COMPUTER-ASSISTED TELEPHONE INTERVIEWING: DESIGN CONSIDERATIONS

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I. INTRODUCTION

The Census Bureau and the Center for Computer-based Behavioral Studies of UCLA began working together about two years ago. At that time the UCLA staff had already developed a prototype CATI system and were quite willing to add features to it that would accommodate the types of interviews conducted by the Census Bureau. Work on another CATI system also began several years ago at Chilton Research Services, and several other organizations have entered the field more recently.

Although each CATI system has unique features, all have at least these elements: interviewers sit in front of a computer terminal with a cathode ray tube display which directs the interviews with respondents by telephone; the computer is programmed to select the appropriate questions to be asked, given the parameters set by the survey designer; each question in turn is displayed on the screen in front of the interviewer (similar to a television screen); after reading the question to the respondent, the interviewer uses the computer terminal keyboard to record the answer; the computer immediately performs the desired checks for consistency and completeness; if clarification or more information is needed, the computer displays a follow-up question on the screen; when an acceptable answer is obtained, the computer stores the information, selects the next appropriate question and displays it on the screen.

II. ADVANTAGES OF A WELL-DESIGNED CATI SYSTEM

Although much thinking and testing remains to be done, consideration of the advantages of computer-assistance during the data collection phase of a survey reminds us that the effort is worthwhile. A well-designed and implemented CATI system offers many advantages, including:

A. Improvements in Quality of Data

A CATI system will facilitate use of supervisors to monitor interviewer-respondent conversation, to check whether the answers given by respondents are recorded correctly, and to give correction and further instruction to individual interviewers as needed. Therefore, we can expect to achieve greater consistency in the way questionnaires are administered and the way in which unstructured probing for additional information is done.

The quality of the final data should also be improved because fewer imputations for missing or inconsistent information will be required. By identifying such deficiencies while the interview is in progress, respondents can be asked to provide the correct information rather than having to rely on imputation formulae or making another call to the respondent.

B. Reduction in Time Required for Questionnaire Preparation and for Data Processing

New questionnaires can be entered into the computer system much faster than they can be typeset for printing and then printed in sufficient quantity. Data will be in the computer within seconds of when they are received, rather than days, weeks, or even months later. Periodic tabulations could be made of data received to date.

C. Ability to Pretest Questionnaires More Thoroughly

Current methods of pretesting questionnaires are primitive compared to those available with the computer-assisted interview system. Computer software has been developed to facilitate this important phase of questionnaire development, so that questions can be inserted, deleted, and changed quickly. A researcher can receive daily tabulations, change a developmental version of a questionnaire overnight and try the new version the following day. In addition, several versions of the questionnaire could be installed in the computer and used alternately during the testing process. This flexibility is impracticable in the current system where each of the versions has to be typed and printed and interviewers taught when to use each.

D. Ability to Tailor Questions to Respondent Characteristics

Those who have worked in questionnaire development know that compromises have to be made between making questions better suited to individual respondents and trying to avoid making the questionnaire instrument too complex for interviewers to administer correctly and easily. Most have wished that they could alter a series of questions a little for respondents with certain characteristics, but have resisted the temptation because it would make the questionnaire longer or too complex, and interviewers might use the altered questions for the wrong people or fail to use them for

the intended people. Computers can handle such variations with relative ease. If questions are better suited to respondents, better data should result.

E. Enhanced Ability to Do Methodological Research

Although quite a number of studies have been conducted on the effects of question wording, question sequencing, and length of questionnaires, most have been of limited value because of small sample sizes, relatively unsophisticated study designs necessitated by interviewer inability to follow complex designs, and/or lack of good controls in the administration of the studies. Computers can be programmed to alternate the use of several different wordings of individual questions; they can randomize the order of presenting response choices to respondents; they can be programmed to administer questionnaires of varying lengths; and they can be used to standardize the amount and type of feedback given to respondents. By varying the introduction to the survey which is read to the respondent we can study the effects of different amounts of detail and various statements about confidentiality of data.

