

Census 2000 Internet Form and On-Line Help: Evaluating the User's Experience

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Abstract: During the 2000 Census, the U.S. Census Bureau fielded an Internet-based version of the decennial short form. Prior to launch, an 18-month development period included system testing and usability testing. The primary purpose of usability testing was to identify problems that actual respondents might have in accessing, navigating, and submitting their census forms over the Internet. The on-line help system was also tested for ease of use. Testing identified numerous usability violations, ranging in severity. High-priority problems were corrected, and some other revisions were made. A post-census evaluation of customer satisfaction indicated that research is needed on what information respondents will look for in help files. In preparation for Census 2010, lessons learned have been documented for planning purposes. An important lesson from this experience and from other domains is that usability needs to be considered from the earliest possible moment in Web-site development.

Key words: electronic questionnaire, usability testing, web-based data collection, help-system usability, customer satisfaction research

Acknowledgements: We appreciate the contributions made during the testing period by other members of the Census 2000 Internet project team, especially David Coon, Rosemarie Cowan, Bonnie Damon, and Elizabeth Martin. We are grateful to David Coon, Jennifer Guarino, Kent Marquis, and Tracy Mattingly for their helpful reviews of earlier drafts.

1. Introduction

1.1 Transition from Paper-based to Electronic Data Collection

Moving from paper-based questionnaires to electronic forms presents data collectors with challenges and opportunities. Electronic media allow the use of features not possible on paper (e.g., dynamic edits, on-line help); but the effects of diverging from the “look and feel” of paper are largely unknown in an Internet context. Pointing out that the Internet differs in fundamental ways from paper, Couper (2000) says, “we have much to learn about what design knowledge and practice translates across media and what does not” (p. 476). In the design of on-line surveys, concerns about unknown mode effects often contribute to decisions that the Internet-based surveys should look as much like their paper counterparts as possible. Although electronic collection of data provides the opportunity to reduce costs dramatically, especially in such a large-scale undertaking as

¹ This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a Census Bureau review more limited in scope than that given to official Census Bureau publications. This report is released to inform interested parties of ongoing research and to encourage discussion of work in progress.

the U.S. Census, the transition from paper to electronic forms requires caution and rigorous testing.

Making the design of an Internet-based questionnaire conform to the design of a paper form, however, is likely to create usability issues that do not occur with the paper form. For example, where it is easy for respondents to flip through a paper form and look back at previous questions, doing this is much more difficult when a computer screen presents only part of the questionnaire and scrolling is required to move back and forth. Although it is good design practice to include arrows that help the respondent navigate on paper, trying to replicate arrows on an Internet form is problematic because their location cannot be specified and will vary from browser to browser.

Assessing the usability effects of trying to replicate a paper form was a key objective of the present research: Would respondents be able to navigate and provide their information on the Internet via an electronic questionnaire that was a close replication of a paper form?

In this paper, we begin by discussing just one aspect of the testing of the 2000 Census Internet form – usability testing – which was intended to identify difficulties that actual respondents might have when attempting to access the form and provide their information. We describe the usability testing methods applied to the process of gaining access to the Internet form, the Internet form itself, and the associated on-line help system. Results of these methods indicated that test users had little trouble entering their information once they succeeded in gaining access to the Internet form. Usability testing of help files uncovered a set of problems, most of which could not be corrected within the development timeframe. Results of a Customer Satisfaction Survey conducted during the live Census suggested that the information presented may not have been what users were looking for, even though it was easy to understand the information that was available.

1.2 Background on the 2000 Census Internet Form

As preparations got underway for the 2000 U. S. Census, planners intended to include an optional Internet-based collection of short-form data. These plans were cancelled when a strong concern arose over public perception of the Internet as insecure. Later, the Department of Commerce revived the Internet form in a new program, but it was not included in the formal pre-testing effort, known as the Census Dress Rehearsal. At the time the program was revived, 18 months remained before Census Day (April 1, 2000). Usability testing began 11 months before Census Day.

Because of the short time for development and concerns about security, the developer ruled out any attempt to include features such as dynamic edits, but he did agree to include a help system. The development objective was to replicate the paper form on the Internet, to the extent possible. This effort to develop an Internet version of the Census short form had three major purposes:

- To reduce respondent burden by allowing short-form recipients to complete the Census form on-line and not mail in the paper questionnaire
- To supplement more traditional data-collection methods
- To develop experience in Internet data collection for future censuses

Development of both the Internet form and its associated help system was the responsibility of an interdivisional team at the U. S. Census Bureau.

1.3 Background on Census 2000 Help Files

Internet help for a decennial census was implemented for the first time in Census 2000. The major objectives of the Census 2000 Internet help system were as follows (Coon, 1999):

- Provide online help to respondents who need assistance completing traditional paper forms
- Provide online help to respondents who need assistance completing the web-based Internet form
- Allow respondents to search for help on specific questionnaire items
- Provide general information about the census form
- Provide answers to Frequently Asked Questions (FAQs) about Census 2000

The Internet help system consisted of a collection of Web pages containing all of the materials from an internal Census glossary and other general Census 2000 information. The help system allowed users to search an alphabetic list of topics or select a popular help topic from a pull-down menu. On-line help also contained instructions on how to fill out each questionnaire item. People who wanted help in filling out their paper form could access the on-line help system from the Census Bureau's home page. Those who went on-line to provide their census information could access the help system from within the Census 2000 Internet form.

