Case Management and Communications for Computer Assisted Personal Interviewing

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Abstract: This paper presents a brief history, current assessment, and occasional future vision of CAPI case management and communications as employed in national, household surveys. It is based both on the authors' experience at the U.S. Census Bureau and on reports from the broader CAPI community. While traditional methods of transmitting survey materials continue in use, telecommunications are increasingly relied on for transmission of CAPI interviewing assignments, survey data, dispositions, and questionnaire changes. This trend is encouraged by technical solutions to issues in the confidentiality, data integrity, computer security, and cost effectiveness of telecommunications. The evolution of CAPI case management systems at both the interviewer and the central office levels also is progressing rapidly as these systems increase in functionality and sophistication. These advances may significantly change both the operation and future capabilities of household interview surveys.

Key words: Computer assisted interviewing; CAPI; data communications; case management; household interview surveys.

1. Introduction

This paper begins with a brief review of the institutional development of CAPI case management and communications for national household surveys. It is then divided into three main sections. The first describes communications and transmissions between survey offices and individual CAPI field interviewers. The second section examines local case management and backup systems at the interviewer level.

The third section considers survey office case management at organization headquarters and at other supervisory, processing, and supporting offices. The final section offers some observations on the pace of change in the technology of personal interviewing.

Computer assisted personal interviewing (CAPI) is a newly developing field. The Netherlands Central Bureau of Statistics (Van Bastelaer, Kerssemakers, and Sikkel 1988), together with Statistics Sweden (Lyberg and Dean 1989; and Blom, Blom, Carlson, Henriksson, Mårstad, and Pettersson 1989), have led European development, testing, and implementation of CAPI. The first national household survey to use CAPI for all of its data collection,

the Netherlands Labor Force Survey, began interviewing in January 1987. Adoption of CAPI by the U.K. Office of Population Censuses and Surveys (Manners 1990; and Blackshaw, Trembath, and Birnie 1990), and CAPI planning by INSEE in France (Bernard 1990) has been based on the methods and software developed by the Netherlands Central Bureau of Statistics (CBS).

In the U.S., the first national household survey to use CAPI for at least part of its data collection was the 1987 Nationwide Food Consumption Survey, conducted by National Analysts (Rothschild and Wilson 1988). Concurrent development work by the Research Triangle Institute (RTI) (Sebestik, Zelon, DeWitt, O'Reilly, and McGowan 1988) was followed by major tests of CAPI activities by the National Opinion Research Center (Bradburn, Frankel, Hunt, Ingels, Wojcik, Schoua-Glusberg, and Pergamit 1991; Speizer and Dougherty 1991) and by Westat (Sperry, Bittner, and Branden 1991). The Census Bureau (Nicholls 1988) has undertaken several tests of CAPI and has planned CAPI applications with the National Center for Health Statistics (Thornberry, Rowe, and Biggar 1990) and the Bureau of Labor Statistics. Details of the Census Bureau's plans have been presented in a separate paper by Kindel (1991).

Despite the newness of the field and the geographic dispersion of development, progress in CAPI case management and communications has been remarkably well coordinated through presentations at professional meetings, exchanges of working documents, and informal conversations. Progress has been cumulative, and a shared sense of the state of the art has begun to emerge.

2. Transmissions and Communications

Face-to-face household interview surveys require a substantial flow of information between the geographically dispersed interviewing staff and the survey organization's central offices. When paper-and-pencil methods are used, training materials, interviewing assignments, and blank interview forms typically are mailed to the interviewers or distributed during group training sessions. Completed interview forms, reports on the disposition of uncompleted cases, and related information are mailed back. Unpredictable communications, such as last minute questionnaire corrections, case reassignments, and the reporting and resolving of field problems, typically are handled by special mailings and voice telephone.

Computer assisted personal interviewing (CAPI) changes both *what* is sent to and from the field and *how* it is transmitted. The two-way flow of paper documents is replaced by an initial shipment of computing hardware and software followed in most cases by a two-way flow of computer data and messages. The traditional methods of providing interviewers with necessary information and materials remain available, including: distribution during group training sessions; mail or delivery service; and voice telephone. But with CAPI new options also become available, such as: the mailing of diskettes rather than documents; telecommunication via modems; and (possibly in the future) radio data networks.

2.1. Hardware, software, systems, and questionnaires

To begin, each interviewer must be equipped with a portable microcomputer, general software to run CAPI applications, and a CAPI instrument, or questionnaire program, for a given survey. These general hardware and software components, which have no exact counterparts in paper-and-

pencil (PAPI) surveys, typically have been distributed during interviewer group training sessions or by parcel delivery to the interviewers' homes shortly before group training. Hardware failures are uncommon but since they are most likely to occur during the first few hours of use, diagnosis and replacement are easiest during group training.

