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Computer-assisted Interviewing in a Decentralised Environment: The Case of Household Surveys at Statistics Canada

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ABSTRACT

In 1993, Statistics Canada implemented Computer-assisted Interviewing (CAI) for conducting interviews for some household surveys that were conducted in a decentralised environment. The technology has been successfully used for a number of years, and most household surveys have now been converted to this collection mode. This paper is a summary of the experience and the lessons that have been learned since the research started. It describes some of the tests that led to the implementation of the technology, and some of the new opportunities that have arisen with its implementation. It also discusses some challenges that were faced when CAI was implemented (some are on-going issues), and ends with a brief overview of where this may lead us in the future.

KEY WORDS: Household surveys; Data collection; Computer-assisted interviewing; Decentralised environment.

1. INTRODUCTION

The first systems of computer-assisted interviewing (CAI) were developed in the early 1970s (see Nicholls and Groves 1986). These systems were mainly developed by market research organisations in the United States and, a little later, independently by well-known university research centres. During the late 1970s and early 1980s, computer-assisted interviewing systems became much more sophisticated, and their use expanded greatly. By the late 1980s, a number of universities and survey research centres in the United States had a computerised collection system (see Lyberg, Biemer, Collins, de Leeuw, Dippo, Schwarz and Trewin 1997). Clark, Martin and Bates (1997) provide an overview of the development and implementation of such systems in four major government statistical agencies.

In 1987, Statistics Canada conducted its first experiment with computer-assisted interviewing for household surveys. At that time, the tests were done in a "centralised telephone collection environment". The series of tests with computer-assisted interviewing was extended into the early 1990s to try to adapt to the more general collection methodology.

At Statistics Canada most household surveys share a common sampling frame and data collection environment. The main user of this frame is the monthly Labour Force Survey (LFS). Data collection is decentralised with the initial interview in person at the selected dwelling and the subsequent five interviews by telephone from the interviewer's home. To accomplish this, almost a thousand interviewers have been equipped with portable computers. Interviewers are attached to one of the five regional offices located throughout Canada. A number of household surveys in the bureau follow a similar collection strategy by subsampling from the Labour Force Survey sample, by administering a series of supplementary questions after the Labour Force Survey interview or by contacting persons who have formerly participated in the survey. As a result, not only is the Labour Force Survey sample shared with other surveys, but so is the collection infrastructure. All interviewers are required to work on the Labour Force Survey for a specified week each month, and for the rest of the time, they have been trained and equipped to collect data for other surveys. For further details on the Labour Force Survey methodology, see Statistics Canada (1998).

The 1990s saw testing of the implementation of the computer-assisted collection mode not only for the LFS but also for other surveys sharing that common infrastructure and having very different requirements. The results of the various tests led to the implementation of computer-assisted interviewing for the LFS in November 1993 (Dufour, Kaushal, Clark and Bench 1995) while its supplementary monthly surveys have been changed gradually. In January 1994, a new longitudinal survey, the Survey of Labour and Income Dynamics (SLID) was launched using computer-assisted interviewing (see Lavigne and Michaud 1995). Since then, the National Population Health Survey (NPHS) along with the National Longitudinal Survey of Children and Youth, (NLSCY) introduced in August and November 1994 respectively, have also adopted this collection mode (see Tambay and Catlin 1995, Brodeur, Montigny and Bérard 1995). For further details on the structure and implementation of this computerised collection mode in longitudinal surveys, see Brown, Hale and Michaud (1997). Today most of Statistics Canada's household surveys are collected using a computerised mode and a common infrastructure.

This article focuses primarily on methodology aspects of decentralised computer-assisted interviewing for household surveys. We provide an overview of the implementation process for the statistical agency as a whole, a brief discussion of the challenges associated with the new collection vehicle and a list of references for more detailed information on specific topics. Despite "growing pains", Statistics Canada is continuing to experiment with and

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implement this new technology in various surveys to render these surveys more cost efficient and to improve data quality and the survey monitoring process.

The article is divided into five sections. In the next section, aspects of implementation are discussed with reference to several surveys. Section 3 details new opportunities arising from computer-assisted interviewing. The ongoing challenges and new problems that surveys face as a result of using a decentralised computerised collection mode, as well as the changes that are taking place, are discussed in Section 4. The last section describes the future of CAI for household surveys at Statistics Canada.