III. THE ROLE OF COMPUTER-ASSISTANCE IN TELEPHONE INTERVIEWING

This overview of some of the features of CATI shows that the driving force behind efforts to develop a CATI system is a desire to improve the quality and timely processing of survey data. This translates into an effort to help the interviewer do his job better and to get the data he receives into machine-readable form more quickly. This section addresses the question: how can we best accomplish these two goals?

Basically, an interviewer's job is to elicit information from those selected to be interviewed. To do this in a scientifically acceptable way, he is supposed to gain the cooperation of the respondent, present him with questions (generally without changing their wording), and make an accurate record of the answers given by the respondent. (Of course he is asked to do other things, such as, recognize when an answer is not complete or to the point, formulate non-directive questions designed to elicit a more complete answer, and be a good public relations representative for his employer.) In essence the interviewer must juggle the sometimes competing demands of "good interviewing practice" and those of the person(s) he is interviewing.

In proposing to introduce a computer into this process, we recognize that for better and for worse we are interjecting a relatively rigid instrument into a conversation between two (or more) people.

A general characteristic of interactive computer systems is that the person (operator) is there to either: (1) do what the computer tells him to do (such as in data entry from a document and computer-assisted instruction), or (2) choose a course of action from a limited list presented by the computer. Such systems are modeled on a two-way interaction between the computer (C) and the terminal operator (O) which can be illustrated by the following:

$$C \longleftrightarrow O$$

With CATI, there is a three-party communication which makes the interviewer (I) the operator, and adds the respondent (R) to the above model:

$$C \longleftrightarrow I \longleftrightarrow R$$

In this case the interviewer is the link between the computer and the respondent. No one of the three has a clear dominant role. The computer is programmed to accomplish certain things and is set on a course which is designed to meet those objectives. The respondent is seen as necessary, but unpredictable and uncontrollable; that is, information is needed from him in order to proceed at each step, but he cannot be "programmed" to respond exactly as we would like him to. Neither the computer nor the interviewer can force the respondent to select one answer from a given list, answer every question, and be consistent from one answer to the next.

It is the job of the interviewer to elicit information from the respondent; it is the job of the computer to provide support to the interviewer in doing his job: that is, it is to tell him what question to ask next if the respondent selects one of the anticipated answers. But, as we all know, the respondent might:

-- insist on some answer that is not on the list,

-- want to change his answer to an earlier question,

-- insist that he cannot answer certain questions,

-- only partially complete an interview while agreeing to continue with it at a later date?

Clearly, this aspect of interviewing requires closer attention in CATI than in personal visit interviewing. The simple actions of an interviewer to review and possibly change an answer made two days or even 10 minutes earlier require careful planning in CATI. One of the early revisions to the UCLA-CATI system was made to allow interviewers to call to the display screen the answer to any

question entered during the current interview. Later, features were added to restore information from a previous interview so that it could be used during a follow-up interview. A system of boundaries has been provided so that the survey designer may specify sections of questions that may be changed or not changed after they have been asked. With these tools a designer may specify that answers to a certain series of questions may not be changed after the interviewer has reached a particular point in the interview. So long as an interviewer is not specifically prohibited from changing an answer, he may do so with one brief command.

The UCLA system has also been designed to provide interviewers the ability to skip an entire section of questions if the respondent is unable or unwilling to answer questions on the subject of that section. Decisions about what may and may not be skipped are left to the survey designer, and, of course, administrative control must be exercised to prevent excessive use of this and the other tools given to the interviewers through which they can alter the order of the questions.

What we have really been discussing is: how much control over the order to questions should be given to interviewers, and how much should be under the control of the survey designer through the computer? The answer may depend on the objectives of the study and the amount of resources one wants to invest in a CATI system. As one designs a CATI system to make it more responsive to the needs of study directors, and more flexible to take account of different types of respondents and interviewers, he finds that he has a system whose complexity requires greater sophistication to use. If we keep CATI simple, it may mask the human variability that is the subject of a survey; if we allow it to become more complex, the system may be too difficult for study directors and interviewers to use well.

