usable CATI and CAPI software are the same as the advantages of usable on-the-job software for any organization employee: faster learning, better performance, and higher job satisfaction.

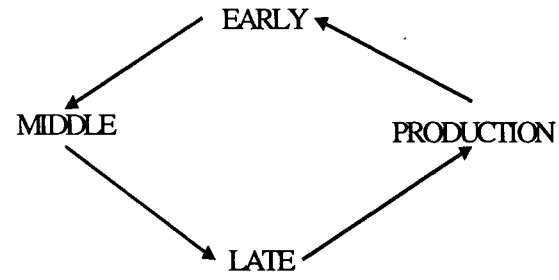
Data customers benefit in measurable ways from usable interfaces to our databases. Fast comprehension, ease of use, low error rates, and high customer satisfaction are all measurable outcomes. (For a broader consideration see, for example, Landauer, 1995 or Bias and Mayhew, 1994).

2.0 METHODS-- The Product Development Cycle

The next question a planner might ask is, "How should I incorporate usability into my applications?" Luckily, much study has been devoted to matching usability testing strategies to the product development cycle.

New software products go through a development cycle with four stages. The usability methods vary depending on the stage (Nielsen 1993, Hix and Hartson, 1993).

Fig. 1 Stages of the Software Development Cycle.



2.1 Early Cycle Methods (Design Basic System Features)

Early cycle work is conceptual, coming up with the basic features of the system. For usability, an early focus is on user analysis: who are the various categories of users and what tasks do they want to perform? What scripts, schemas and mental models do they bring to the situation? What innate abilities will experts and novices have? We employ questionnaires and laboratory methods, such as card sorting, to answer these questions.

Task analysis involves a description of the activities and activity sequences that users need to follow to accomplish goals effectively. Observation studies are the chief data collection method and task data are examined with existing simulation models (e.g., the GOMS model of Card, Moran and Newell, 1983)) to help the design process.

Next comes the design of the performance support system. Knowing about users and tasks, the interface designer considers what help novices and experts will need and how extensive that help will have to be. The software designer considers flyover bubbles, dialog boxes, help pages, wizards, on-line tutorials and even paper-based manuals to help the user operate the functions of the system.

Rapid prototypes of the user interface, often just paper and pencil mock-ups of computer screens, are quickly tested in an iterative fashion during the early cycle design phase. Emphasis is on verifying appropriate

metaphors for the interface design, arranging appropriate work sequences, and clarifying the meaning of words, icons, widgets, and other major features.

2.2 Mid-Cycle Methods (Functioning Prototype)

In the middle of the product cycle, developers create one or more working prototypes. Let's consider 3 usability methods for this stage:

1. The expert or heuristic review is conducted by usability experts often with the aid of a set of heuristic principles of good design (e.g, Shneiderman, 1998, Nielsen and Mack, 1994). Experts usually test all functions, screens and navigation paths available in the prototype.

2. Small scale usability tests observe real users solving real problems.

During a usability test, recruited subjects perform representative tasks. A usability tester will ask a recruited subject to perform these tasks, usually in a testing laboratory. Behavior is recorded on video along with the screens as seen by the subject. Behavioral events are logged automatically or by an observer. Performance is scored on dimensions such as time to completion, number of paths taken, number and type of actions attempted, and success-failure. The professional testers summarize and interpret the test results and communicate them to the designers and programmers on the client's staff (see, for example, Dumas and Redish, 1993).

3. Finally, questionnaires are used to assess user satisfaction and reactions to the usability of the entire system and its specific parts (e.g, Chen, Diehl and Norman, 1988).

2.3 Late-Cycle Methods (Beta Testing)

As the project begins the beta testing phase, the usability focus is on detecting problems through large scale evaluations with real users using the product at their work sites.

During the beta test, one may keep a systematic record of the usability and functionality issues that result in calls to the help desk.

Finally, one can embed user metrics that keep track of the user's actions and achievements. You can capture this information when the user sends it over the web or as part of a planned electronic submission of completed questionnaire data.

2.4 Production Usability Methods

Usability data are still retrievable when the product is in actual commercial or public use outside of the developing organization. For example, you can monitor help desk queries or you can collaborate with the marketing department to conduct evaluation surveys. Also, you can invite a sample of users to voluntarily submit their embedded metrics data.

3.0 CUSTOMER CONSIDERATIONS

What is not addressed throughly in the literature is the planner's question of "How should I best treat my customers so that they find this process helpful and will implement it in future projects?" This question is especially relevant when an organization is starting up a usability program. At the Census Bureau, there currently is not a mandate that all new computer applications meet usability criteria. Perhaps eventually there will be, but in the near future, our initial success or failure will, in part, depend upon the experience our customers have. Our limited experience has already identified some special issues to consider.

Usability testing is designed to find faults. And communicating faults to a client on a tight development schedule can be difficult. So we quickly learned three important lessons about communicating usability violations:

1. Establish a constructive, collaborative relationship with the client.
2. Provide quick, short, focused reports that highlight corrective actions in priority order.
3. Provide positive feedback for instances in which there were not usability problems.

A relationship to avoid is where the client expects to obtain a "seal of approval" from usability testing, perhaps because of a requirement imposed externally by management or a clearance process.

It is important that the client genuinely desire to improve the interface and be willing to make design and programming changes to overcome problems. And, on the other side of the coin, both tester and client need to acknowledge that interface design is an art, usability testing is an inexact science, and sometimes a tested product will still be imperfect in practice. So there can be no such thing as a usability seal of approval.