2.2. Assignments, survey data, and dispositions

Once CAPI interviewers are equipped with the basic hardware, general CAPI software, and questionnaire, the major information flow consists of sending interviewing assignments to the field and completed interview data and case disposition reports back to central offices. Increasingly sophisticated and automated methods have been developed for these transmissions.

Early CAPI systems often wrote completed interview data to diskettes rather than to hard disks as is more common today. The mailing of diskettes therefore replaced the familiar mailing of paper forms back to central offices (Rothschild and Wilson 1988; Thornberry, Rowe, and Biggar 1990; and Hofman and Keller 1991). Overnight delivery services provided faster delivery at higher cost.

Although these procedures transmitted data to central offices in machine-readable form, the mailing of diskettes also had serious drawbacks. These included: (1) the costs of buying and recycling the diskettes; (2) problems of diskette handling, including occasional breakage or failure; (3) interviewer confusion of data, system, and backup diskettes with occasional overwriting of important files; (4) the delays of mailing or the costs and inconvenience of delivery services; and especially (5) the difficulties of checking in, merging, and unduplicating data files from multiple diskettes

in central offices (Hofman and Keller 1991; Nicholls 1989; and Speizer and Dougherty 1991).

As experience with telecommunication of CAPI data increased, first in Europe and then in the United States, telephone transmissions via modems have become the preferred method of transmitting completed interview data back to central offices. A CAPI microcomputer is plugged into a modem (or has its own internal modem) which is plugged into a telephone jack, usually in the interviewer's home. The interviewer may initiate the session or the microcomputer may wake up at a pre-specified time to begin automatic transmission without the interviewer's intervention.

The Dutch, British and Swedish labor force surveys all use telecommunications to send completed interview data *back to central offices* as did a major test of the French labor force survey (Hofman and Keller 1991; Manners 1990; Blom et al. 1989; and Bernard 1990). In the U.S., the Research Triangle Institute (Sebestik et al. 1988) pioneered the use of telecommunications for these and related purposes while NORC greatly enhanced these methods for the 1990 National Longitudinal Survey Youth Panel (or NLS). Based on the NLS experiences, Speizer and Dougherty (1991) concluded that telecommunications provide faster, more reliable, and less expensive means of transmitting CAPI data to central offices than do mailed diskettes. In the NLS, telecommunications also proved cost competitive with the mailing of paper forms while greatly shortening delivery time.

To avoid possible data loss during its initial use of telecommunications, the NLS also copied each interview's completed data to a diskette to be mailed to the central office and also preserved an additional copy on the laptop's hard disk until the end of the

survey. Since the NLS telecommunications proceeded without data loss, a reduction in the number of duplicate backup files is planned for the future.

The Census Bureau plans to write a copy of each interview's data to a protected area of the laptop's hard disk as it is transmitted. This process will be fully automatic and invisible to the interviewer. That file will then be unprotected and erased after a signal is received, usually on the following day, that the central office has received the file and confirmed its integrity and completeness.

The use of telecommunications to send interviewing assignments *to the field* has developed more slowly. Surveys which use both CAPI and paper forms in the same interview typically have used paper for making the assignments and had the interviewer key enter the case ID and other case information from the paper document at the start of each CAPI interview (Rothschild and Wilson 1988; and Thornberry, Rowe, and Biggar 1990). The Dutch and British labor force surveys, although eliminating paper questionnaires entirely, initially sent interviewing assignments to the field staff on paper or diskettes. However, early work by the Research Triangle Institute (Sebestik et al. 1988), more recent tests by NORC, the Netherlands's CBS, the Census Bureau, and Westat (Speizer and Dougherty 1991; Kindel 1991; and Sperry et al. 1991), all confirm the viability of sending interviewing assignments to the interviewers via telecommunications.

While interviewing assignments often consist of no more than a list of addresses to be interviewed, they may include extensive data on assigned cases from prior interviews or other records. Two-way telecommunications of interview data are especially attractive to panel surveys with closely spaced waves since they may make possible (or speed) incorporation of each wave's data in the next. They also expedite the transfer of cases between modes when the same survey employs both CAPI and CATI data collection.

The current status or disposition of each assigned case also may be sent to central offices via telecommunications: (a) to permit traceability of each case at any time; and (b) to provide concurrent field progress reports for survey supervisors and managers. Disposition reporting, however, is not necessarily incorporated in automated interviewer telecommunications at present. The NORC NLS interviewers, for example, reported dispositions (and costs) to their local supervisors by voice telephone and the supervisors then key entered these data in a separate Field Management System linking supervisors and headquarters (Speizer and Dougherty 1991).