IV. BASIC ELEMENTS OF A CATI SYSTEM

Although we are in an early phase of CATI development and have many unanswered questions, we have outlined some basic elements of a CATI system. At the level of overall design of a system, we feel that it should include the following:

A. A "language" that can be learned readily by survey designers and used to communicate a questionnaire and its edit specifications to the CATI system. This language is simply the bridge between the persons who have designed a survey and the software needed by the computer; it should provide the survey designer review capabilities similar to those he now has when he reviews a questionnaire before it goes to the printer and checks the editing, imputation, and tabulation specifications before they go to programmers. While it may be necessary to have specially trained persons provide at least part of this bridge, it is desirable to have as many as possible of the questionnaire and edit specifications set by the survey designer up to the time the computer takes over to mechanically convert the specifications into runtime software.

B. Computer response time that provides the next screen display within 1½ - 2 seconds of interviewer response to the previous display.

C. A system of notation that clearly distinguishes between what is supposed to be read aloud to the respondent and instructions to the interviewer which are not to be read aloud.

D. A series of brief command forms that the interviewers will use to instruct the computer to: back up to an earlier item (either to refresh his memory or the respondent's, or to change the entry), skip over items that a respondent can't or won't answer, terminate an interview at any point, accept and store a comment which explains or limits an answer, etc.

E. A means to prepare interviewers for follow-up interviews when a partial interview has been completed and to notify the computer of which section(s) can be completed on a particular follow-up call. Prior to placing a follow-up telephone call, the interviewer should be able to review the information recorded during the earlier interview(s) and get a general idea of what remains to be obtained.

F. Software that can handle storage and retrieval of data collected in a panel survey that is to be used in subsequent interviews.

G. Software for activities related to interviewing. Examples of these include: training of interviewers, survey administration (scheduling interviewer workload and callbacks; implementing experimental designs which vary the content of the questionnaire), progress reporting for survey administrators, preliminary tabulations, generation of telephone numbers for a "random digit dialing" sample, and selection of a sub-sample of the original sample based on information collected during the first interview.

V. SOME UNANSWERED QUESTIONS

As work on these features moves forward, we must also begin to address some unanswered questions like the following:

A. How much editing should be done during interviewing?

A major feature of CATI is the ability it provides to systematically check responses against a set of rules of consistency and logic. When an unexpected answer is recorded, the system can display a follow-up question designed to correct the apparent error in reporting. How to store and retrieve answers used in consistency or range checks becomes an

important issue for system designers when the number of answers to be stored and retrieved exceeds what can be held in core. Retrieval from peripheral devices is likely to result in delayed screen fills and, thereby, interrupt the interview. Clearly there are trade-offs between response time and extent of editing involved in decisions concerning the type of operating system and size of core that are selected to support a CATI system.

B. What effect will a CATI system have on an existing field staff?

1. Interviewers. The first question that is usually asked on this subject is: will we be able to use the same staff of interviewers that we have now? The question should probably be: will the same people who are attracted to interviewing now also be attracted to it under different conditions? In order to attract and maintain an adequate interviewer staff, a survey research organization should be alert to the human factors inherent in decisions related to computers. Some of the relevant questions are:

-- What will happen if an interviewer perceives his role to be little more than that of a robot doing the bidding of a computer? Will the quality of his work decrease because he lacks a sense of personal involvement and contribution?

-- How should an interviewer's work be structured? That is, how many hours a day should he interview and how should work periods be divided? Should other activities be introduced to relieve emotional or physical stress that may come from talking to people for several hours at a time? What amount and arrangement of work space is best suited for interviewers working with CATI?

-- What kind and amount of supervision for interviewers is optimal for a CATI system?

-- What type of feedback should be given to the interviewer regarding the quality of his work? Should it come in the form of a computer printout, or is more personalized (and subjective?) feedback from a supervisor needed? The criteria used to judge interviewers may change as we learn to utilize the computer more fully for administrative records.

