

Pamela W. Ferrari, Richard R. Storm, and Francis D. Tolson, U.S. Bureau of the Census

1. BACKGROUND AND INTRODUCTION

Computer-assisted telephone interviewing, more generally referred to by its acronym CATI, is a method of data collection in which interactive computing facilitates centralized telephone interviewing, data entry, editing, and coding. Some CATI systems (including the Census CATI System) also are capable of performing sample management, call scheduling, case assignment, generation of progress reports, analysis, and tabulations.

Uses of CATI systems vary from market research and polling to academic research to complex government surveys and censuses. In the usual situation, an interviewer reads the question from a computer display terminal to the respondent, records the answer via a keyboard entry system, and then the computer performs necessary consistency and validity checks on the responses. The computer will ask for additional or corrected information as required. Once a response has been accepted as valid by the computer, it is stored and the next appropriate question (determined by previous responses and programmed logic) appears on the screen. This sequence is repeated until all required data have been entered.

The CATI field is a relatively young one. One of the first commercial CATI systems was developed by Chilton Research Services for American Telephone and Telegraph in 1972.[1] The University of California at Los Angeles, the University of Wisconsin, and the University of Michigan were academic pioneers in CATI design in the early and mid-1970's. Since that time other organizations in the academic and private sectors, such as the University of California at Berkeley, Audits and Surveys, Westat, and Research Triangle Institute, have designed or adopted CATI systems. Leaders in government applications of CATI systems include the Census Bureau and the Statistical Reporting Service of the Department of Agriculture.

The Census Bureau became interested in CATI systems in the early 1970's. General background and feasibility research was initiated. Two small pretests were conducted, one from the CATI facility at the University of California at Los Angeles for the Current Population Survey in 1978. The other pretest was conducted on the Bureau's main computer.[2]

The Census Bureau began more active research on CATI systems in 1980. General user requirements were written and computer hardware was purchased in 1981. Work then began on the software development. The first major test of the Census CATI System was conducted between August and November 1982 as a nonresponse follow-up to the 1982 National Survey of Natural and Social Scientists and Engineers. The evaluation results of this test have not been finalized. The second test, conducted between May and September 1983, was a nonresponse follow-up to the mailed 1982 United States Census of Agriculture.

The census of agriculture generally has been taken every five years as mandated by law under

the provisions of Title 13 of the U.S. Code. Questionnaires for the 1982 census were mailed out in late December of 1982. A series of follow-up letters, some with questionnaires, were mailed to nonrespondents at approximately three-week intervals. A non-CATI telephone operation followed up the residual nonrespondents that met minimal size requirements beginning in May 1983.[3] The 1982 census planned to test the use of CATI as an alternative method for conducting nonresponse follow-up. This paper addresses some of the operational components and preliminary results of this CATI test.

A sample of approximately 10,000 nonrespondents that had expected sales between \$100,000 and \$999,999 and estimated land in farms of less than 30,000 acres was selected for the CATI agriculture census test. These criteria were based on available 1978 historical data and varied somewhat among states. A corresponding sample of 10,000 cases was selected to be used as a comparison group. The comparison sample was interviewed by regular (non-CATI) telephone methods from the Census Bureau's Data Preparation Division located in Jeffersonville, Indiana; while the CATI sample was interviewed via CATI methods from Washington, D.C. In addition, the Jeffersonville facility attempted approximately 95,000 follow-up telephone interviews that were not part of the comparison sample.

The sample selection was accomplished by means of a stratified cluster sample within each of the 48 contiguous states. The sample size for each state was determined by the proportion of nonrespondents eligible for selection from that state. Nine strata were defined by source [4], mailed size [5], and the major type of operation [6]. The strata were sorted geographically by state, county, and ZIP Code. Within each strata a systematic sample of pairs of nonrespondents was selected, with cases within each pair randomly assigned to either the CATI or comparison samples. Prior to the beginning of the interviewing period, 12 states were deleted from both samples due to their early close-out deadlines (the dates that the interviewing for particular states had to stop in order to maintain the continuous processing flow). The interviewing for the remaining states (approximately 8,500 cases for each sample) began in May 1983 and continued through August 1983.

2. ADAPTATION OF THE QUESTIONNAIRE TO THE CATI SYSTEM

Developing a CATI version of the census of agriculture questionnaire proved to be a complex and time-consuming process. This actually involved three distinct tasks that were undertaken concurrently.