In our limited experience, we have encountered both customers who wanted us to identify the problems, but not propose alternative design solutions, and customers who have wanted our design suggestions. The extent of the relationship should be defined up front, and has much to do with the skills of the usability staff and the customer's project staff.

Our experience has also suggested several conditions that the usability group should try to negotiate with the client.

First is early involvement. This increases the chances of finding major usability issues when it is not so expensive to address them. Production deadlines often are the primary force driving the application. Early involvement increases the likelihood that usability issues will be resolved prior to production, and not for the next version of the application.

Second, it is important to have a high-level usability person on the customer's project team. This person is often the buffer between developers and usability testing results. This person should have the authority to demand that usability be built into a project's timetable, including sufficient time for revisions based upon usability findings. This person should also be able to make priority decisions when it comes to implementation in a production environment. Often this person will be very familiar with the users and the tasks that they perform.

Third, try to build-in iterative usability data collection and testing throughout the project in keeping with the product development cycle discussed earlier.

Fourth, negotiate a plan and schedule for each test that specifies who does what, by when. And make sure you have a stable, working prototype to test.

Fifth, agree on conditions for observing the tests. Observers can get noisy, defensive, and disruptive. If resources permit, move them to a multimedia observation gallery.

4.0 CENSUS BUREAU START UP

Finally, the planner asks, "So, how do we begin?" The answer to this question will vary depending upon the funds and structure of your organization. At the Census Bureau, we have experienced invaluable support from upper level management which is a key to success in large organizations.

Our first steps were tentative, since no one working on the project had a background in usability engineering or human factors. The staff, however, was sprung from the existing cognitive survey research methods staff, which seemed to be a natural fit. Students, mid-career researchers and a technical manager began learning about usability by doing a lot of reading, visiting web sites, taking courses and touring existing usability laboratories. In the last year, this staff initiated or supported about half-a-dozen iterative usability projects.

Our lab's presence has grown consideably due in part to the hiring of an experienced human factors specialist who will lead the program. We have also entered into a partnership with the Human Computer Laboratory at the University of Maryland, directed by Professor Ben Shneiderman, which will lend visibility to the program, provide direction for future research projects, and potentially offer additional temporary staff when projects overlap. In addition, we will hire additional researchers, student interns, and testing specialists with a background in a usability-related area.

Equipment and laboratory space are other issues to resolve. We are building a laboratory that will have three testing studios. The lab will have remote testing capabilities and, perhaps, a separate multimedia observation room for clients. We decided to invest in this laboratory devoted solely to usability to promote a climate of permanence, in addition to our forseeable need for such space with increased organizational demand for usability.

In addition to staffing the laboratory, we also must furnish it. Much debate ensued over the evolution of computer equipment and when to buy it. Namely we discussed the pros and cons between buying an analog system and a digital system. The goal is to be forward-looking but buy reliable, tested technology. The new equipment should provide good image quality and a range of opportunities for data editing, indexing, storage, retrieval and archival research. We plan to acquire editing and logging software and to use electronic questionnaire software to capture testers' subjective feedback about the application being tested.

We have some immediate research and testing plans in three applications areas.

1. We plan to do a task analysis for the CATI and CAPI programs to help transition these surveys to a GUI rather than DOS-based interface.
2. For self administered questionnaires, we are starting

several projects on topics such as navigation and editing trade-offs, eye tracking, text analyzer tools, and the effects of respondents' computer experience on data quality.
3. For accessing data products, we've started menu design research for the new industry classification codes and have many subsequent possibilities.

We have found that the challenge is to balance research and the needs of our internal customers while providing more usable products. As we continue to grow our lab, we're looking forward to having an exciting time!

NOTE: This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a more limited review than official Census Bureau publications. This report is released to inform interested parties of research and to encourage discussion.

REFERENCES

Bias, Ralph G. and Deborah Mayhew (1994), Cost Justifying Usability, San Diego: Academic Press.

Card, Stuart K. Thomas P. Moran and Allen Newell, (1983), The Psychology of Human-Computer Interaction, Hillsdale, NJ: Lawrence Erlbaum Associates.

Chin, J. P., V. A. Diehl, and K. Norman, (1988) "Development of an instrument measuring user satisfaction of the human-computer interface," Proceedings of the Association of Computing Machinery, Computer-Human Interaction Section,(Washington, DC), pp. 213-218.

Dumas, Joseph S. and Janice C. Redish (1993), A Practical Guide to Usability Testing, Norwood NJ: Ablex Publishing Corp.

Hackos, Joanne and Janice C. Redish (1998), User and Task Analysis for Interface Design, New York: John Wiley & Sons.

Hix, Deborah and H. Rex Hartson (1993), Developing User Interfaces: Ensuring Usability Through Product and Process, New York: John Wiley & Sons.

Landauer, Thomas K. (1996), The Trouble with Computers: Usefulness, Usability and Productivity, Cambridge MA, MIT Press.

Norman, Donald A,(1988) The Psychology of Everyday Things, New York: Basic Books.

Nielsen, Jakob (1993) Usability Engineering, Chestnut Hill MA: Academic Press.

Nielsen, Jakob and R. L. Mack (Eds.) (1994), Usability Inspection Methods, New York: John Wiley & Sons.

Rubin, Jeffrey (1994), Handbook of Usability Testing, New York: John Wiley & Sons.

Shneiderman, Ben (1998), Designing the User Interface, Strategies for Effective Human-Computer Interaction, 3rd Ed. , Reading MA: Addison-Wesley.