2. Supervisors. A major effect is that supervisors of interviewers will have to know quite a lot about how the CATI system works, as they will likely be called on to help interviewers out of difficult situations during interviews. Other effects, similar to those mentioned for interviewers, should also be anticipated and studied.

3. Coders. It seems logical to think that if parts of interviewing are automated that current practices for clerical coding should also be reviewed. Perhaps coding can be done "on-line" using the same computer terminals that are used by interviewers as suggested by Shure and Meeker (1978).

C. What is the best way to restart an interview which has been partially completed?

Restarting a partially completed interview is likely to be a much greater problem for the interviewer than it will be for the computer system, unless more of the burden can be shifted to the machine. It is relatively easy to prepare a computer program that edits an interview for completeness, identifies missing items/sections, and systematically selects the first (unanswered) question to be asked in the follow-up interview. However, that item might not be a good first question for a follow-up interview. We may find that it is desirable to allow the interviewer a choice of several starting points.

D. How will data from personal visit interviewing be integrated with data from a CATI system?

Unless personal visit interviewing is eliminated from surveys for which CATI is used, the master plan for data processing will have to provide a way to integrate data recorded on paper questionnaires with that resulting from a CATI system. More than that: comparability of data may be difficult to achieve if information from some respondents is subject to more sophisticated edits during data collection than information from others.

VI. COMPUTER IMPLEMENTATION

Computer technology is now at a level that all of the desirable aspects of a CATI system can be realized. However, guidance based on research by social scientists is needed to assure that the systems delivered are responsive to the needs of survey researchers. The first part of this paper has explored a variety of questions and issues of both immediate and long range importance and at a detailed and general level. These will continue to be examined and worked on in the years ahead. We now turn from what a CATI system "could" do to how some of these capabilities have already been achieved by the CATI system at UCLA. While this system has been fully operational for more than a year, it is being modified and extended by the UCLA staff and other users. Both the Census Bureau and the Survey Research Center at UC Berkeley have joined the UCLA staff in making significant improvements and additions to the system. The system has been described elsewhere (Shure and Meeker, 1978; Meeker, Rogers, Rogers, and Shure, 1978); in what follows, we will illustrate how the CATI system

at UCLA has incorporated a comprehensive set of refinements and capabilities to support telephone interviewing. These capabilities reflect the major functions accomplished at three stages of the interviewing activity: (1) the pre-interview schedule design stage, (2) the interactive interviewing stage, and (3) the post-interview data processing stage. These interlocking programs, all written in Fortran IV, operate at UCLA on a PDP-11/45 computer under the RSX-11D and RSX-11M systems (see Figure 1).

A. The Pre-interview Questionnaire Schedule Design Stage

The first of these functional areas is composed of two programs designed to assist investigators in preparing schedules for computer administration.

The Schedule Editor and Interview Generator Programs are used to convert a written interview schedule into an interview sequence appearing on the computer console screen at the command of the interviewer. The Schedule Editor transforms a written interview schedule into an Interview Specification File; the Interview Generator Programs then use this file to create the specific Interviewing Program which governs the display of items and the recording of responses during the interview itself.

The first step facing the investigator is how to produce the Interview Specification File. These specifications must be in a form that will be machine-readable by the Interview Generator Programs. At the same time, it is very important to make this specification process as similar as possible to that used in designing field-administered interview schedules.

The machine-readable aspect of it can be accomplished either by manuscripting the questionnaire and having it keypunched or by direct entry with a general computer system editor. The content of the specifications is, of course, the interview instrument itself. There are provisions for question presentation, for the specification of coded responses appropriate to any given question, and specification of how questions interrelate with one another (in terms of skips, branches, tests, etc.). Some skill is required in translating a paper-and-pencil questionnaire into the specification form but the translation is direct and easily learned as it has high correspondence to the forms used in paper-and-pencil versions. Following is an example of the format used:

```
<12>  Did you do any work at all last
      week, not counting work around
      the house?

      <1>  Yes          [GOTO 18]
      <2>  No
      ===>
```

The instruction "GOTO 18" would not be displayed on the screen.