2. Role of Usability Testing

Usability testing can be likened to cognitive pre-testing of questionnaires in that it is intended to identify problems that respondents may have with user-interface software before the software is fielded. Usability testing is not experimentation in the strict sense, but it is effective in identifying violations of user-interface design principles (e.g., maintain consistency, provide useful feedback). In an Internet context, the typical role of usability testing is to identify problems that actual users are likely to have when they visit a Web site.

In the context of the Census 2000 Internet form, one of the primary issues for initial usability testing was related to the method of authorizing valid respondents. For security reasons, potential respondents who wanted to complete their Census form on-line were required to enter a valid 22-digit identification number associated with their housing unit. Figure 1 provides an example of the 22-digit Census ID number, which was required to access the Census 2000 Internet form.

| |
|-----------------------------|
| 00224-2571156-28-120-112-93 |
|-----------------------------|

Figure 1. A typical 22-digit Census 2000 ID number

A management concern at the Census Bureau was that people would not be able to enter this number accurately. This issue became the focus of early usability testing, to which we refer as “Phase 1.”

2.1 Phase-1 Testing Issues

Phase 1 focused on the ease of accessing the Census 2000 Internet form and providing census information for a household. The on-line help system was not available for this phase of testing. The following were the major issues addressed in Phase 1:

- What difficulties do test participants have in locating and entering the required Web address and linking to the screen where they can enter their Census ID number?
- Are test participants able to locate their Census ID numbers in a mailing package that resembles the official package they will receive at home?
- Are test participants able to type in their Census ID number correctly within three attempts?
- What kinds of usability problems do users have when filling in the electronic form (e.g., difficulties in seeing/reading/navigating; confusion about instructions)?
- What problems, if any, do users have when attempting to submit their completed forms?

To answer these questions, we used various methods of gathering objective and subjective user data.

2.2 Phase-1 Testing Methods

Data collection for the first phase of usability testing took place between April 29 and May 18, 1999. Phase-1 testing was held in the cognitive testing laboratory, a facility located in the Census Bureau's Statistical Research Division (SRD).

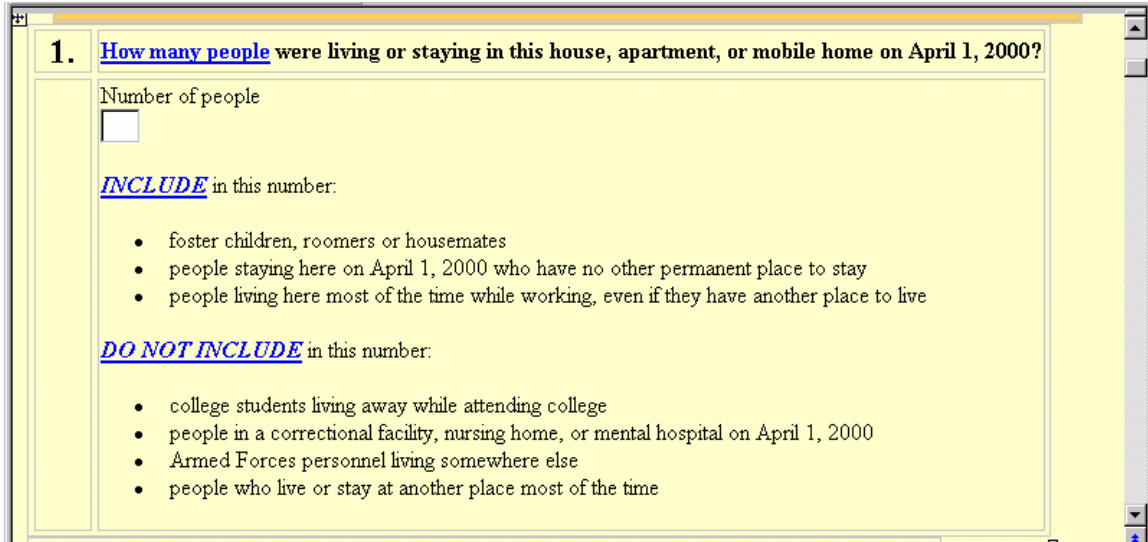
2.2.1 Participants in Phase 1

We recruited 22 usability test participants² with attributes of the expected respondent population: familiarity with the Internet and representation from various demographic groups. Participants included some Census employees not directly involved in survey development and some who came from outside the Census Bureau. Participants included members of the African-American, Asian, and Hispanic communities who were familiar with using the Internet. Participants ranged in age from pre-teen to middle aged. Both sexes were represented.

² A relatively small number of participants (5-10) is considered sufficient to identify most of the usability problems in a user interface (e.g., Nielsen, 2000; Virzi, 1992). Usability testing is not experimentation and does not involve statistical hypothesis testing.

2.2.2 Phase-1 Materials

The electronic form was a long, scrollable page designed to look as much like the paper form as possible. The first question from the electronic form is shown in Figure 2.