Since the standard questionnaire had been written as a self-administered, mail-out and mail-back form, the first step was to revise or rewrite the questions for telephone interviewing. For example, the implied question "All land owned" on the mail form was revised to "How many acres of land did you own?" The major problem

in performing this task was to decide how many of the detailed explanations, qualifications, and exceptions printed on the mailed form (often in small print) actually should be read to the farmers during an interview. An extended process of planning, revision, and review was required to ensure subject-matter consistency between the forms while preparing a telephone interview likely to be acceptable to the farmers. Since a telephone follow-up of large nonresponse cases was planned even before CATI was considered, this task would have been necessary in any event; but planning for CATI required that it be undertaken further in advance and in greater detail than in previous agricultural censuses.

The second task was to adapt the telephone interview questions to the new medium of CATI. In computer-assisted telephone interviewing, the interviewer typically sees only a few survey questions at a time, in part because the computer terminal screens used for CATI usually display only 20 to 24 lines of text at once. Long question sequences had to be broken up into smaller sets; large tables had to be rearranged or their information obtained in different ways; and methods had to be found to ensure that the interviewer always had all the prior information needed to ask each question and correctly record its answer. Again a long process of planning, design, and review was necessary to maintain content consistency. In addition, edit checks possible in CATI had to be selected while the complex branching (or skip instructions) of the paper and pencil form had to be both reproduced and, in many cases, made more precise where instructions were vague or relied on human judgment rather than strict programmable rules. The edit checks identified invalid or out-of-range responses that were corrected by the interviewer when a message to try again or a new screen appeared on the terminal.

The third task was to set up or program the questionnaire to run on the Census CATI System. A user language, called QISC for Questionnaire Implementation System-Census, was employed. This user language was designed by the Census Bureau CATI Project based on earlier versions of QIS-type languages developed by the Universities of California at Los Angeles and at Berkeley. The questionnaire was set up in QISC, usually section-by-section. These sections were submitted to a translator program which converted QISC to FORTRAN, and then compiled the FORTRAN program for a running version for production interviewing.

The use of CATI was not restricted to the items on the paper and pencil questionnaire. It also was applied to a variety of screening and field work tasks the interviewer had to complete (or at least be ready for) before the interview could begin. This began with the introduction of the interviewer and the survey to the person answering the telephone and the identification of a qualified respondent. If the farm operator was not available, interviewers asked to speak with someone else at least sixteen years old who was knowledgeable about the agricultural operation for the specified census year. In some cases, it was necessary to call the farmer's accountant or trace the successors or beneficiaries of deceased farmers. When a qualified respondent

was identified but was not available at that time or did not have the necessary information at hand, an appointment callback was arranged.

Next, interviewers confirmed the information that would have been found on the mailed form's mailing label and checked to see if the respondent had received more than one agriculture census report form. If this had occurred, the names, addresses, and identification numbers of each were requested; and procedures were followed to identify duplicate forms, determine which had been mailed back, and decide whether a telephone interview was necessary in this case. All of the above steps were built into the CATI interview so that the interviewers only had to record accurately each response through this complex process to satisfy the detailed field requirements.

In addition, the CATI interview included options to probe and correctly handle a variety of special situations. Persons who claimed they were not farmers were asked a few key questions to determine if they met the definitions of a farmer for the agricultural census. When a respondent had died, questions were asked based on the date of death to determine whether an interview was necessary and who should be asked about the farm. Respondents who claimed to have mailed back their report forms were encouraged strongly to provide the information by telephone if closeout for that state did not permit time to confirm a mail return. Others were recalled when the claimed mail return was not confirmed within a reasonable period. Those promising to mail in their report forms were encouraged to do so or to answer by telephone depending on the proximity to closeout of their states. The development of questions, probes, and branching patterns to accommodate all these and many other field work requirements, their setup in the QISC user language, and their integration into the content questionnaire added significantly to the effort required in preparing for the CATI survey.

3. TRAINING OF CATI INTERVIEWERS

The CATI interviewer training program began two weeks prior to the actual interviewing. During the first week of the two-week training session, the CATI interviewers received the identical information as their counterparts in Jeffersonville (regular non-CATI telephone interviewers). The concepts presented during the first week were introduced with a three-hour cassette tape and self-study workbook, followed by formal classroom training and question and answer sessions. Instruction relative to effective techniques for telephone interviewing was presented by demonstrating and contrasting various approaches. Information regarding the legal requirements for confidentiality of census data also was discussed. In the time that remained, the interviewers conducted practice interviews with each other.