These procedures do not require programming. By this we mean the system provides a bridge between the usual conventions of preparing interview schedules and FORTRAN IV compilable code. This bridge is an automatic translator which takes in an interview schedule specification file and puts out FORTRAN code--the Interviewing Program. When compiled and executed, this program implements the schedule through the computer. The translator successfully recognizes most item forms and procedures found in interview schedules, and can be easily extended to incorporate new forms. Of course, it will never be completely comprehensive in its ability to translate interview schedules and for that reason there are advantages in having FORTRAN code as an intermediate step since that code, with relatively little programming effort, can be modified to deal with idiosyncratic applications. Modular construction of this system also provides for on-site addition of modules programmed by investigators who wish to add new capabilities.

The end result of the first stage translation processing is a set of FORTRAN sub-routines that are unique to a given questionnaire. They contain the content of displays; and they contain the logic of the display controls and storage controls. These are combined with the generalized CATI operations package to create the execution system for the interview.

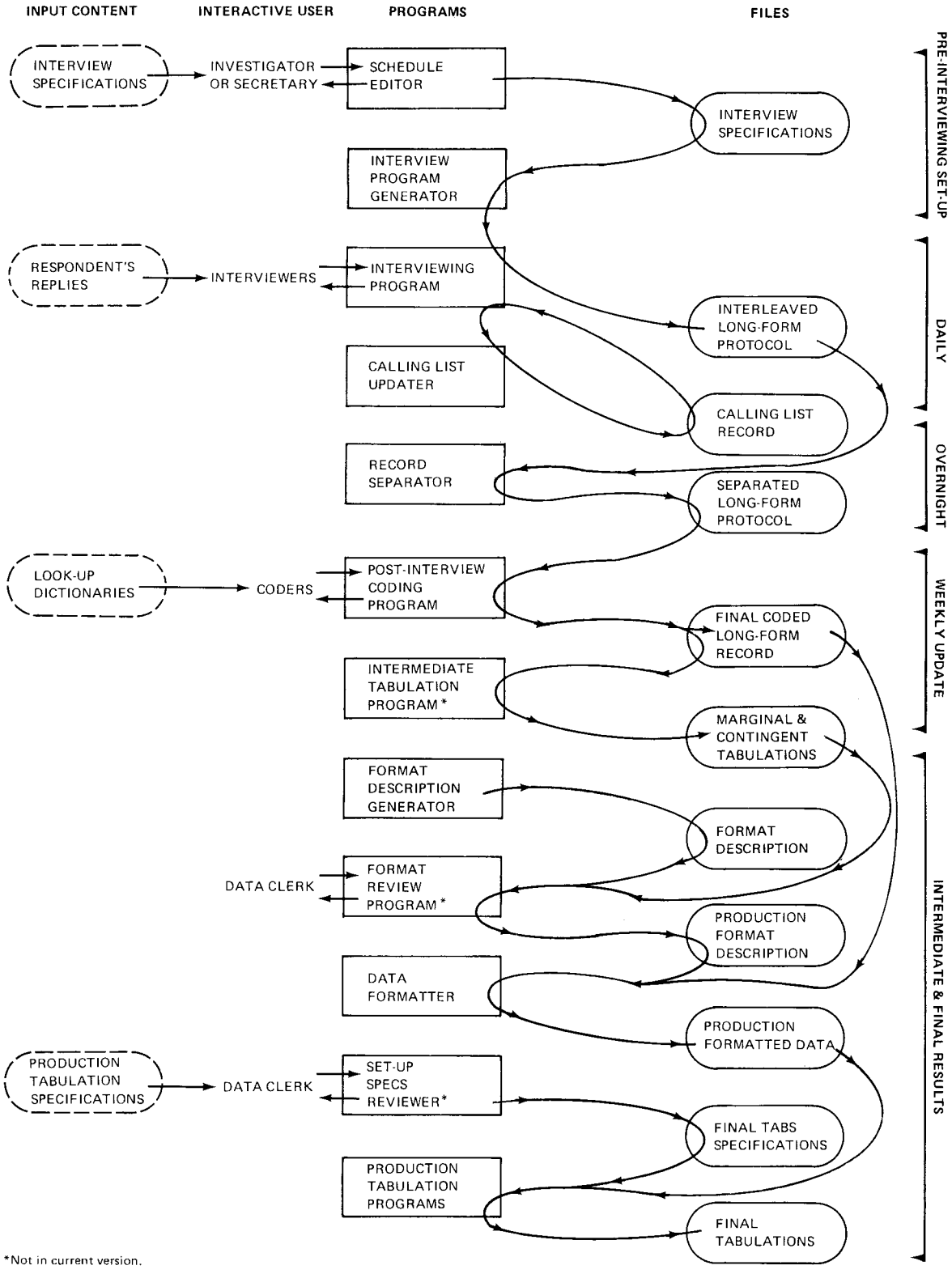
The sub-routines specific to the interview questionnaire are compiled and then combined with the compiled main program to form the program set that will run the interview.