1. How many people were living or staying in this house, apartment, or mobile home on April 1, 2000?

Number of people

INCLUDE in this number:

- foster children, roomers or housemates
- people staying here on April 1, 2000 who have no other permanent place to stay
- people living here most of the time while working, even if they have another place to live

DO NOT INCLUDE in this number:

- college students living away while attending college
- people in a correctional facility, nursing home, or mental hospital on April 1, 2000
- Armed Forces personnel living somewhere else
- people who live or stay at another place most of the time

Figure 2. The Census 2000 Internet form reflected the design of the paper form. Respondents were required to complete an authentication process before gaining access to the form.

Written primarily in Hypertext Markup Language (HTML) and minimal JavaScript, the form provided space to enter complete census data for six people and to enter names for up to six additional people.

Test administrators used a version of the Questionnaire for User Interaction Satisfaction (QUIS) to assess participants' subjective satisfaction with the electronic form (Norman, Shneiderman, Harper, & Slaughter, 1998). The second author of the present paper developed a Customer Satisfaction Survey (CSS) and its associated evaluation questionnaire.

We developed probes to be administered during a debriefing session. The probes were designed to elicit participants' descriptions of conceptual and navigational problems with the electronic form. For example, various probes asked about the relative ease of accessing the electronic form, the ease of entering the Census 2000 ID number, and the ease of following on-screen instructions. Data from the probes contributed to the identification of usability problems.

Browsers used during testing were Netscape 4.0 and Internet Explorer 4.0. Monitors used in the laboratory testing had 16-inch screens. Resolution was set to 800 by 600 pixels.

2.2.3 Phase-1 Procedure

Participants read and signed a consent form, which documented their willingness to be videotaped. The test administrator read aloud an introductory statement about the

purposes of the testing and the participant's role in the testing. The test administrator stayed in the testing room with the participant for the duration of the test session.

The test administrator explained that the electronic questionnaire was an alternative to the paper form. Each participant received a Census 2000 mailing package, with mailing label affixed, containing a paper questionnaire, letter, and return envelope. The Census 2000 ID number appeared on the mailing label. A slip of paper containing the Internet address (URL)³ for the electronic questionnaire was visible on the tabletop in the testing room.

Without aid from the test administrator, participants were asked to access the URL, find the instructions on locating their Census ID, and enter their 22-digit Census ID number to access the electronic short form. Before calling a participant's attention to the URL, however, the test administrator handed the participant an official-looking envelope, containing a Census 2000 form. The test administrator then asked participants what they would do to find the Web site. This procedure was followed to replicate the real-world situation that actual respondents would face if they attempted to use the Internet option to provide their Census 2000 information: They would have to obtain the URL from some source other than the printed materials (e.g., from the www.census.gov site).

All participants searched through the pieces of paper inside the envelope – the letter from the Director, the form itself, and the return envelope – looking for the URL. If they were not able to find the URL within a reasonable amount of time, the tester pointed it out to them and explained that it was not included in the mailing package. Figure 3 shows the data-entry fields into which respondents entered their Census ID numbers.

The screenshot shows a web browser window with the following content:

- Header: "United States Census 2000 Internet" with a padlock icon.
- Section Title: "Enter and submit your Census ID Number..."
- Instructions: "In order to complete your census form over the Internet, your form must have a 22-digit ID number. Enter the number, exactly as printed on the paper form, in the spaces provided below, and click on the SUBMIT button."
- Note: "Note: For security reasons this page expires 5 minutes after it is created. If necessary, please [start again from the 'Introduction Page'](#)."
- Form Fields: A row of input boxes for the ID number, labeled "Census ID Number (Required, exactly as printed on paper form)". The boxes are grouped by digit count: "5 Digits", "7 Digits", "2 Digits", "3 Digits", "3 Digits", and "2 Digits". A "SUBMIT" button is to the right.
- Warning: "Warning: Reckless or improper use of the Census 2000 Internet Form or Web Site is a violation of federal law and is punishable by fines or imprisonment (Title 18, United States Code)." in red text.
- Footer: "United States Census 2000" logo.

Figure 3. Census 2000 Internet Form: Data-Entry Section for the Census ID Number (version tested in Phase 1)

³ At the time of Phase 1 usability testing, there was no link from the Census Home Page to the Census 2000 Web site. Therefore, it was necessary to give participants the Universal Resource Location (URL) for the development site.

All participants were asked to provide their own 'think-aloud' commentary while they completed the forms, i.e., they verbalized what they were doing and why. Upon completion of the Census 2000 form, participants provided ratings of the user interface using a selected sub-set of QUIS items. They also completed a usability evaluation questionnaire, a Customer Satisfaction Survey and another short questionnaire to evaluate the Customer Satisfaction Survey. A debriefing period followed, during which the test administrator asked participants a series of pre-defined probes. Some additional probes were asked of each participant to follow up on observations made during that participant's testing session.