The first fully automated telecommunications system for field disposition reporting was designed for the 1989 pilot study of the National Household Seroprevalence Survey (NHSS) (O'Reilly, Weeks, Deloach, DeWitt, and Batts 1989). Although the NHSS used paper questionnaires rather than CAPI, the sensitive and complex nature of the field work, the need to ensure that in-home collected blood specimens reached central labs within 72 hours after being drawn, and the sponsor's request for daily reports on field work progress required unusually prompt, accurate, and thorough field reporting. The Research Triangle Institute equipped each NHSS interviewer and supervisor with a laptop microcomputer with an internal modem. Every evening, each interviewer entered information about each assigned case, prepared electronic mail messages for her/his supervisor and the central office as necessary, and connected the laptop to a telephone line before midnight.

Automatic transmissions occurred at preset times during the night, first between the interviewers and the central host and then between the host and the supervisors who received copies of reports and mail messages from those they supervised. New messages from supervisors to interviewers were delivered the next night. The central project's control system data base was updated with each transmission, ready for preparation of progress reports to survey managers the next morning. The incorporation of similar disposition reporting methods in CAPI case management and communications is currently being developed by the Census Bureau, the Netherlands CBS, and Westat and is being explored for NORC (Kindel 1991; Hofman and Keller 1991; and Sperry et al. 1991).

2.3. Other information transmitted

Two-way electronic mail, as used in the NHSS pilot study, is a high priority option for virtually all CAPI systems. Work is in progress to incorporate other unpredictable transmissions within the same system, such as: late corrections to the questionnaire; and reassignment of cases from one interviewer to another. These applications have been explored and tested by the Research Triangle Institute and the National Opinion Research Center and also are being examined by the Census Bureau and Westat (Sebestik et al. 1988; Speizer and Dougherty 1990; and Kindel 1991). Once established, the telecommunications system can be used, at least in principle, for a variety of other functions ranging from segment listing for field sampling to reporting of payroll hours, mileage, and travel expenses.

2.4. Confidentiality, security, and data integrity

The growth of CAPI telecommunication has been facilitated by increasingly standardized technical solutions to potential problems in respondent confidentiality, computer security, and interrupted transmissions.

Since CAPI data files contain only the answers to survey questions, not the questions themselves, they would seem to offer inherently better protection of respondent confidentiality than paper forms. Further protection is provided by encryption and compression of all files during transmission and by password access to CAPI equipment. In addition, most transmissions are accomplished by putting data into separate packets, further confounding the data on line. These procedures probably provide better protection of respondent confidentiality than mailed forms.

At Statistics Sweden (Blom et al. 1989) a variety of additional steps have been examined to ensure respondent confidentiality, such as separating names, addresses, and similar identifying information from survey answer files prior to their transmission. They are recombined at headquarters. To protect identifiable data while the interviewer is in the field, some systems also store survey data and even survey questions in compressed and encrypted form on the CAPI interviewers' laptops should they fall into unauthorized hands.

The security of central computer systems from unauthorized or inappropriate dial-in access is an equally important concern. These problems are usually addressed by restricted password access, by sending data transmissions to stand-alone systems, and by security scanning or filtering these data before they are copied to the central system for processing and analysis. No direct connection is established between the remote CAPI microcomputers and the central computers.

Telephone transmissions can be disrupted

by noise on the telephone line or by call waiting signals. Speizer and Dougherty (1991) report a transmission failure rate of roughly 10% in the National Longitudinal Survey. Fortunately, commercially available packages can detect interrupted transmissions, retry failed transmissions immediately without user intervention, and defer files which continue to fail for a later session. This process is becoming increasingly efficient. Early protocols required resending entire files if the transmission failed at any point. Newer protocols resume the transmission where it was interrupted and link the sections automatically.

2.5. Cost effectiveness of telecommunications

Telecommunications have often been viewed as cost effective for small files, but not necessarily for large ones. The Netherlands's CBS, for example, currently employs telecommunications primarily for small, interviewer-dependent files which are frequently transmitted. They continue to use mailed diskettes for large, interviewer-independent files which are transmitted infrequently, such as new questionnaire versions (Hofman and Keller 1991).

Improvements in the efficiency of telecommunications, however, can modify these guidelines. For example, the U.S. Current Population Survey typically includes a supplement on topics which change from month to month. The most complex is the March supplement which triples the length of the CPS. To transmit the 1.3 megabyte questionnaire program and various supplementary records with current equipment via a 2400 baud modem requires about 50 minutes of transmission time per interviewer. But with 14400 baud modems, which the Census Bureau has acquired for the future, transmission of the same files is

estimated at approximately 7 to 8 minutes at a cost of under one U.S. dollar in line charges. This is cost competitive with mailing diskettes or paper forms.