B. The Interactive Interviewing Stage

The second major functional component of the system provides computer assistance during the interviewing itself. UCLA-CATI currently supports up to sixteen simultaneous computer terminal positions for telephone interviewers. This system operates in a multistation mode in which the console positions may be occupied by supervisors, monitors, data entry clerks and coders, as well as interviewers who are served concurrently by the same program. These positions could also be allocated to run more than one survey at the same time.

The UCLA implementation of CATI is designed for efficient management of computer system resources during the interviewing process. All data frequently required by interviews-in-progress is kept in main memory. All other data is kept in specially designed disk files which optimize access based upon content and usage. Computer terminal input/output is performed using special buffering software which allows a single program to handle

FIGURE 1



*Not in current version.

multiple interviewer terminals with minimum overhead. All of these functions are controlled by parameters which are initially either set to general values or automatically generated from the questionnaire specifications. These parameters may be fine-tuned to minimize response times and maximize the number of simultaneous interviews.

Any special utilities required for execution have been isolated wherever possible; input/output procedures that might be dependent on equipment configurations in a given installation have also been isolated for reducing problems of adaptation to other sites.

C. Post-interview Data Processing Programs

The third functional component of CATI is a collection of linked programs for on-line data processing, including cleaning, coding of open-ended responses, and formatting and labelling of the variables so that the data can be input directly into standard statistical programs.

The Data Output Package consists of sets of programs designed to take the interview output resulting from the interview and process the data into formats suitable for review and/or analysis (see Figure 1).

D. Telephone Number Management Package

Before concluding our brief overview of the UCLA CATI system, a set of programs that operates at all three of the stages described deserves a few comments from the software perspective. This program package provides for the administration of sampling and respondent selection procedures. It uses the Waksberg sampling algorithm for random digit dialing (Waksberg, 1978) and governs the management of sampled telephone numbers. The program automatically assigns numbers from lists generated off-line. These numbers may be within any specified range of digits with given telephone area codes or exchanges. The computer keeps track of numbers requiring call-back reassignment, rotates the time of day for successive attempts, records the disposition of calls, and performs other record keeping functions.

The Telephone Number Management Package uses a large, direct-access data file to store information required by the scheduling procedures which determine when each telephone number will be called and what type of interviewer is required. This file is also used by other components of the CATI system such as household roster management, call-back data storage, run-time system commands, etc. A set of programs is provided which permits users to build and configure a version of this data file appropriate to each individual questionnaire and to each CATI facility.

Parameters supplied to these programs permit the user to specify such factors as: how many simultaneous interviewers are expected, how many unique interviewer identification numbers are to be used, the maximum number of telephone numbers that can be simultaneously active at one time, etc.

The UCLA system assumes that the initial primary set of telephone numbers to be called is generated outside CATI and is supplied in machine-readable form. Use of the Waksberg procedure yields a secondary sample of telephone numbers based on a given set of primary numbers.