2.2.4 Indicators of Performance and Satisfaction in Phase 1

In Phase 1, we collected the following kinds of performance data and subjective responses:

- Difficulties in accessing the electronic form, including any problems in entering the 22-digit Census ID number
- Accuracy of entering information (e.g., in the correct fields)
- Difficulties encountered in reading and following instructions embedded within the electronic form, based on observation and participant comments
- Ratings of items in the satisfaction questionnaire (QUIS)
- Responses to probes

2.3 Phase-1 Results and Recommendations for Redesign

Immediately after the completion of Phase-1 testing, a set of "quick turn-around" results was developed for presentation to the interdivisional team. A dozen salient issues were identified. The high-priority issues are presented below:

2.3.1 Problems with the Census 2000 Internet Form

- Locating and Entering the Required URL -- Based on our observation of their searching behaviors, participants expected to find the URL in the printed materials. Their comments indicated that attempting to locate the URL was a frustrating experience for all participants. Once we gave the participants the URL for the development site, they were able to type it in and go to the instructions for completing the form on-line. We recommended that the Census 2000 URL be provided on the envelopes that were yet to be mailed. This recommendation was not implemented for Census 2000. For Census 2010, we recommend that the URL be included in the mailed questionnaire package.
- Locating the Census ID Number -- More than half of the Phase-1 participants (55%) had trouble finding their Census ID numbers. They tended to look through the paper form for their numbers and typically needed to be told where to look. Participants also needed to be told which of the numbers was the Census ID number because there were two long strings of numbers under the bar code on the

paper form. We recommended revising the instructions to inform respondents that the mailing label might be on the back of the paper form, depending on the type of form they had received in the mail. The developer provided a graphic in the help files showing the exact location of the Census ID number. In early testing for Census 2010, an arrow printed on the envelope will point in the general direction of the Census ID number. The arrow is meant to help respondents find the required number so that they do not have the problem experienced by our test participants.

- Entering the 22-digit Census ID Number -- Although they had trouble finding their 22-digit Census ID numbers, most test participants had no problem in entering their number once they had found it. Developers helped respondents with this task by providing parsed data fields for the groups of numbers into which the 22-digit number was already divided. Although participants had to be very careful about entering the correct subset of numbers in the correct field, the average rating for ease of entering the ID number was 7.5 on a nine-point scale (1 = difficult, 9 = easy).⁴ This high mean rating may reflect the benefits of providing parsed data fields. No changes were recommended for the 2000 Census. Currently, the plan is to use parsed, 22-digit housing-unit-identification numbers for the 2010 Census.
- Filling in the Electronic Form -- Most participants found that filling in the form was fairly easy. Some had difficulty in getting used to navigating by scrolling and moving the cursor from one field to the next. Many of those who had navigational problems were trying to tab through the form. Tabbing often resulted in the loss of the cursor. We also found that some response fields were too short for the potential number of characters in a response (e.g., White Mountain Apache). Checkboxes made it possible for the respondent to mark more than one selection (e.g., both male and female). As recommended, instructions on how to navigate were added and response fields were lengthened. We recommended the use of radio buttons to prevent selection of more than one response where only one was correct. Radio buttons were not implemented, primarily because of the mandate to mimic the paper form, which used checkboxes. Radio buttons are being used in early development and testing for the Census 2010 Internet form.
- Submitting a Completed Form -- Phase-1 test participants generally had no trouble submitting their completed forms. However, they were not entirely sure that the "Thank You" page was the "confirmation page" mentioned with the instructions on submitting the form. As recommended, this page was renamed the "Confirmation Page," and the content was re-worded so that respondents would be sure that their submission has been received.

⁴ The standard deviation was 2.1.

2.3.2 Reported Satisfaction

Table 1 provides a summary of participants' ratings on the QUIS items:

Table 1

Phase-1 Usability Testing of the Census 2000 Internet Form:
Summary of Satisfaction Ratings on a Nine-Point Scale (1 = Low, 9 = High)

| Item | N | Minimum | Maximum | Mean | Std. Dev. |
|--|----|---------|---------|-------|-----------|
| 1. Overall reaction to e-form ⁵ | 22 | 5.00 | 9.00 | 7.546 | 0.963 |
| 2. Ease of accessing e-form | 22 | 1.00 | 9.00 | 6.136 | 2.513 |
| 3. Entering ID number | 22 | 1.00 | 9.00 | 7.546 | 2.110 |
| 4. Screen layouts helpful | 21 | 5.00 | 9.00 | 7.333 | 1.197 |
| 5. Information amount | 22 | 5.00 | 9.00 | 7.818 | 1.332 |
| 6. Information arrangement | 22 | 5.00 | 9.00 | 7.818 | 1.332 |
| 7. Screen panel sequencing | 22 | 6.00 | 9.00 | 8.000 | 1.155 |
| 8. Going back | 20 | 3.00 | 9.00 | 7.900 | 1.553 |
| 9. Use of terminology | 22 | 3.00 | 9.00 | 8.046 | 1.588 |
| 10. Adequacy of instructions | 22 | 3.00 | 9.00 | 7.727 | 1.609 |
| 11. Positioning of instructions | 22 | 3.00 | 9.00 | 7.727 | 1.695 |
| 12. Predictability of result | 22 | 4.00 | 9.00 | 7.864 | 1.246 |
| 13. Overall experience (entry) | 22 | 3.00 | 9.00 | 8.227 | 1.510 |
| 14. Progression through form | 22 | 7.00 | 9.00 | 8.591 | 0.666 |
| 15. System response time | 22 | 4.00 | 9.00 | 8.500 | 1.102 |
| 16. Making changes to answers | 21 | 7.00 | 9.00 | 8.762 | 0.625 |

These results are consistent with other findings in the literature on human-computer interaction (e.g., Andre & Wickens, 1995): Subjective measures and performance measures often disagree with each other. In spite of observed performance difficulties, users may report a generally high level of satisfaction. In the case of the Census 2000 Internet form, participants' mean ratings of the user-satisfaction items did not generally reflect the frustrations and problems observed when they were trying to access the form. Where low ratings were given, they can be taken as a reflection of difficulties and frustrations for those respondents.