The Census Bureau, NORC, and the Netherlands's CBS have all compared the costs of public electronic mail (e-mail) systems with dial-in connections to their own organization's gateway PCs and servers. All three found the public "store and forward" e-mail systems more costly. Speizer and Dougherty (1991) estimated the cost of sending a 30,000 byte file by public e-mail at roughly two to three times the cost of a dial-in system to NORC's own equipment.

The efficiency of dial-in operations will partly depend on the cost of the central equipment required. The number of receiving ports required is a function of the anticipated peak load which can be reduced by higher transmission speeds and by spreading that load over time. The Census Bureau plans to assign each interviewer a standard transmission time during the night and early morning hours. Interviewers need not be present when the transmission occurs. As in the RTI NHSS, they merely connect their CAPI microcomputers to a modem and a telephone jack, and the call and transmission will take place automatically during the night. Provision has also been made for the occasional emergency transmission initiated directly by the interviewers.

2.6. Future visions

The development of CAPI communications has focussed to date on immediate production needs, containing costs, and improving timeliness. Their full effect on survey design remains to be seen. Three possible visions of this future may be shared, although none is likely within the next few years.

The first is the possibility of rapid response national personal interview surveys, consisting of face-to-face surveys mounted in a few days. Computer assisted *telephone* interviewing (CATI) helped make rapid response telephone surveys possible. CAPI telecommunications may make rapid response personal interviews possible. The main obstacles may be in advance preparation of samples, slowness in authoring CAPI questionnaires, and arranging approvals of governing agencies, such as the Office of Management and Budget in the U.S.

The second vision of the future is to bring field interviewers back into the questionnaire pretesting loop. Early CAPI studies generally had sufficient trouble mounting their questionnaires on microcomputers that little time was left for field pretesting. The primary interaction was between content experts and CAPI instrument authors. Growing experience in CAPI questionnaire design and rapid, cost effective communications between interviewers and central offices may again permit pretesting of early versions of CAPI questionnaires. The speed with which CAPI authoring systems can revise or patch CAPI instruments, rather than the logistics of installing new versions in interviewers' laptops, may again become the limiting factor in the preparation of new questionnaire versions.

The third future vision is the replacement of telecommunications by wireless radio data networks. One such network was formed in 1991 by IBM and Motorola and licensed by the U.S. Federal Communications Commission. It reportedly has 300 sending/receiving stations and will permit one-way or interactive transmissions from almost any indoor or outdoor urban location 24-hours a day without the need for a modem or telephone jack. Software control may permit seamless movement from data collection to data transmission; and transmission may be interviewer initiated or automatically scheduled. Other competitive networks are becoming available. It is too soon to tell whether this new technology will live up to its promise, prove cost effective, and provide sufficient protection of respondent confidentiality.

3. Interviewer Case Management

The literature has much less to say about CAPI case management than about CAPI interviewing and communications. We do know that survey organizations have designed their case management systems with initially different objectives or emphases. The NORC NLS case management system (Speizer and Dougherty 1991) placed a very high priority on protection of completed interview data and on managing a field comparison of CAPI and PAPI methods. The case management system of the U.K. Labour Force Survey (Manners 1991) emphasized display of the previous wave's responses in the current wave and the coding of occupations and industries of employment by the field interviewers. The Netherlands's CBS (Hofman and Keller 1991) designed their case management system from the start for concurrent use with multiple surveys, while the Census Bureau's CAPI case management system has focussed heavily on use in multi-mode (CATI-CAPI) designs and on the inclusion of supervisory and administrative functions in the same system. In this paper, we will emphasize Census Bureau plans and developments as those we know best.

Case management for CAPI has two main parts: (a) managing survey cases and related records on the individual CAPI microcomputers; and (b) managing survey cases and related records at headquarters

and at any other organizational offices involved in the design, supervision, and administration of survey data collection and processing. For brevity, we will call these the "interviewer" (or "local") case management system and the "office" case management system, respectively.

Personal interview surveys which used paper-and-pencil methods were never thought of as having "interviewer case management systems." What they had were various forms, lists, maps, and clerical procedures (often summarized in interviewing manuals) designed to accomplish all the tasks a field interviewer must perform. These might include: updating or drawing maps of sample areas; locating sampled housing units or sampled persons; deciding which sample units to visit first; recording these visits and their outcomes; listing household members and their characteristics; transcribing information from one form to another; editing completed interview forms for legibility and completeness; preparing time sheets of hours worked and travel vouchers for costs incurred; and mailing various forms to headquarters, a regional office, or their local supervisor. In time, CAPI interviewer case management may automate, or at least accommodate, all or most of these functions. However, it has focussed on those functions most central to completion and transmission of CAPI interview data while continuing to rely on clerical methods for more peripheral functions.

