

Kent Marquis, Heather Tedesco, Richard Hoffman III, Elizabeth Murphy,
Renate Roske-Hofstrand, Lelyn Saner, Susan Ciochetto and Chanda Harris
Kent Marquis, Census Bureau, Washington DC 20233

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1.0 Background¹

Computer technology becomes obsolete faster than you expect. And when this happens to a mission critical system, it raises a lot of anxiety and poses many problems. This paper deals with such a mission-critical system at the Census Bureau, and covers some first steps toward its possible redesign.

The Census Bureau's household data collection systems will have to be reworked soon, because they run under DOS, a computer operating system that will not be supported in the future. There are many possibilities for reworking the current system ranging from very minimal changes to force the current system to work within a different operating system all the way through a complete redesign and implementation of a brand new system.

We, in the Census Bureau's Usability Group, have begun preliminary work on a user-centered redesign for CAPI, the computer-assisted personal interviewing component of the Census Bureau's household data collection system.

Traditionally, CAPI system design has focused on replicating paper questionnaires in an electronic format, ensuring proper routing and branching through the questions, making sure that terms are properly filled within the questions and that the answers are edited correctly. Traditionally, the CAPI communication design has focused on getting cases to the field and back. Designers and programmers, not users have conducted system testing.

In contrast, user-centered redesign looks at the whole set of interviewer tasks from the users' point of view. That perspective offers the opportunity not only to increase user effectiveness and satisfaction, but also to

¹ 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.

incorporate new features to increase response rates, enhance data quality and improve efficiency. Other advantages of creating usable systems include less time devoted to applications programming, less need for user training, consistency across applications, fewer demands to devise workarounds, more reliable performance, and higher employee morale.

While the Census Bureau is forming its teams of technicians and managers to address the many facets of the redesign, our usability group has gone ahead to do some of the preliminary work that underlies a good user interface design, conducting several kinds of studies of interviewers who use the current system.

Our goal is to identify areas where usability can be enhanced in a newly designed system. In order to do this, we must first learn about the users of the current system and the tasks they do in their job. This allows us to design laboratory usability tests for the relevant categories of users and their most important tasks. And it allows us to observe the important context variables that affect performance so these variables can be represented properly in subsequent laboratory testing. But perhaps initially most important, the data we collect to learn about users and their tasks can be used to suggest areas for improved processes, for what additional things the system should do, and how to design the user interface to support those additional things,

Such approaches to the human factors side of designing software are relatively new to the federal statistical agencies. Because of this newness, we are sharing our current approaches and preliminary findings here in order to stimulate interest and get feedback from both users and the professional community.

For the rest of the paper we first describe the data collection methods and then describe tasks and features that could be automated to support the interviewers' work. Some suggestions imply changes in how we organize and implement the work. All suggestions involve currently available technology that should, within a few years, become standard and affordable.

2.0 Methods

We deliberately limit our attention, in this paper, to in-person field interviewers working on demographic

(household) surveys. The acronym for the data collection system is CAPI, which stands for computer-assisted personal interviewing². The two basic methods we used to elicit information about users and tasks were focus groups and ethnographic observations. These are discussed next.

Focus Groups and Brainstorming

We conducted five focus group and two brainstorming group sessions to get group input on the strengths and weaknesses of the current interviewing system and ideas about redesign. We held two focus groups at headquarters, one attended by interviewers from the eastern United States and one attended by interviewers from the western United States. We also held focus groups in three of our 12 regional offices. The attendees were relatively homogeneous, consisting of interviewers working for the Census Bureau conducting household surveys.

A typical focus group session went something like this:

We started with informal introductions and some story telling about computer related experiences.

Then we spent about an hour discussing the way they currently use their laptop computer for typical interviewing assignments. After we listed the uses, the interviewers identified the most important functions currently performed by the computer.

At this point, the focus group leader demonstrated some Windows features. These included, for example, drop-down lists, radio buttons, and navigation capabilities.

We spent at least 30 minutes listing some wished-for features in redesigned data collection system. Many interviewers used Windows in home or second-job applications and offered wide-ranging advice about how automation could support their interviewing work in the future.

Our structured discussion covered several topics:

What tasks do you currently use paper for?
What other non-computer aids do you use?

² While our data collection did cover telephone interviews, housing surveys, and regional office operations, these activities will not be discussed here. Other important areas not covered include field listing activities and headquarters activities in the survey management, operating, and subject matter divisions.

What other software tools do you use?

How can a future computer help with maps, listing, probing?

What things are currently automated that shouldn't be?