The high mean satisfaction ratings support the case for usability testing: If we had simply asked for subjective satisfaction, we would not have discovered the problems that we identified through usability testing.

3. Phase-2 Testing Issues

When a more mature prototype was available, we conducted a second round of usability testing, which was designed to answer the following questions:

⁵ electronic form

- Are there remaining usability issues not identified in Phase 1?
- Have any new usability issues been created by the re-design?
- How usable are the help screens?

The laboratory portion of Phase-2 testing was held in the Census Bureau's usability laboratory, from January 19 through 27, 2000. Available facilities included three instrumented testing rooms adjacent to a control room, session-logging equipment and software, and a full suite of audio-videotape-recording and monitoring equipment. Laboratory participants signed a standard consent form agreeing to be videotaped. There was a non-laboratory portion, during which Census employees accessed the test version of the Internet form from their desks. In all cases, networked equipment and software captured the data and comments submitted by test respondents.

3.1 Phase-2 Laboratory Testing

3.1.1 Participants. From a group of about 140 volunteers at Census Headquarters, we selected a random sample of 12 to participate in laboratory testing (10 regular participants and two alternates). Nine of these volunteers completed testing in the Usability Laboratory.

3.1.2 Scenarios for Phase-2 Laboratory Testing

We developed a set of scenarios to test various aspects of the help system. The scenarios purposely included relatively rare/difficult household situations, about which test participants might have questions. The idea was for the difficult situations to trigger questions and to cause participants to use the help system. Instructions to participants encouraged them to look in the help files if they had any questions or uncertainties about how to respond to particular questions on the Census 2000 Internet form.

3.1.3 Materials for Phase-2 Laboratory Testing

Just as actual respondents would need to have a paper form with their Census ID number, laboratory participants needed to have a paper form with a dummy Census ID number. To mimic the real situation as closely as possible, laboratory test participants were given the appropriate paper form and the scenario/script selected for their session. They completed evaluation questionnaires at the end of their testing sessions.

Materials developed for laboratory testing included an introductory script and several hypothetical situations to be presented to participants to help them become familiar with the help system

3.1.4 Phase-2 Laboratory Procedure

The test administrator explained the purpose of the testing, emphasizing that the software user interface, not the participant, was being tested. After agreeing to be videotaped, the participant was given a paper Census package and a household scenario

to consult in answering the questions. Since we assumed that the participant knew about the option of submitting by Internet and had been able to find the site, the computer displayed the Census 2000 Internet form.

From the control room, the test administrator began the testing by reading aloud several hypothetical situations that required participants to find various kinds of information in the help files. This practice with the help system was intended to familiarize participants with the kinds of information available in the help files and to increase the likelihood that they would access help files during the testing. The test administrator urged participants to use the help system if they had any questions while responding to the Census 2000 Internet form. This emphasis on the help system was intended to counteract participants' normal hesitancy to access help files during testing, which we have observed in testing other user interfaces.

After the introduction to the help system, participants were instructed to begin with the screening questions that determined respondents' eligibility to provide Census data over the Internet. These screening questions were part of a process to determine whether the user had a paper census form and a pre-assigned census ID number. A note-taker used logging software to record participants' comments and to note instances of various kinds of problems that participants experienced as they proceeded through the electronic form. All test participants submitted their data in exactly the same way as household respondents would, and their data became part of the usability evaluation data file.

3.2 Non-laboratory testing

We invited all Census Bureau employees, nationwide, to participate in the on-line testing from their offices. Although the developer was interested in gauging the system effects of multiple simultaneous submissions, this was also an opportunity to obtain responses to the satisfaction questionnaires from a larger number of participants than had volunteered at Census Headquarters. Many of the remaining local volunteers and other employees from across the country participated in this combined load-and-usability testing. Census employees who participated in the non-laboratory evaluation of the Census 2000 Internet form were able to access instructions posted on the Census intranet. Volunteers accessed the Internet form on their own (from their offices), filled out the form, and submitted their data. If willing to do so, they then completed the on-line satisfaction questionnaires. Those who participated from their offices submitted their data in exactly the same way as household respondents would, and their data became part of the usability evaluation data file.

3.3 Phase-2 Indicators of Performance and Preference for all Participants

We collected the following kinds of usability data and feedback from 281 test participants:

- Problems in accessing and navigating the electronic form (based on observations and comments)
- Difficulties in navigating the help files (based on observations and comments)

- Responses to the site-satisfaction questionnaire
- Free-text comments entered by users on the questionnaires

Participants in the laboratory testing provided all four kinds of data. Because they were not observed, non-laboratory participants provided only their responses to the items on the satisfaction questionnaires and free-text comments.