3.1.   Core local case management functions

There are eight core functions local case management systems generally perform on the individual interviewer's CAPI microcomputer for household surveys:

1. **Accept and store** interviewing **assignments.**

2. **Display** a list of these **assignments** for the interviewer.
3. **Select a case** to interview.
4. **Store the interview data** and retrieve it when necessary for partial interviews.
5. **Record the status** or disposition **of each case,** such as complete, partial, appointment, or untried.
6. **Initiate telecommunications** or prepare a diskette for mailing.
7. **Perform** various **system functions,** such as logging in, setting and using passwords, and maintenance of core files.
8. **Provide** unidirectional or bi-directional **e-mail communications** between interviewers and supervisors.

These are "core" functions both because they are central to what a CAPI interviewer must do and also because this is the current state of the art. Few interviewer case management systems for CAPI presently do more than this, and some lack some of these capabilities.

3.2.   Directions of development

Local case management is only at its first stage of development. More elaborate systems are being planned with four common directions of development.

The first is *core function enhancement*. A simple list of assigned sample addresses may be insufficient in many cases. Interviewers may require options to update, edit, append, sort, search, prioritize, and annotate the list. In panel surveys, interviewers also may want to "preview" the household composition or review notes from the previous interviewer before calling at the address. Additional enhancements could include: automatic preparation of a displayable record of calls at each assigned household; routines to prepare and send hardware or software trouble reports; and more elaborate e-mail options.

A second direction of development is *fuller automation of both core and enhanced functions*. Sending completed interview data to headquarters has sometimes been designed as a multi-step operation of identifying the cases to send, copying them to a new format, dialing the central office, starting the transmission, etc. Better design as used in the NLS (Speizer and Dougherty 1991) makes this a one-touch operation with the computer performing all these steps automatically. The system identifies the appropriate files, prepares them for transmission, and completes the call to the central office automatically. Advanced systems will provide confirmation not only of successful transmission but also for receipt of a complete data set.

The third – and probably most significant – direction of development is *managing multiple surveys at the same time*. Only one of the interviewer case management systems thus far described in the literature, the Netherlands's CBS "*Laptop Information system for Personal Surveys*" (LIPS), will accommodate multiple surveys concurrently (Hofman and Keller 1991). A separate diskette is inserted for each survey, containing its questionnaire, while the data for all surveys are stored in common to facilitate transmission to headquarters. The LIPS system was installed in CBS laptops in April 1991. The Census Bureau is planning a data management and communication system for use with multiple surveys by early 1993 or 1994. Unlike LIPS, it will store all survey-specific files and questionnaires on a common hard disk.

The fourth and final direction of development in interviewer case management is *adding functions beyond basic interviewing*. For example, when interviewers in the U.K. Labour Force Survey return home, they convert respondent occupation and industry descriptions to I&O codes before

the data are transmitted to central offices (Manners 1990). For the Census Bureau, top priority additional functions are training, reinterviewing, reporting hours for payrolls, and data used in management information systems (MIS). In time, support also may be provided for other tasks interviewers frequently perform, such as updating maps of sampled areas, listing housing units in sampled blocks, and abstracting records at government offices.

3.3. Interviewer needs and the context of usage

One of the most neglected considerations in the design of interviewer case management systems has been the preferences and perceived needs of the interviewers themselves. In the rush to meet essential requirements for survey production, headquarters staff typically have made their best guesses of what would be suitable for and acceptable to the interviewers. None of the papers in this field have yet mentioned interviewer contributions as a significant component of the design of CAPI case management systems nor described interviewer reactions to the methods provided them. As laptop case management continues to develop and to present the interviewers with increasingly complex tasks to perform, we hope that interviewer input will become increasingly important in designing more convenient and efficient means of completing the CAPI interviewers' work. The Census Bureau is currently collecting data from interviewers and supervisors in both formal and informal settings to help evaluate its CAPI communications and case management system and plan further development. The results of this research program are to be separately reported at a later time.

A related general consideration in design

of interviewer case management systems is the social and physical context in which that system is used. A system designed for laptop or tabletop interviews inside a sample housing unit may not be equally appropriate for doorstep or screening interviews. When the contact with a household is brief and tenuous, it may be more important for the computer to display the first question as soon as a household member answers the door. The nature of real or perceived threats CAPI presents to interviewer safety also could influence the design of CAPI case management. If interviewers are reluctant to be seen using their CAPI computers while parked in their cars or on the streets of sample neighborhoods, routines to help them review and select households to interview just prior to knocking on the doors of households may be of dubious value. Emphasis might be placed instead on preparatory review in the interviewer's home and rapid access of needed cases once inside the respondents' homes.