We also conducted two brainstorming sessions at headquarters with the regional office supervisors and clerks who work on the Current Population Survey, one of the largest surveys that the Census Bureau conducts³. We asked the groups to spontaneously generate wish lists of features that a redesigned data collection system should have. Understandably, many suggestions were for features to aid just the supervisors or clerks (e.g., ability to reassign work from a remote location). For this report, however, we use only their suggestions for improvements affecting the field interviewers.

Work Observations

Headquarters staff made about 20 trips to the field to observe household interviewers working on their assignments. Two basic methods were combined: observation of the work, and interviews or conversations about specific parts of the job.

Typically the headquarters observer visited an area for two days. The first part of the first day might be spent in the regional office, observing or interviewing regional office employees. Afternoons and evenings were spent observing and interviewing the field interviewers⁴. Sometimes an observer worked with the same interviewer both days but, typically, there was an opportunity to observe two interviewers. We arranged to observe a mix of experienced and less experienced interviewers.

The observations were conducted in various parts of the United States and involved five major household

³ The CPS is conducted for the Bureau of Labor Statistics by the Census Bureau and provides data used in determining the monthly unemployment rates in the United States.

⁴ Work rules prohibit observing work in an interviewer's home. So we were limited to asking about home-based activity such as receiving and organizing an assignment, plotting map routes, preparing advance letters, getting messages from the answering machine, conducting telephone interviews, hooking up to the modem and transmitting information to headquarters, backing up data, communicating with the regional office, time and expense reporting, etc.

surveys currently conducted by the Census Bureau⁵. Different observers tried different methods of structuring their observations and interviews: Some observers, for example, set out to identify tasks, information flows and decision points. Others focused on critical incidents or specific technological features.

Each observer prepared a written report detailing the findings from both observations and interviews at a site and circulated the report to colleagues for comments. The results in this paper were derived from the material in the observation and focus group reports.

3. 0 Results

Here are a few initial generalizations from the various data sources:

1. The system as currently designed and implemented, is workable but could be improved.
2. The data collection job involves much more than navigating successfully from question-to-question in the interview. The whole set of interviewer tasks needs consideration in any redesign.
3. A redesigned system may help meet the general business goals of the organization and its clients, namely higher response rates, improved data quality, and enhanced efficiency.

We are going to list features, noted by interviewers and observers that can be part of an improved system. And we have organized the features by how they might contribute to enhancing valued outcomes of statistical data collection, namely: higher response rates, better quality data, and more efficient performance.

3.1 Response Rates

A major concern to interviewers is getting high response rates. This means identifying the ineligible households accurately (e.g., vacancies, group quarters), persuading someone in the eligible household to respond, maintaining that person's cooperation through the interview and, if necessary, through repeated interviews in a panel survey. Here are some changes that interviewers and observers noted that might improve response rates.

⁵ American Community Survey, American Housing Survey, Current Population Survey, National Health Interview Survey, and the Survey of Income and Program Participation.

Information to Gain Entry. To gain entry to buildings and determine eligibility of units, interviewers need faster access to information about building owners or managers, data about locations of local post offices, and access to records in property tax offices. Accessing at least some of this information on their laptop computers (in databases reached via the Internet) would help.

Persuasion Support. New computer assisted tools can help interviewers persuade eligible households to cooperate. Interviewers wish they could compose and print personalized, customized letters on-the spot, often in a language other than English. Such letters can be used to persuade gatekeepers and managers to grant access. They can also help persuade individual household members of the value in participating. Currently, the interviewer can only request that the regional office send a form letter of the appropriate type. This is time consuming and not completely customized. Other persuasion features include laptop access to name and address directories on the Web to learn who lives at an address, and the ability to show the respondent a brief video or slide show about the survey from the laptop.

Telephone Mode. Interviewers would like more support and encouragement for interviewing by telephone, which they do from their personal home offices. They feel an increasing number of households do not want a strange interviewer arriving on their doorstep and insisting on conducting an interview inside.

Burden—Making It Easier for Respondents. Interviewers feel that minimizing respondent burden helps increase response rates, especially in panel (repeated interview) surveys. They suggest, for example, programming "short" interviews containing only the most important questions for very reluctant respondents. They suggest keeping track of answers from previous interviews and using them to remind respondents of what they said before. Both of these suggestions involve possible trade-offs with data quality. Several interviewers strongly encouraged surveys to use information from administrative records instead of asking it again in yet another government survey.

Respondent Empowerment. Giving the respondent a sense of control over the interview and otherwise motivating her to continue may increase response rates. The most frequent suggestion is to redesign the system so you don't make the respondent wait long periods while the laptop is booting. And to reschedule any inappropriate, time consuming screens and tasks, that

now come after the boot, for example, requiring the interviewer to reset an expired password.