2. FIRST YEARS OF IMPLEMENTATION

Adopting a computerised collection method for household surveys held the promise of several benefits: (i) a decrease in survey costs, (ii) better data quality, (iii) the possibility of using more complex questionnaires, (iv) data made available more quickly, (v) a tool for tracing operations, (vi) the possibility of using dependent interviews, and (vii) a generalised collection method for all of the agency's household surveys. However, these benefits were not realised overnight, or without effort. Ongoing evaluations and adjustments were required in the introduction and stabilisation phases.

Despite a number of tests being conducted before the implementation of CAI, unforeseeable problems occurred with the adoption of this method, but over time, they became less frequent and easier to solve. In addition, during this period, the series of quality indicators analysed carefully by different groups of Statistic Canada experts were somewhat disrupted. It took about one year to realise the anticipated benefits. This section describes the main points in the process of changing from the traditional paper approach to computer-assisted interviewing, where collection and capture are integrated.

2.1 Centralised Computer-assisted Telephone Interviewing

The traditional approach to interviewing used a paper questionnaire filled out in pencil to facilitate edits made by the interviewer. Often such an approach is referred to as Paper and Pencil Interviewing (PAPI). In this traditional mode, an interviewer edited the questionnaire to ensure that the information was correct and complete. Information abbreviated to shorten the interview was filled-in in detail after the interview and before the form was sent for data capture. The first change towards computerisation was the use of Computer-assisted Telephone Interviewing (CATI). This computerised collection mode was used for surveys that were conducted by telephone from a central location. CATI was the first instance of amalgamation of the collection and capture of information in household surveys. Given the state of technology at that point, the computers capable of handling the complexity associated with computer-assisted interviewing were fairly large. Hence, CATI could replace PAPI only in centralised telephone surveys. In the 1990s, with the advent of more powerful portable computers decentralised CAI replaced PAPI. A decentralised collection mode is, in effect, what is used in most household surveys. In addition, data collection often required the ability to do either telephone interviews or personal visits. However, much of the know-how and experience of computer-assisted telephone interviewing could be applied to decentralised computer-assisted interviewing.

Since the 1980s, it was the Labour Force Survey (LFS) that served as the main research and testing vehicle for CATI technology. The first test, conducted in 1987, was a controlled study that compared CATI in a centralised environment to PAPI. It consisted of a research project carried out jointly between Statistics Canada and the US Bureau of the Census (see Catlin and Ingram 1988). The study showed that there were differences between the two collection methods in terms of data quality indicators, and those differences were in favour of CAI in terms of lower rejection rates on edit, reduction in path errors on the questionnaire and decrease in undercoverage in the LFS.

While CATI was never implemented for the LFS, the experience was used to set up a CATI facility for use in random digit dialling (RDD) in household surveys. As technology progressed, CATI was used to collect more complicated RDD surveys like the General Social Survey (GSS) and the Violence against Women Survey. Computer-assisted telephone interviewing continues to be used as an integral part of household collection at Statistics Canada complemented by the computer-assisted interviewing infrastructure.

2.2 Technological Testing

A new wave of testing began in the early 1990s as part of the decennial redesign of the LFS (Singh, Gambino and Laniel 1993; Drew, Gambino, Akyeampong and Williams 1991). The launching of three large scale longitudinal surveys by Statistics Canada made the investment for a CAI infrastructure possible by sharing the costs among a number of surveys. Consequently, in 1991, a second test was conducted using the LFS and SLID to study the feasibility of using new technologies (see Williams and Spaull 1992). Portable computers which require the use of a stylus rather than a keyboard for entering data were tested. The results showed that the technology was promising but that it needed further improvements for it to be used to handle the requirements of Statistics Canada's household surveys.

The following year, from July 1992 to January 1993, a third and a fourth test were conducted, this time using conventional portable computers. The results for the LFS are documented in Kaushal and Laniel (1995), while the results for SLID are reported in Michaud, Le Petit, and Lavigne (1993) and Michaud, Lavigne and Pottle (1993). For the LFS, the main objective of this third test was to determine if the transition to the new technology would disrupt the LFS data series. The secondary objective of the test was to determine whether the new technology affected

data quality and interview costs. Additional objectives of this test were the operational development and evaluation of the CAI approach. For the longitudinal surveys, the main concern was the length and complexity of the questionnaires and the addition of new functions, such as tracing. Consequently, the main criterion in assessing the application was the feasibility of developing various functions. The results showed that CAI had no major impact for the LFS on either the data series disseminated, the survey's main quality indicators, or interview costs. On the strength of general comparisons with outside sources and an analysis of missing variables, the new technology was adopted.