3.4 Phase-2 Results and Recommendations

Soon after the Phase-2 laboratory testing, we presented general findings on both the Census 2000 Internet Form and the help system to the project team. Many of the findings from the laboratory testing were considered further, and recommendations for revised wording were developed. Comments and ratings provided by employees in the non-laboratory testing reinforced the laboratory findings. Recommended edits and screen markups were submitted to the development team. Selected findings, recommendations, and outcomes are presented next:

3.4.1 Problems with the Census 2000 Internet Form

- Navigation problems – Many users still had trouble adjusting to navigating by scrolling and then clicking in a data-entry field to insert the cursor. As recommended, instructions about navigation were added. The problem with instructions, however, is that users skim over on-line instructions, if they even look at the instructions. A usable design eliminates the need for lengthy instructions.
- Unexpected error messages – When one of our participants first tried to submit her Census ID number, she received an error message. The solution was to click again on the submit button, but there was no way for the respondent to know what to do. Our concern was that some respondents might give up if they received such an error message. Several participants in the non-laboratory testing reported a similar problem. As we recommended, the developer investigated and resolved this problem, which had the potential to be a “show stopper.”
- Security concerns – When participants clicked on the appropriate button to check the Web site's authenticity, they received messages saying that their connection was not secure. These messages appeared to contradict help information on site security. We recommended adding a short explanation about what was and was not secure to help users confirm the security of their personal information. This information was added to the on-line help files.
- Inconsistent behavior of links – Some hyperlinks led to help, but others took the respondent to another part of the Census 2000 Web site. At this point, it was too late to re-design the behavior of links, but we have recommended avoiding this problem for Census 2010 and for the interim Internet forms to be tested in the near future.

- Uncertainties about navigation keys and how to proceed – Some participants pressed the ‘Enter’ key to move from a completed field to the next blank field. This action took them out of the form. Although they could press the ‘Back’ button to get back into the form, any data they had filled in previously would now be gone. Because of the catastrophic nature of this problem, we recommended that a coding solution be developed. A solution was implemented.
- Missing or misleading link labeling – The Census 2000 logo was provided at the bottom of help screens as a way for respondents to return to the top of the help file. Most users did not realize that this unlabeled logo was a link. We recommended adding a text label to the right of the logo. Although not implemented for Census 2000, logo labels are required for the Census 2003 Internet form, which will undergo national testing.
- Unfulfilled expectations – Some participants expected the cursor to advance automatically to the next field when they were entering their 22-digit ID number and when there were multiple data-entry fields within a question on the electronic form. We were told that automatic advance was not possible because of certain JavaScript limitations. Since there was already an instruction about using the mouse to move the cursor, we recommended finding a way to call attention to this instruction. Automatic cursor advance is required for the Census 2003 Internet test form.
- Browser problems – A shortage of space allocated to browser cache contributed to several participants' not being able to submit their data. The lower part of the form was cut off, and the send button was not displayed. There was nothing to indicate what to do if this occurred, and participants typically had no idea of what the problem was. This was another potential “show stopper.” The sub-group charged with editorial revisions agreed there should be some message indicating what to do if this were to happen during a "live" session. It was not possible to provide a context-sensitive message because Census software had no way of knowing what was happening at a particular respondent's location prior to submission of that respondent's data. Allocations of browser cache will be adequate for the Census 2003 Internet form and subsequent versions.

Although time and technical limitations did not permit the implementation of all recommendations from usability testing, numerous improvements in the design of the Census 2000 Internet Form were included before its release to the public:

- Streamlined authentication process
- Clarified instructions to respondents
- Additional graphical help to locate Census ID number
- Elimination of “show stoppers”

Lessons learned from usability testing the Census 2000 Internet form were fed into the post-Census review process and documented for the benefit of the Census 2010 Internet project. Lessons learned have informed the development of requirements for the Census 2003 Internet form, which will be tested for usability prior to its use in a national test.

Lessons learned from the following problems with help files have also informed the process of developing requirements for the next generation of the on-line help system.

3.4.2 Problems with Help Files

- Limited information on specific topics – Help on the relationship question did not offer information on all the relationship categories.
- Missing information on some topics – There was no information about where to get help filling out 'Some Other Form Type,' which was an option that respondents could click on in the screening questions that preceded entry of the Census 2000 ID Number.
- Path dependencies lead to different results – The terms "houseboat" and "boat" led to information on different questions from the long form but not to the help that a respondent was looking for, i.e., whether a houseboat is considered to be a residence.
- Positioning of help windows causes content to be cut off – In some cases the help window came up positioned so far to the left that half the information was off the screen.
- Inconsistent behavior of links – Respondents became confused when some links took them to a new screen, while others took them to a different location on the same screen.
- Navigation problems in the Frequently Asked Questions (FAQs) – Some users reported feeling lost in the FAQs.
- Census-centered and Technical Terminology – Participants generally did not know the meaning of phrases such as "Population Questions" and "Housing Questions." Information about obtaining a secure connection was written in highly technical language, which participants had trouble understanding.

Following the laboratory testing, the findings were noted and change recommendations were submitted to the project team and programming staff. Some changes required the addition of content to the help files. The subgroup responsible for wording developed a package of recommended wording and layout changes, based on the laboratory testing findings. As a result, wording changes were made where needed. As recommended, the information on how to obtain a secure connection was shortened and re-written in less technical language.

Other issues reflected structural, software-based dependencies. Resolution of such issues required that the help files be re-structured to improve their internal consistency and level of integration. This would have required a re-design of the help system's architecture. Because of time pressures, it was not possible to resolve any issues that required changes in the underlying design of the help files. All issues identified have led to requirements designed to avoid their occurrence in the Census 2003 Internet form, and they have been documented for Census 2010 planning.