3.4. Backup systems

Since computing hardware and software occasionally fail, the designers of large CAPI surveys prudently devote substantial attention to backup systems and procedures. Persons trained in traditional survey methods often first think of paper forms as the obvious backup medium; but paper backup systems have many disadvantages. Paper forms cannot duplicate many of the new features, such as dependent interviewing and complex branching, increasingly used in CAPI surveys. Training CAPI interviewers in paper methods also is wasteful when most will never use paper forms or use them only long after that training was received.

Paper backup forms also may encourage some interviewers to revert to paper-and-

pencil interviewing and use their CAPI microcomputers only as home key entry stations. Such patterns, which occurred in early uses of CAPI in the NHIS (Thornberry, Rowe and Biggar 1990), circumvent the advantages of computer assisted interviewing while adding costs through the interviewer double entry of answers on paper and then by keyboard. For these and other reasons, most survey organizations using CAPI have eliminated paper backup as an option.

The alternative is to build replacement methods and redundant procedures into the new technology. Laptop or other CAPI hardware failures are rare and best solved by replacement from ready reserves by overnight delivery services. Faulty software is corrected by new self-installing programs distributed on diskettes or by telecommunications. Copies of interviewing assignments can be re-sent from central offices. Frequent (e.g., daily) transmission of completed interview data to central offices (where files are easily copied) probably affords better protection from loss than batch mailing of paper forms. Interviewers also may be instructed to make and retain copies of data files for each day's interviewing on removable disks (Speizer and Dougherty 1991). The Census Bureau's system performs automatic backups to a hard disk.

The success of these backup procedures will partly depend on rapid detection and diagnosis of hardware and software problems as they occur. An accessible and responsive technical staff, perhaps reached via a toll-free number, seems essential, especially during the first week or two of a new CAPI survey. Thereafter, demand typically drops off. Inclusion of electronic mail and trouble reporting systems in interviewer case management systems may become key elements of backup procedures. Technical

advice may be superseded when necessary by direct intervention using software packages that permit headquarters support programmers to operate CAPI microcomputers remotely to diagnose and correct problems.

4. Office Case Management

Office case management facilitates operations at survey headquarters (and at regional or other specialized offices) to manage, supervise, and support CAPI data collection in the field. It begins with the need to assign CAPI cases to interviewers, to obtain reports of their costs and progress, to redirect cases and resources as needed to complete the work, and to coordinate the retrieval of case records and data by the survey's end. Its functions may expand to include a variety of supplementary sampling, supervisory, management, and accounting purposes. To accomplish these purposes, data bases are constructed and programs are written to control, monitor, and summarize information flowing to and from the field interviewers, among relevant members of the office staff, and to the survey managers.

The literature provides relatively little information on office CAPI case management systems at organizations currently utilizing or building CAPI capabilities. One exception is the reported success of the NORC CAPI office case management system in providing: (a) timely cost and production information for program managers; (b) rapid identification of problem cases or problem areas for field directors; and (c) constructive feedback to interviewers and their supervisors (Speizer and Dougherty 1991).

4.1. Opportunities and challenges

The development of a CAPI case manage-

ment system provides many opportunities to automate, enhance, and streamline survey office functions beyond the exchange of information between office and interviewers. Managers and supervisors may identify problems and track costs more rapidly, interviewer performance reports can be generated more quickly, payroll and travel reimbursement processes can be expedited, while labor intensive clerical activities are eliminated. Automation of both office and interviewer activities also may permit new and more effective ways of performing key survey tasks that were previously hindered by paper-and-pencil technology.

As an example, the U.S. Current Population Survey employs a rotating panel sample consisting of four main components: (1) specific housing units selected from the last census; (2) specific group quarters and other special places selected from the last census; (3) newly constructed units drawn from building permits in permit issuing areas; and (4) an area frame listing of housing units, group quarters, and other special places on blocks sampled from the last census. One-eighth of the cases are rotated in (and out) of the sample each month. Similar samples are employed for other Census Bureau surveys, such as the National Crime Survey.

Paper and pencil methods leave insufficient time to route locally collected information on new addresses back to headquarters for review, consolidation, and sampling. Hence, coordination of these sampling activities has been delegated to staff located in the Census Bureau's 12 regional offices utilizing paper records and following general procedures established by headquarters statisticians.

Automation of both field collection and office activities should improve data quality by editing address list and permit data as they are entered and by building routine

sampling procedures directly into the collection system. With a central sampling data base, all sampling components can be updated and combined more rapidly, and a monthly, national, master list prepared of all sampled housing units in each household survey. This should reduce the accidental selection of the same housing units for more than one survey and allow headquarters to participate more actively in the ongoing sample.