2.3 New Dimension of Nonresponse

With the adoption of CAI, there was an unintentional development of a new dimension of nonresponse that is due to "technical problems". Such nonresponse resulted from cases that were lost or not received before the end of the collection period. The PAPI version of this type of nonresponse was related to occasional postal problems. Conceptually, these situations do not refer to real nonrespondents; however, the information is not available in time to produce estimates.

These technical problems assume three different forms: (i) transmission problems, (ii) equipment problems, and (iii) unavoidable problems. Transmission problems are the most common. They arise, for example, when telephone lines are down, when there is a problem with the automatic downloading of data, when an attempt is made to download data while maintenance is being carried out on the mainframe computer, or simply because of a malfunction in the CAI system. The second type of problem, although less common, occurs when a hard drive crashes, the magnetic tape drive fails, there is insufficient memory or there are computer equipment problems at the regional offices. Finally, unavoidable problems, which are even less common, include specific problems implicitly created by the above two categories, for example when only one of the two components expected from a respondent is transmitted or if the initialisation parameters needed for the proper functioning of the programs are missing.

Nonresponse due to technical problems diminished over the initial months. This component of nonresponse was analysed quite carefully to explain an upward trend in nonresponse and to assess the performance of the CAI approach (see Simard, Dufour and Mayda 1995; Dufour, Simard and Mayda 1995). At the start of the conversion of the household surveys to CAI, technical problems represented on average 15% of total nonresponse and could alone explain up to 25% of nonresponse. It took almost a full year before any significant reduction was observed in this component of nonresponse. Today, in 1997, the nonresponse due to technical problems is practically non-existent.

In the first year, the bulk of the problems were due to a conflict over memory management in the notebook computer between two pieces of software used in case management. This was resolved by a re-write of a part of the software, which eliminated the conflict and made the system more efficient. The more subtle issues of the transition were communication and experience. A communication strategy was developed to enable the different players (in particular technical personnel and interviewers) to better understand each other, disseminate information more quickly and adequately inform all persons concerned. When CAI was first introduced, it took technical support personnel more than a day to find a solution to some problems. Faster response procedures were established, and a 24-hour support service was set up at head office in Ottawa. With such a substantial change, a learning and adjustment period is required, and Statistics Canada was no exception.

2.4 Impact of CAI on Nonresponse

Are there grounds for believing that the use of CAI had an effect on nonresponse rates? The answer to such a question has to be yes in light of the technical problems encountered, primarily at the beginning of the conversion process. However, if this aspect of the nonresponse is discounted, there is no indication that CAI had any lasting effect on nonresponse rates. The LFS nonresponse fluctuated following the introduction of CAI, but these fluctuations may be explained by a number of other factors (the redesign of the sample, which is now more urbanised; hiring of new interviewers; *etc.*), since the LFS was undergoing a major overhaul. It took just under two years for overall nonresponse to return to levels similar to those recorded in the paper and pencil era.

In the LFS, the conversion took place over a period of five months during which time the CAI and PAPI nonresponse rates could be compared. These comparisons show that the nonresponse rates for CAI (excluding technical problems) and those for PAPI were in the same range and exhibited the same trends (see Simard and Dufour 1995). Moreover, all the main components of nonresponse, namely refusal to participate in the survey, household temporarily absent, no one at home and other reasons, exhibited similar annual patterns before and after the implementation. There were concerns that respondents would be more reluctant to answer due to the presence of a computer for personal interviews, resulting in an increase in refusals. However, no change in the refusal component was detected.