3.9 Major Lesson Learned

The need for early and iterative usability testing of Web sites for data collection was reaffirmed by test users' experience with the Census 2000 Internet form and the associated help system. We were reminded that it is never too early to start planning and conducting usability assessments, even if the project is still in its conceptual stage. Although we did not have the opportunity to test paper prototypes, given the time, that method could have been used to uncover many of the issues that we identified when it was too late to make changes. A whole spectrum of methods (e.g., expert review, cognitive walkthrough) can be used to evaluate the usability of user interfaces before a working prototype becomes available. These methods can be applied again and again as the look and feel of the user interface matures.

Research in other domains suggests that building time into project schedules for these assessments can save time later, reduce user error, and improve user satisfaction (e.g., Bias & Mayhew, 1994; Dumas & Redish, 1999). Improving the usability of a Web-based questionnaire (i.e., making its design more "respondent friendly") can also be expected to improve response rates (Dillman, 2000, pp. 299-300). Building usability into the engineering lifecycle is a strongly recommended design practice (e.g., Mayhew, 1999). We have recommended cycles of usability testing in the planning and development, already underway, that will lead up to the launching of an Internet form and on-line help in Census 2010. Usability testing is a requirement for the Census 2003 Internet option.

Next, we describe the process of collecting and analyzing satisfaction data from respondents during the "live" Census.

4. Customer Satisfaction during Census 2000

As an additional means of evaluating the users' Census 2000 Internet experience, two customer satisfaction questionnaires were developed to measure the satisfaction of Internet users during Census 2000. Before implementation, the questionnaires were tested and evaluated along with the Census 2000 Internet form during both phases of usability testing.

4.1 Background

During the actual data collection period for Census 2000, two separate customer satisfaction surveys were implemented: one with a sample of users who successfully

completed their Census 2000 Internet form and another with a sample of users of the Internet help screens⁶. Internet users who successfully submitted their census form online received a survey invitation at their confirmation screen, and users of the Internet help system were able to link to the survey from various help pages within the system. We used these survey results to analyze the degree of actual respondent satisfaction with the Census 2000 Internet form and the Internet help system. There were two primary customer satisfaction research questions:

- Are users satisfied with the Internet Help system?
- Are users satisfied with the Census 2000 Internet form?

4.2 Methods

4.2.1 Sample design of the customer satisfaction surveys

We selected a sample of help system users to fill out the survey by a link made available on various pages throughout the help system. A second sample was selected from the universe of respondents who successfully submitted their census form online. This group received a survey that focused on questions about the Internet Form.

The sample designs for the two satisfaction surveys are as follows:

- *Internet Help System sample*: The Internet Help System sample universe includes all users of the help system. We selected a sample of these users based on time. The survey was initially open to general help users who visited during a pre-selected five-minute window each hour. However, on April 6, 2000 the window was increased to 15 minutes for the remainder of the data collection period because of low response to the survey.
- *Internet Form sample*: The Internet Form sample universe includes only those respondents who submitted their census questionnaire via the Census 2000 Web site. We selected a sample of these respondents based on time; that is, the survey was open to respondents who submitted their census form online during a pre-selected five-minute window each hour. The survey was available for five minutes, each hour, for every hour of the day.

4.2.2 Data analysis

Customer-satisfaction survey data were analyzed using various descriptive statistics. Frequencies, proportions, and unweighted means and variances were calculated to summarize and describe the data.

⁶ We cannot determine whether users of the Internet help screens completed a paper form, an on-line form, or whether they responded to the census at all.

4.3 Results

4.2.1 User Satisfaction with the Internet Help System

Response to Internet Help System survey was low, with just 234 completed surveys. We were unable to compute a response rate because the number of people who saw or clicked on the link to the survey is unknown. Because of the unique environment of the Internet and the administration methods of our survey, we are unable to identify the exact number of people exposed to the survey invitation on the help system. We can only identify the number of 'hits' to the survey link, which is not equivalent to the number of unique people exposed to the link⁷. Therefore it is impossible to compute an accurate response rate for this survey.

Of the 234 respondents to this Customer Satisfaction Survey, most were not satisfied with the Internet Help System. Nearly 62 percent of the respondents indicated that, overall, they were not at all satisfied. Although nearly 77 percent of the respondents reported finding it easy or very easy to understand the help system information, about 58 percent said it was not at all easy to find the help topics for which they were searching. In addition, 65 percent of the respondents stated that the help system information was not at all helpful. These findings suggest that while the information presented on the site was easy to interpret, it may not have been the appropriate information for the users.

We should note, however, that those respondents who did find the information helpful were more satisfied overall. Reported helpfulness of the help system information was highly associated with reported overall satisfaction with the Internet help system. ($\gamma = 0.9693$)⁸ among our respondents.

Based on the reported levels of respondent satisfaction, we observed that, although the information on the Internet help system was easy to understand, it was difficult to locate, generally unhelpful, and did not provide the information that respondents were seeking. Respondents need complete and accurate help that is organized around their tasks and goals (Mayhew, 1992). Research is needed to discover what kinds of on-line help respondents want and need when they are providing their census information either on paper or over the Internet.