The CATI interviewers used the paper and pencil version of the telephone questionnaire to become familiar with the questions and basic definitions. In order for the interviewers to obtain accurate responses, agricultural concepts and terms such as "this place," "principal county," and "feedlot operators" were discussed in detail. The interviewers were introduced to different

types of agricultural operations including dairies, grain, feedlots, hatcheries, and nurseries and greenhouses. Practice interviews focused on the different types of operations.

During the second week of training, the CATI interviewers received specific instructions relative to the use of the interactive terminals. Each interviewer was assigned to an interviewing station, which was comprised of a video screen and keyboard connected to the minicomputer. After a brief tour of the CATI facility and a demonstration of the terminals, the interviewers began a self-study module which focused attention on the use of the terminals and special program-function keys. These keys allow interviewers to move forward, backward, jump back to previous sections, and change responses, much like regular interviewers move through paper and pencil questionnaires.

Through a second self-study module and trainer-directed discussions, the interviewers became familiar with the CATI version of the questionnaire. Differences between the CATI questions and the regular telephone questions were explained. In addition, the interviewers were shown how branching paths -- the logic that directs the interviewer from one question to the next -- differed based on the respondent's answer.

The interviewers continued training by interviewing each other in pairs by telephone using "fact" sheets and scripted interviews. The trainee acting as respondent read the responses on the scripts or "fact" sheets and the trainee acting as interviewer entered the responses directly onto the terminal. Since each exercise was designed to stress different concepts or problems, group discussions followed. This technique of paired practice interviewing also was used with the introduction section of the CATI instrument to help interviewers answer questions frequently asked by respondents, gain cooperation from respondents, and become familiar with the screening questions to determine whether or not the respondent was qualified or eligible to proceed with the interview. A final practice interview was observed by the supervisor prior to the assignment of a trainee to production interviewing.

Refresher training was administered through the Quality Circle Program. This program was a series of meetings with the interviewers and supervisors where problems and concerns were identified that could affect data quality and production. Through group discussions, possible solutions were presented. The quality circles served as a support system for the interviewers, as well as a mechanism for on-the-job training.

4. CASE MANAGEMENT

Case management is an important component of any CATI system which can influence greatly the performance of an interviewing operation. It generally has several major functions: (a) specifying data input and data output, (b) scheduling calls and callbacks, (c) supplying cases to interviewers in a controlled fashion, (d) assessing the appropriate next action for a case at the end of each call, (e) maintaining status information and processing history for

each case, and (6) producing periodic progress reports.

The Census CATI System included a general case management system adaptable to the needs of different studies but which had been tested in only one prior survey. Field work design required both providing specifications and parameters to this system, and in some instances, adding new capabilities to the system.

Among the advance specifications required were: (a) case input variables, including information to be shown to the interviewers about each case prior to calling; (b) hours of interviewing facility operation and times for which appointment callbacks could be made; (c) the criteria for a completed interview so that the system would know when calling to a case would stop; (d) a variety of parameters including the maximum number of calls per case allowed (20), the number of calls without respondent contact per case allowed (15), and the number of refusals allowed per case (2); and (e) a series of rules specifying the next action based on a call's outcome, the above parameters, and other criteria. Most of these calling rules were variations of rules preexisting from the prior survey. The system then ensured that these rules were enforced.

One important addition to the case management system required for the agriculture census was a method of accommodating state-by-state closeouts. Stop dates were added to the case management system which would: (a) be set by state by actions of the field supervisors, (b) be displayed on the interviewer's screen as a reminder, (c) be used to modify appeals for participation by the proximity to closeout, and (d) determine when calling to a state had to cease and its output generated.

The scheduling of calls and callbacks was performed by the system. Highest priority went to appointments and other callbacks based on information received in a previous household contact. Cases which had not yet reached a household were selected for calling based on a variety of factors, including the proximity to the state closeout, relative frequency of failed prior calls in various timeslots, and the number of elapsed days since the last call to that case. Cases which reached nonworking or incorrect numbers were routed automatically to Directory Assistance calls.

The case management system also provided periodic status reports in both on-line summaries and printed format. These reports were aggregated in various categories depending on the need of the user. In addition, permanent data files containing portions of the case management data were provided for use in evaluation and analysis.

5. OPERATIONAL DIFFICULTIES

Most of the operational difficulties were related to transmitting data to and from the CATI system. The data file formats were not immediately compatible between the CATI computer and the Census Bureau mainframe. This necessitated a special programming effort for conversion routines and reformatting. It is anticipated that this problem will be resolved in the future.