In early 1995, the three longitudinal surveys (SLID, NLSCY and NPHS), as well as the LFS, were conducted during similar collection periods. The current case management environment, as well as the sharing of the infrastructure among surveys, created extra pressure on interviewers in the field. Moreover, the survey collection periods were limited because there was a limited number of applications that could reside on the computers at the same time. Analysis was done to determine if response problems arose from conducting several surveys simultaneously, or in quick succession, in the field using CAI. For the quarterly collection of the NPHS, interviewers followed-up nonrespondents in previous collections. An analysis was

carried out to determine the possible conversion rate. The results showed that in the case where there were fewer CAI surveys in the field at the same time, a first wave of follow-ups of nonrespondents increased the response rate, but continuing the process for a second or third time brought few gains (an increase of 5.76% from the first to the second quarter, 0.97% from the second to the third, and 0.91% from the third to the fourth). However, a last follow-up was carried out in June 1995 when there were almost no surveys in the field. This procedure improved the overall response rate by approximately 5%, which was higher than expected. This led to the conclusion that CAI had to be able to give more flexibility in the length of the collection period and allow multiple applications to reside on the computer in order to maintain the response rates that would have been obtained in a paper and pencil environment.

3. NEW OPPORTUNITIES FOR HOUSEHOLD SURVEYS

The adoption of CAI collection has added new opportunities to household surveys. These new opportunities, which were either non-existent or operationally difficult in a paper and pencil mode, help to reduce non-sampling errors, to collect more specialised information, to facilitate the reconstruction of family units and to make contact with family units that break apart or merge. In fact, this collection method is better suited to adjust the collection process according to the changing needs of today's society.

3.1 Dependent Interviews

The introduction of the new technology served to resolve household survey problems that had proven intractable under the traditional paper and pencil interview approach. In particular, CAI helped to increase the information that could be provided by the interviewer to a respondent contacted for the second time for the reduction of (i) response error (coding, capture or recall error), in particular the seam problem and telescoping, and (ii) response burden by confirming the information instead of requesting it again (or by requesting only partial information).

The seam problem has been documented for longitudinal surveys in Murray, Michaud, Egan and Lemaître (1990), which notes that the problem arises in reconciling data from successive collection periods. If no reconciliation has been attempted between collections, an artificially large change in estimates is generally observed at each collection transition. This problem is generally explained by respondents' difficulty in pinpointing the date when a change occurs. As to telescoping, it results from a tendency to include certain events that occurred outside the reference period.

Under the traditional PAPI approach, the type of information that could be provided to interviewers was limited. Questionnaires could only be pre-printed with basic information, as there were physical limits to the amount of information that could be pre-printed, especially for long questionnaires. In some cases, additional information was even printed on a separate questionnaire. This procedure also involved additional logistical problems for the interviewer. The use of information from earlier occasions in the process is known as feedback. With computer-assisted interviewing, feedback is made possible in two ways: proactively and reactively. A discussion of this is also provided in Brown *et al.* (1997).

Proactive use of feedback is used to reduce response error by helping the respondent to situate him/herself. For example, SLID gathers detailed information on a maximum of six jobs in the previous year. Without feedback, the name of the employer or the occupation might be written slightly differently, and a job that continued over a period of two years could be incorrectly classified as a change. Initially there was some concern that the respondent would perceive feedback negatively, but in fact, few negative comments have been received.

The confirmation rate is generally high – over 90% for data that are presented to the respondent (see Hale and Michaud 1995). The study of Hiemstra, Lavigne and Webber (1993) concerning the labour market suggests that while feedback generally serves to reduce the seam effect, the problem is only partially solved. For example, SLID confirms employment, job search or joblessness at the beginning of the previous calendar year over a one-year recall period. Micro-comparisons with a cross-sectional monthly survey, conducted over the first five months of the year, suggest that feedback greatly reduces the seam effect. However, consistency with cross-sectional data decreases over the months, which seems to suggest that response error, although eased by feedback, is still a problem.

The proactive use of feedback may, however, underestimate measures of change. For this reason, for sensitive information and for reasons of confidentiality, the technique is also used reactively. The reactive use of feedback can be used to detect unusual changes, or to confirm inconsistencies in the data. As an illustration, in the interview for the first wave of SLID, jobless spells are identified and for each spell the respondent is asked whether employment insurance benefits have been received. The second wave interview asks for detailed information on various sources of income and amounts received including employment insurance benefits. Comparisons with outside sources suggest that traditionally, the amounts of employment insurance reported in a survey represent approximately 80% of the contributions paid. In SLID, previous information was stored in memory. If an amount was not reported and there was an indicator flagging an inconsistency with the first-wave interview, an additional question was asked to determine whether the amount had been omitted. An analysis of the first wave of SLID suggests that reactive checking increased the number of reported cases by nearly 30%. However, 28% of these persons who had neglected to report an amount, confirmed that they had received an amount but were unwilling to

report that amount. There was thus confirmation of the source, but the amount had to be imputed and the problem was not totally solved. More details on this subject may be found in Dibbs, Hale, Loverock and Michaud (1995).