We observed many interviewers trying to turn their laptop screens toward the respondent to make her a coparticipant in the questioning process. There may be better ways, such as giving the respondent an answering device and allowing her to control the pace of the interview. The ultimate in empowerment, and suggested by a few interviewers, is to allow those who wish it to respond to the survey using a self-administered Internet questionnaire. A redesigned system might strive to create this capability⁶. Currently, respondents do have the option of answering the survey questions by telephone, but this can be less convenient than Web access

Help Desk. Interviewers may be able to salvage situations that otherwise would result in nonresponse if there were help desk services immediately available during peak household interviewing times, which are evenings and weekends.

A Reliable System. An interviewer's greatest nonresponse fear, heard again and again in various forms, is that the system will crash in the middle of the interview, the answer data will disappear, and the household will be too angry to do the interview over again, or to continue with the panel study in later months. So creating a reliable system would possibly increase response rates if fewer cases were lost due to mid-interview crashes. Interestingly, from our observations and detailed interviewing, there are very few actual cases of losing data this way. Indeed, the interviewers' perception that the system will crash is really an issue of quality, which we discuss next.

3.2 Data Quality

Navigation to fix answers: In addition to the fears about losing a case in mid-interview, certain shared ideas have developed about what causes fatal crashes. These ideas about causes usually involve the interviewer's "backing up" in the questionnaire (returning to a previously asked question) to change answers. A result is the interviewer's reluctance to risk changing an answer. Not changing incorrect answers causes quality problems. So one suggestion for a redesigned system is

⁶ A redesigned system might have software that generates Web, paper, telephone and personal visit questionnaires from a single set of question specifications, using preset usability standards and guidelines appropriate for each mode.

that it allow navigation anywhere in the instrument without causing the system to crash.

Navigation to reduce repetition: A second advantage of flexible navigation, according to interviewers, is reducing the appearance of repetition. If a series of questions is asked about a family member and then the series is repeated again and again for each of the other family members, respondents get annoyed. Interviewers want to ask the questions once and record the answers for each family member in a family-style procedure. But they want to preserve the capability of asking about one person at-a-time if, for example, the person is a peripheral member of the unit and the current person responding really does not know much about the person.

Item Error Checks: But some questionnaire designers are still reluctant to implement flexible navigation because of the problems it creates for a different quality feature, item error checks. In the current system, an interviewer may not advance to the next question until an acceptable answer code is entered. To the extent possible, answers are checked for range reasonableness and consistency with other information before advancing to the next question. Designs that allow free navigation may generate omitted questions and such systems must postpone edit failure notifications until later in the interview. Corrections made later may be of lower quality and, indeed, may never be made. So a new system must satisfy the need for flexible navigation and still provide feedback from item error checks. And the feedback must result in all the errors being corrected.

Using past answers. Some interviewers would like to increase quality by having the system check current answers against information given in past interviews. They would like to confirm with the respondent, for example, that a change has truly taken place. On the other hand, when information from past interviews drives the current interview's question logic (e.g., implementing a rule such as don't ask rich families if they receive food stamps), then interviewers want to be able to change the past information if the respondent thinks that it is wrong. Our current household survey processing systems cannot accommodate changes to previously processed data.

Audio-assisted self-administration. Research suggests that respondents are more willing to report sensitive or embarrassing information if we use audio-assisted self-administration. Sensitive information includes such things as teenage smoking, drug use, certain health conditions and being criminally abused. The method

requires a sound card in the computer and a large hard disk to store audio files. The interviewer turns the laptop computer toward the respondent, explains the task, asks the respondent to put on headphones, and starts the self-administered questionnaire sequence. The respondent has the option of turning off the question display on the screen for increased privacy. Several interviewers were aware of this technology and recommended that it be used.

Help Features. While it may surprise some, interviewers really do need and want to use an automated help system. We observed successful use of existing help systems when respondents asked for clarification that the interviewer needed to look up (e.g. do you consider my son's summer car washing business a job?). Unfortunately, we observed many occasions where the interviewer clearly needed help and was unable to get it, for example, wanting to move on to the next question and not being allowed to do it. Currently, user interface designers are beginning to devise what they call Electronic Performance Support (EPS) Systems. They are based on an information about the tasks being performed, the skill levels of the individual user, the kinds of assistance needed in each context, and the software technology now available for implementing artificial intelligence applications. These EPS systems deliver a wide range of assistance, tailored to the circumstance: For example:

A simple explanatory bubble if the interviewer pauses the cursor over a place on the screen

A hyperlink to the definition of a term in a question and examples of adequate answers.