Another difficulty was in maintaining an

adequate flow of cases to the CATI interviewers. At times when the close-out date for a state (or group of states) was approaching, the call scheduler had an inadequate number of cases to make efficient use of the call scheduling algorithm. This was because the next group of states to be processed was not always available to be entered into the call scheduler, which left only a few cases in the scheduler that may have had specific times to be called. There were few, if any, cases left that could be called at any time, which led to some interviewers not having cases to call. This problem could have been alleviated had the transmission of the next group of states scheduled to be interviewed been planned better.

The state close-out dates also presented other problems. Because the CATI system had to transfer the data back to the processing site in Jeffersonville, the closeout dates for CATI were about three days earlier than the Jeffersonville closeout. Some cases had not reached the call cutoffs and therefore were unresolved at the time of transmission. Jeffersonville tried to resolve these cases through the secondary source program (contacting sources other than farmers, such as a county extension agent) before the actual closeout. This practice may have adversely affected CATI response rates.

Other difficulties were occasioned by having a separate CATI sample at a different site from where the main processing was located. Special procedures were necessary to handle the transmissions of data between the two locations. A clerical review was performed in Jeffersonville on all interviews that failed the computer edit, but clerks utilized a printed protocol (listing of responses) for the CATI cases rather than the questionnaire as used for the non-CATI cases. Special training was necessary for the clerks who reviewed the protocols. Legal requirements made it necessary to keep the printed protocols in addition to the CATI computer tapes. The protocols were not the same size as the regular questionnaires, causing inconvenience in the storage areas.

6. PRELIMINARY RESULTS AND PLANNED ANALYSIS

At this time, only limited results are available. Very few results that pertain to the comparison sample have been tabulated. For these reasons, no attempt will be made here to evaluate the CATI results or the quality of the CATI-generated data. Certainly, it is important to determine the comparability of the CATI and Jeffersonville results, especially in the areas of response rates, data quality, and costs. However, several factors which cannot be isolated may confound the comparisons. The CATI interviewers had more opportunities to practice interviewing during their training on the terminals. Also, the effects of two different interviewing management philosophies may have had an impact on the results.

In order to compare the costs of the two data collection methods, some workload and budget

reports have been reviewed. At this time, only three major components have been identified--clerical hours, supervisory hours, and training hours. Clerical hours include interviewing, records control, general review of completed questionnaires, data entry, and quality control activities for the non-CATI operation. Since CATI combines all of those steps into the interviewing phase, the CATI clerical hours represent the interviewing hours. CATI spent an average of .480 clerical hours per assigned case, while Jeffersonville spent an average of .719 clerical hours per assigned case. Note that these averages do not include any computer programming time or preparation of procedures. Similarly, CATI spent an average of .161 hours per assigned case for supervisory activities, while Jeffersonville spent an average of .069 hours per assigned case. It should be noted that the employee-to-supervisor ratio was approximately 5 to 1 for CATI and considerably higher for Jeffersonville (approximately 12 to 1). The planned training hours per employee were 60 hours for CATI and 30 hours for Jeffersonville. Further cost data are required before any meaningful comparisons can be made.

Table 1 below displays the distribution of CATI sample cases by the final interviewing disposition or outcome. The category "Respondent claims already filed by mail" may contain cases that were returned by mail and therefore should be reclassified as "Ineligible;" the remaining cases will be classified as refusals. In addition, the categories "Other Noninterview," "Unlocatable," and "No Contact Made" may have the same problem. This is currently being researched by examining auxiliary records.

Table 2 presents various response rates. Three similar rates are available from the entire telephone operation at Jeffersonville, which includes the comparison sample. The Jeffersonville response rate is 40.1 percent, the claims filed rate is 17.1 percent, and the claims filed as a percentage of all noninterviews is 28.5 percent. It is not known, however, if the denominator for these rates includes some ineligible (mail-returned) cases. With the ineligible cases included, the CATI response rate is 50.9 percent, the claims filed rate is 8.4 percent, and the claims filed as a percentage of all noninterviews is 17.1 percent. Table 2 gives the corresponding rates excluding the ineligible cases. It is not possible to calculate the other rates with the available data. The results that can be compiled from just the comparison sample will ensure that the definitions of final resolutions remain constant, allowing tests for significant differences to be made.

Table 3 presents the average number of calls and average total length per case for the various final resolution categories. The large standard deviations will make comparisons to the non-CATI sample less precise. One factor that did influence these results was the state close-out deadlines. The deadlines limited the number of calls that could be made in some instances.