At the same time, the design of an office CAPI case management system may present greater organizational challenges than the design of an interviewer case management system. Interviewers are typically part-time or intermittent employees, dispersed across large geographic areas, who often are hired for their flexibility and ability to complete their work under new procedures. By contrast a survey office is typically staffed by full-time employees and usually organized into a variety of specialized positions and suboffices, each with its own tasks, responsibilities, and accustomed flows of work and information.

Automation of these activities as part of a CAPI office case management system may be seen as a threat to survey office staffs because new systems may eliminate traditional clerical functions, require new skills, rearrange current allocations of duties and responsibilities, and provide managers with more detailed information on performance, cost, and progress than was previously available. The system developer must tread a careful path between the sometimes divergent goals of: (1) building a system that optimizes office efficiency by changing the way the work is done; and (2) being responsive to the needs and preferences of office staff currently performing these tasks with traditional methods. The organizational sensitivity of office CAPI case management suggests that the nature

and range of functions successfully encompassed within it probably will vary more across organizations than the functions included in interviewer CAPI case management.

4.2. Census Bureau CAPI office case management

At the Census Bureau, office case management is viewed as encompassing six primary systems:

1. The **questionnaire system** which contains and controls the core questionnaire, updated versions, questionnaire supplements, and associated training materials.
2. The **sample control system** which contains and controls the sample addresses, segments, and/or other units for which information is to be collected.
3. The **check-in, assignment, and status system** which controls the overall survey process, including assignments to specific interviewers, assuring coverage through strict check-in procedures, and providing status reports of the data collection effort.
4. The **administration and payroll system** which stores interviewer data, payroll information, and other administrative data used to manage field operations.
5. The **interviewer performance system** which contains information on hours worked, cases completed, and other data on field performance functions.
6. The **survey system** which feeds the interviewing process and controls operations such as reinterview, dependent interviewing, history notes, follow-up data and other such processes.

The Census Bureau's commitment to automation across these areas in part derives from its traditional emphasis to the close management of its field operations

necessary to achieve high response rates (95% or more of sampled households) in brief field work periods (frequently one to two weeks).

The Census Bureau's central office case management system has three main components.

The first is a *set of data bases* in which information necessary for the conduct of the survey are stored. These contain the information required for effecting the six functions described in the previous section. They will be partitioned (or indexed) by survey, by regional office, and by interviewing period to facilitate access to most needed current information in specific areas.

The office CAPI case management system does not include a data base for the interview data themselves. The interview data are passed through the office case management system to client divisions responsible for each survey who may construct individual survey data bases for editing, tabulation, analysis, archiving, and related functions.

The second component of the central case management system is a *library of computer programs* to edit and update information in each data base as needed, to move data (in full, in part, or in summary form) from one data base to another, and to transmit information to appropriate staff members at fixed schedules or on demand. Additional programs will prepare standard summary reports for managers and supervisors drawing on information across several data bases or permit them to generate special purpose reports and analyses based on data from the same sources.

The third component is the *communications network* which links all relevant parties to the CAPI survey process. It includes: (a) dial-in telephone modem links between the interviewers and central office; and (b) a wide area network (WAN) by which access is provided to the headquarters data base by authorized users at headquarters and at other Bureau offices. Different users will, of course, have varying privileges to read, edit, write, transmit, and erase different types of information in the system. Access will be restricted to those previously authorized on the basis of need.

The further development of the office case management system will follow the same general directions already outlined for the interviewer case management system. It will begin with essential core functions and then move toward: (a) enhanced options for the functions; (b) increased automation to minimize the steps required of central office and other staff to accomplish their activities; (c) expansion from one-survey to multiple-survey capabilities; and (d) extension to additional functions as time permits. A modular approach to adding future functions is planned. Modules by definition will be separable and replaceable to maintain flexibility and to accommodate the system to future requirements with minimal change to the overall structure and other components.

4.3. Functional complexities

The design of office CAPI case management systems will undoubtedly vary greatly across data collection organizations to accommodate their organizational structures, combinations of data collection methods, stage of transition to computer assisted methods, and varying roles vis-a-vis survey sponsors and funding agencies.

For example, the wide-area network for the Census Bureau's general CAPI case management system must accommodate a headquarters in Washington, D.C., a processing center in Jeffersonville, Indiana, 12 regional offices, two telephone centers and possibly 200–250 local supervisors. Even

within these larger organizations, various divisions, branches, and other subunits exist with primary responsibilities for mapping, sampling, data collection on different surveys, reinterviewing, processing, coding, payrolling, and budgeting. All may have a stake in the information entered, stored, and retrieved from the data bases of the CAPI case management system.