A brief screenful of specific information that is accessible by a simple search (e.g., how do I change my battery in the middle of an interview?).

"Expert" programs, sometimes called wizards, that operate in real-time to guide the interviewer through a complex series of steps that are not memorized, such as forming more than one household in a dwelling based on information about how the people are related to each other.

Artificial intelligence applications to help interviewers correctly classify a respondent's job within industry and occupation code systems.

Tutorials to cover complex subjects such as training the interviewer to execute a new section of the questionnaire that will be added next month.

Other suggested items that could affect answer quality include:

A real-time communications capability (or "instant messaging" email) available during an interview, to contact a supervisor or headquarters about important problems.

A device to allow the respondent to see automated flash cards in a language of the respondent's choice.

Automatic backup of answer data, in background mode, at short intervals during an interview (to minimize crash fear and reluctance to enter corrections).

Access to on-line translation facilities for special language situations.

The ability to view a complete list of all household or family members on demand.

Show the name of the current sample person at the top of the screen at all times (in case the question refers just to "you" and the interviewer has lost track).

For longer-term quality enhancements, interviewers and observers have suggested:

That supervisors use computer-based protocols when doing quality checks to judge work quality (e.g., when observing interviewers or scoring a reinterview for consistency and source of error), and that standardized results be communicated to the interviewer right away. Thus, the interviewer has a better chance of remembering the actual interview and benefiting from the feedback.

That headquarters provide more and better automated refresher training (tutorials to be completed at home)

That a moderated, Internet chat room be run for interviewers to share knowledge with each other.

3.3 Efficiency

Interviewers and observers noted a large number of features that could increase the interviewer's efficiency. These are discussed next.

Quick Access to a Case: The most frequently mentioned efficiency features involve speed of accessing a case, either to enter information about it or to open it for an interview. The current system requires a long time to "boot" or start-up the laptop computer and often

requires navigating through additional screens before any work can be done. Currently all interviewers write notes about a case on paper if their laptop is not "awake." Some interviewers conduct interviews with apartment managers about vacant units from memory and write information on paper later. Eventually the paper information is entered into the laptop and observers said that it was not uncommon for the interviewer to have forgotten to ask certain questions.

Look and Feel: A standardization of functions, processes and question wordings, according to interviewers, would aid efficiency. This is also called a common look-and-feel and it is achieved through organization-wide usability and metadata standards.

Information On-the-Spot: For efficiency, interviewers and observers suggest that several kinds of information, now on paper, be accessible by laptop such as maps, address listing sheets and address segment folders, lists of primary sampling units and their locations, flash cards, calendars, and daily appointment logs. These are in addition to the ownership and name-address databases mentioned in the response rate section, that need to be accessible via the Internet, possibly with cellular phones or satellite links.

Home Office Equipment: Interviewers have to maintain home offices to do their jobs and feel they would do better work if their offices were equipped with standard features, such as a telephone answering machine, a printer, a fax machine, an autodialer, a postage machine, and a headset for telephone interviewing.

Hardware enhancement suggestions from interviewers include a harness for the laptop to facilitate doorstep interviews, moisture-proof and "ruggedized" laptops, screens that are readable in sunlight or at an angle, faster boot times, "sleep-mode," and a more convenient system for backing up the hard disk, since current procedures can require using 20 or more diskettes and lots of interviewer time.

Desirable software enhancements, according to the interviewers, include email, word processing, a compatible system for reporting time and expenses, a telephone number list of key operations people in the regional office and at headquarters, automatic virus scanning and disk defragmentation and the ability to reassign and transmit partly completed interview cases to another interviewer, and retain the existing notes and answer information.

4.0 Next Steps

Our results are a broad range of user-oriented features and redesigned processes that conform to current technology and, within a few years, should be affordable. Redesigning the system with these features should increase interviewer job satisfaction while also achieving the business goals of reducing response rates, increasing data quality, and enhancing productivity and efficiency.

The next step is to define the scope of a redesigned system and turn this information into both a user interface design and a set of specifications for functions to be supported in a redesigned data collection system for households. User-centered design is a new concept at the federal statistical agencies and the idea of designing the software interface based on ethnographic observation is relatively recent. So, as the Census Bureau is forming its various working groups to address aspects of a redesigned support system for household interviews, the usability laboratory staff will be experimenting with various procedures for translating the observations into a design for the user interface. Our goal will be to learn the strengths and weaknesses of some of the different design methods and to produce a product that might be useful to the people who will need to implement the actual redesign decisions.

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