Table 1

Distribution of Final Resolution

Type of Resolution	Number	Percent of All Cases	Percent of Eligible Cases
(A) Complete Interview (farms and nonfarms)	4,160	48.9	54.0
(B) Partial Interview	174	2.0	2.3
(C) Refusal	337	4.0	4.4
(D) Respondent Claims Already Filed by Mail*	715	8.4	9.3
(E) Other Noninterview	1,095	12.9	14.2
(F) Unlocatable (no telephone number)	1,142	13.4	14.9
(G) No Contact Made	67	0.8	0.9
(H) Ineligible (returned by mail)	822	9.6	0.0
Total	8,512	100.0	100.0

Table 2

Response Rates

Type	Rate	Formula**
Response Rate	56.4	$\frac{A+B}{A+B+C+D+E+F+G}$
Refusal Rate	4.4	$\frac{C}{A+B+C+D+E+F+G}$
Respondent Claims Already Filed* Rate	9.3	$\frac{D}{A+B+C+D+E+F+G}$
Noncontact Rate	15.7	$\frac{F+G}{A+B+C+D+E+F+G}$
Partials as a Percentage of Completes	4.0	$\frac{B}{A+B}$
Completes and Partials as a Percentage of Contacts	66.9	$\frac{A+B}{A+B+C+D+E}$
Refusals as a Percentage of Noninterviews	10.0	$\frac{C}{C+D+E+F+G}$
Respondent Claims Filed as a Percentage of Noninterviews*	21.3	$\frac{D}{C+D+E+F+G}$
Refusals as a Percentage of Contacts	5.2	$\frac{C}{A+B+C+D+E}$
Respondent Claims Filed as a Percentage of Contacts*	11.0	$\frac{D}{A+B+C+D+E}$

* These cases have not been verified as mail returns. They eventually will be reclassified as either ineligible or refusals.

** The terms in the formulae correspond to the categories in Table 1.

Table 3

Average Number of Calls and Total Time Per Case to Reach a Final Resolution

Type of Resolution	Number of Calls		Total Time (in minutes)	
	Mean	Standard Deviation	Mean	Standard Deviation
Complete interview--farm	4.56	3.67	36.0	18.9
Complete interview--nonfarm	3.81	3.35	10.8	8.0
Partial interview	6.93	4.86	30.8	15.6
Refusal	6.73	3.85	17.1	10.5
Respondent claims filed	4.75	4.19	12.5	10.7
Unlocatable	2.03	1.74	3.2	2.8
No contact	3.12	1.73	4.1	2.6
Other noninterview	9.15	5.79	18.3	12.0
All types	4.95	4.41	23.7	19.7

Future analysis plans include computing edit error rates and item nonresponse rates in order to provide some indication of data quality. Comparisons of current data (1982) to historical data (1978) also may give an indication of data quality. Cost data, which will have an impact on the specification of a cost model, are currently being compiled and reviewed. It is anticipated that the final evaluation can be completed by early 1985. The results that are presented in this paper are preliminary and therefore subject to change.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Eileen Gray who typed this paper, to Nick Alberti who agreed to present the paper, and to our many reviewers whose comments have been most helpful.

NOTES AND REFERENCES

[1] Fink, James C. (1983) "CATI's First Decade: The Chilton Experience," pp. 153-168 in Sociological Methods and Research, Volume 12, Number 2, November 1983.

[2] Nicholls, William L. (1983) "CATI Research and Development at the Census Bureau," pp. 191-197 in Sociological Methods and Research, Volume 12, Number 2, November 1983.

[3] Related papers presented at the 1984 Annual Meeting of the American Statistical Association, Section on Survey Research Methods.

Dea, Jane Y., Tommy W. Gauden, D. Dean Prochaska: "Record Linkage for the 1982 Census of Agriculture Mail List Development Using Multiple Sources."

Davie, William C., Emily Lorenzen, D. Dean Prochaska: "Coverage Evaluation for the 1982 Census of Agriculture."

Ruggles, Donna R., Jane Y. Dea, Flora K. Kwok, Cindy A. Carman: "Evaluation of the Effectiveness of Data Collection Procedures for the 1982 Census of Agriculture."

Clark, Cynthia Z.F.: "Comparability of Data From the Census of Agriculture."

[4] Source indicates whether the farm was enumerated in 1978 or not.

[5] Mailed size is an indication of the size of the farm based on expected value of sales determined prior to the mailout.

[6] Operations are either classified as crop or livestock.