4.2.2 User Satisfaction with the Census 2000 Internet Form

Some respondents to the Census 2000 Internet Form received a customer satisfaction survey designed to collect satisfaction measures on the following seven aspects of the Census 2000 Internet form:

⁷ Web page hits are not an accurate measure of web traffic volume. They can be used as a relative measure of one page's hits relative to another page's hits, or one server's hits relative to another server's. Web hits are a poor measure of traffic volume, but in most cases it is the only measure available.

⁸ The gamma statistic is a measure of association for ordinal variables and is analogous to the Pearson correlation (cf. Agresti, 1990).

- Time required to load the form
- Moving through the form
- Availability of help screens
- Understanding the help information
- Ease of sending the form
- Security and confidentiality procedures
- Overall satisfaction.

The response rate to this survey was 58.5 percent, with a total of 3,226 respondents. On the surface, this may appear to be a mediocre response rate, but given that historically, customer satisfaction surveys have low response rates, we consider this to be respectable.

Overall, 91 percent of the 3226 respondents to this CSS reported that they were satisfied with the Census 2000 Internet form. Additionally, respondents reported being satisfied with nearly all the individual items they were asked to rate. Reported satisfaction levels reached as high as 94 percent (for ease of sending the form).

Satisfaction ratings lapsed slightly for the two items that dealt with the help system: availability of help screens and understanding the help information (74 percent and 73 percent, respectively). Because satisfaction with these two items was nearly identical, it is likely that respondents may not have made a distinction between the two questions. We also noticed that some respondents answered these questions, even though they did not use the help system. Thus, for these two items, we calculated the percent satisfied for only those respondents who actually used the help system.

We found that respondents who used the help system were somewhat more satisfied with the availability of help information and understanding the help information (83 percent and 82 percent, respectively). That is, the respondents who did not use the help system had given ratings on the lower end of the scale rather than selecting ‘Not Applicable’. However, it is important to note that many respondents (e.g., to the customer satisfaction survey) did not use the help system while completing the Census 2000 Internet form. The percentage of respondents who chose ‘Not Applicable’ on questions about the usefulness of specific help topics ranged from nearly 69 percent to over 85 percent. We understand “Not Applicable” to mean ‘did not use.’

Because of the self-selected response nature of the surveys, these results may suffer from response bias. Respondents are likely to represent customers with stronger feelings (very satisfied or very dissatisfied) compared to those who do not take the time to respond (Wellens & Martin, date TBS). This effect may be evident in the overwhelming satisfaction with the Internet Form. In addition, survey respondents had to successfully complete the Census 2000 Internet form before even reaching the customer satisfaction survey. For this reason, our respondents may be more likely to be satisfied with their experience.

Despite these limitations, the high levels of reported customer satisfaction with most aspects of the Census 2000 Internet form suggest that Internet users could be attracted to use an Internet option in 2010, especially if it is designed to meet the expectations that users have for good Internet forms. The high correlation between helpfulness and overall satisfaction indicates how we might improve customer satisfaction – by focusing improvements on elements that will be helpful to future respondents.

5. Summary of Recommendations

Usability testing of the Census 2000 Internet form identified problems that could not be, and were not, identified by other means (e.g., software testing, load testing). The satisfaction surveys administered during usability testing and the customer satisfaction survey taken during the actual Census also provided invaluable information regarding users' perceptions of the Census 2000 Web site. From these findings come our recommendations for improvements and for further research and exploration. Our key recommendations include the following:

5.1 Test Early and Often with Representative Users

There is no substitute for having real people try out a new or revised user interface. Developers and programmers have the best of intentions, but they are too knowledgeable about the way software works, in general, and about the system they have built, in particular, to be able to recognize every usability issue. Real people will try to interact with a new site as they are used to interacting with other Web sites. They will be surprised and frustrated if a site does not respond to their normal mode of interaction or, worse, if it does things that they are not expecting. Respondents to on-line surveys should not have to learn unusual or non-standard ways of interacting. If time permits, supplement observational methods with collection of human-performance data (e.g., time to complete defined tasks, accuracy). Iterate, iterate, iterate!

5.2 Take the Long View

If an issue cannot be resolved in the current development context, document it thoroughly and pass the information on to planners of the next-generation Web site. Given the rapid pace of new technology, what could not be done one year may be possible the next. Resolutions to usability issues that cannot be corrected for one generation can become requirements for the next. This has certainly been the case in our experience.

5.3 Provide Useful Content in Help Systems Associated with Web-based Surveys

Respondents are likely to have a spectrum of concerns that can be addressed in system help files. Although our respondents found the help system information easy to understand, they were generally unsatisfied with the information presented. The help information focused on questions about the census questionnaire. However, respondents had questions about much more than just the questionnaire. Looking toward 2010, the Census Bureau needs to update and enhance the help information available and investigate the use of additional resources that would provide helpful information to users. Making a help system useful to on-line survey respondents is a non-trivial task.

5.4 Conduct Research on the Knowledge and Perceptions of Potential Respondents

The first law of usability is to know your users. This means developing user profiles that document the characteristics of key user groups. Such characteristics can include the kind of information each group needs in the help system. Just as the Census Bureau needs to conduct research on potential respondents' knowledge of the decennial Census process and their role in it, any organization contemplating a Web-based survey needs to conduct research to help it better meet the needs of respondents.

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Note: Video clips presented at QDET are not included with this text.