Computer assisted personal interviewing (CAPI), moreover, is not the only data collection method requiring an office case management system. The Census Bureau plans to conduct several major surveys using a combination of computer assisted personal interviewing (CAPI) and computer assisted telephone interviewing (CATI) which will share the same sample, computer assisted questionnaire, and data set of completed cases. Other Census Bureau surveys may employ combinations of CATI, computerized self-administered questionnaires, touchtone data entry, voice recognition reporting, and computer assisted data entry from paper forms.

Consequently, the Census Bureau is *not* planning to construct a *separate* general case management system for CAPI surveys but to include CAPI case management within a broader CASIC case management system. CASIC stands for "computer assisted survey information collection" and encompasses all the above data collection technologies.

There are at least two additional complexities general CASIC case management systems must accommodate in large data collection organizations. The first is that various surveys may be converted from paper-and-pencil to computer assisted methods on different time schedules. At the Census Bureau, we estimate that approximately a decade will be required to transfer all (or virtually all) continuing household surveys to computer assisted

methods. While this permits a phased conversion process, it also requires maintenance of management, support, and communication systems for both computer assisted and paper-and-pencil surveys throughout the decade, neither of which is likely to remain constant during this period. This means continuing support for paper-and-pencil surveys at the same time that their basic data collection methods are being replaced by automated systems.

As a final complexity, CAPI case management systems may have to cope with multiple software systems for computer assisted interviewing (CAI) by the same staff of CAPI interviewers. The Census Bureau currently employs its own Micro–CAI system for surveys requiring both CAPI and CATI interviews; but it is moving to the Berkeley Computer Assisted Survey Execution System (CASES) as a new standard. As collection agent for the National Health Interview Survey, the Census Bureau also plans to use the CLASIC CAPI system developed by the survey's sponsor, the National Center for Health Statistics (Gardenier 1991). The Bureau also may use the BLAISE System developed by the Netherlands's Central Bureau of Statistics for selected establishment surveys, while some advisors have suggested closer scrutiny of alternative software. The same or similar choices are facing public and private data collection agencies across the world.

These CAI systems are not merely interchangeable parts. They differ in the functionality they provide, the way their questionnaires are authored, the way their data are stored and retrieved, in methods available to update or correct questionnaires in the field, and in the procedures interviewers may employ to access cases, interrupt and resume interviews, backup to

previous answers, enter notes, and navigate between different interview sections and household members. The manager of an individual survey may view proliferating CAI systems as offering a chance to select the best one for each particular survey; but from an organizational perspective, accommodating more than one CAI system in the same office (and interviewer) case management system or building separate case management systems for each, creates major difficulties.

The problem of multiple CAI systems cannot be wholly avoided. To remain current with advancing technology, changes from one system (or from one version of a system) to another will be necessary at least from time to time. However, the added complexities of accommodating added CAI systems within the same generalized case management system and the desire to protect the interviewing staff from having to learn and operate different systems in performing their work will probably limit the number of CAI systems acceptable within the same data collection organization.

5. Personal Interviews and the Pace of Change

Computer assisted personal interviewing has rapidly evolved within the last five years. In 1987, the field interviewers' ability and willingness to carry 12 pound (5.5 kilo) laptop computers was uncertain and the nationwide transmission of CAPI assignments and interview data via telecommunications was untested. By 1992, the weight of portable microcomputers had been halved, their power had been increased, and two-way CAPI telecommunications became commonplace. New pen-based, "palmtop" computers have been announced halving the weight again (2.9 lbs. or 1.3

kilos) and increasing their memory without appreciably raising the price. They also offer radio data network capabilities as a common option. The new palmtops are so small that they are easily concealed on the person, possibly reducing fears of theft expressed by some interviewers in carrying CAPI computers on the street or consulting case management lists before leaving their cars in sampled neighborhoods.

While the development of CAPI communications and case management has been among the most important additions to personal interviewing technology in recent years, the further evolution of the portable microcomputers themselves may provide the major impetus for changes in the future. The rapid development of voice technology may change the nature of personal interviewing by the use of voice digitized questions read to the respondent with respondent self-response through keyboards or touch screens without interviewer intervention. For enhanced confidentiality, the respondent may hear the questions through a headset. Additional future options may include voice digitizing of detailed respondent answers, the computer conversion of voice input to text, the automatic appending of geographic positioning coordinates to interviews and observations, and the remote monitoring of interview–respondent interactions via radio–data networks. The methodological, legal, and ethical consequences of such possibilities remain unexplored.

While it is tempting to speculate how these and other technological advances may change personal interviewing in the next decade or two, the pace of change has become so rapid that the future of survey methods is becoming increasingly difficult to forecast. We only know that the old pattern of stable interviewing methods applied

year after year to new applications is coming to an end and that survey organizations who plan to stay current with new methods and new opportunities are facing an increasingly technological future.

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