Scheduling is accomplished by a program which assigns each telephone number, whether primary or secondary, to one of eight scheduling rotations. These scheduling rotations determine the time of day (e.g., early morning, late morning, early afternoon, etc.) at which the number will be called on successive days until such time as (1) contact has been established with a member of the household; (2) the number reached has been established as not a household; (3) its number has been placed in a "Hold" status for special action by a supervisor.

Before each interviewing shift, a program is executed that uses the information in the data file and its own internal tables to queue-up numbers to be called for the following shift. Queues are provided for (1) available numbers scheduled to be called first in each of four time slots per shift, (2) a pool of available reserve numbers to be used if any time slot runs out of numbers, (3) numbers requiring Spanish language interviewers, (4) numbers requiring refusal conversion specialists, (5) numbers for use in training interviewers, (6) call-backs scheduled for any interviewer, and (7) call-backs scheduled for each specific interviewer. The output file produced by this program details which phone numbers were queued into each of these queues. A sorted version of this file may be used by supervisory personnel in anticipating the work load for the next shift by various types of interviewers (e.g., Spanish language, refusal converters, etc.).

At the present time, multistation versions of the system have been adapted for a Census Bureau survey and for use at the University of California Survey Research Center at Berkeley, where it is running on a PDP-11/34 computer.

E. Comparison with CAI

After this brief description of the UCLA CATI system, readers familiar with Computer-Aided Instruction (CAI) systems might be lead to inquire whether CAI systems could be adapted for CATI. The question is a reasonable one, as CAI has been used for more than a decade and a half for instruction varying from simple well-defined drills and exercises to those explaining complex concepts. The CAI systems typically provide for the design of these exercises on the computer and for the individualized interactive presentation of

instructional materials to students at computer consoles. These two major components have obvious functional similarities to the schedule design specification phase and the interviewing phase of the CATI system respectively. To answer the question directly, it is possible to use a CAI language to specify interview schedules. In fact, Chilton, one of the first commercial organizations to develop a computer-assisted telephone interviewing system used COURSEWRITER, a CAI programming language, for this purpose.

The earliest version of CATI at UCLA was similarly implemented on a system that was not designed for interviewing, but rather for the design of multi-person laboratory experiments (Shure and Meeker, 1974). It was found, however, that the use of a system created for other general purposes results in significant unnecessary overhead both at the design and user interaction level.

The languages of the major CAI systems are made more complex by the requirement that the designer be able to do far more during the design of a program than specify questions and answers. A tutor-pupil relationship is assumed, in which the computer must appear to be intelligent and friendly, but still very firmly in control of the interaction with the pupil. Those who are familar with the programming languages FORTRAN and COBOL might be able to appreciate the advantages of a CATI system over a CAI language by considering trying to use COBOL for an application best suited to FORTRAN.

Consistent with our argument that existing CAI systems are cumbersome for the needs of CATI is our view of the use of a CATI system for data entry from completed questionnaires. The requirements for efficient and accurate data entry during the interview proper are based on different criteria and human engineering task considerations than those involved in data entry by clerks working from completed interviews. For example, some of the task characteristics and associated requirements of the data clerk which differ from those of the interviewer are dense data entry based on eye-focused reading of documents; multi-field oriented displays, correction and validation; highly efficient keystroke entry; etc. While these requirements can all be satisfied in a CATI system, it remains doubtful whether the data entry provided within the CATI systems designed to date can match for this purpose the efficiency of a small dedicated machine with a specific data entry package.

VII. SUMMARY

This paper has discussed some of the advantages of CATI, outlined what we think are some of the essential elements of a well-designed system, listed some unresolved questions, and described the design of one of the CATI systems currently in use. The use of computers as an aid to interviewing is still very new, so it is not surprising that there are many issues in need of further study. A close working partnership between survey researchers and human factors engineers will be needed in order to develop the types of systems that can best meet the needs for high quality, timely survey data.

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