3.2 A More Efficient Tool

With an efficient collection tool like CAI, it is now possible to collect, to limit, to access and to transfer detailed information which would traditionally have been very difficult, or even not possible, to do with PAPI.

3.2.1 Matrix of Relationships Between the Various Members of a Household

Household surveys create different levels for analysis such as the economic family and the census family, by using the relationships between the various persons in the household with a single person often called the "family head". There are limitations to this method for example, in identifying the children of blended families or reconstructing families to three generations. In a longitudinal context, the concept of family head is a definition that can vary over time and so a number of longitudinal surveys have used a matrix of relationships for all members of the household. CAI can limit collection to the lower diagonal of the matrix. Provided that the composition of a household does not change between two collections, it is not necessary to re-ask it for the relationship matrix. Interactive edits (based on age, for example) serve to correct any relationships captured in reverse (*e.g.*, a parent-child relationship). It took a number of attempts to develop an effective means of identifying relationships that would allow not only for the collection of the information but also for easy correction. With the improved version of the collection procedure, less than 1% of relationships required further correction after collection (as compared to 5.3% inconsistency before the interactive edits on the relationship matrix). Corrections in a CAI environment probably continue to be one of the areas in which research is still required.

3.2.2 Access to More Sophisticated Collection Instruments

CAI has also provided access to more sophisticated collection instruments. For example, the NLSCY obtains a variety of information on a cohort of children aged 0-11 years. One part of the interview is designed to measure the child's vocabulary level. The survey uses the Peabody Picture Vocabulary Test (PPVT) as one of its collection instruments. However, the PPVT is normally used in a more specialised environment, and persons administering it generally need several days of in-depth training since the test involves a series of images, and the child is asked to choose the image that corresponds to a given word. The starting level depends on the child's age. Questions are administered until the child gets a certain number of wrong answers. At this point, the interviewer must return to the starting level and re-administer the previous questions, until the child gives a pre-determined number of wrong answers. The administration of the test calls for determining a threshold based on criteria, counting the number of wrong answers, skipping between questions depending on the number of wrong answers, and stopping the test. These procedures would have required a considerable amount of training if it had been necessary to administer the test on paper. CAI has greatly facilitated the process by allowing programming of the edit rules in advance. The data from the first collection suggest that the computer-assisted conditions of administration yield good-quality results when compared to external norms.

3.2.3 Establishing Longitudinal Links

In the case of longitudinal links, it may happen that all the members of an initial household may be part of the longitudinal sample, as in SLID for example. In subsequent collections, the longitudinal persons are interviewed along with all persons with whom they live. In the case of a household that splits, a new household must be created for the persons who left the original household. With the adoption of CAI, it became possible to create new unique household identifiers linked to the original identifiers, this made it easier to reconcile the dynamics of change in household composition. A particular problem that has been greatly lessened is the treatment of the real duplicates that occur as a result of changes in household composition. For example, an adolescent might belong to a given household at the time of the first collection, then leave his parent's household by the time of the second collection but return to the original household by the time of the third collection. In the second collection, the person is identified as belonging to a new household, and a new identifier is thus associated with him. In the third collection, when the parents' household is again contacted, the adolescent who has returned may be indicated as a new person in the household. If the interviewer is shown the list of persons who have formerly been part of the household, the need to reconcile duplicates is greatly reduced. A similar treatment has been carried out for jobs where a list of previous employers is used for longitudinal reconciliation of jobs.

3.2.4 Tracing of Individuals

With the conversion to CAI, certain procedures such as tracing were automated. Brown *et al.* (1997) gives specific examples. As noted above with respect to establishing longitudinal links, traced individuals may all be put into a new household with a unique identifier. Fewer paper manipulations are required, and it is now possible to obtain more management information. CAI has made it possible to set up a two-level tracing procedure. The interviewer first attempts the tracing. If this is not successful, all information on the case is transferred to a tracing unit in the regional office where more sources for tracing are available. Automation has eliminated many manipulations and transcriptions of records on paper. Formerly when a household split, a new identification sheet was usually created on paper with a link to the previous household. The

names of the persons who had moved were entered on it. If the person to be traced was not found, all the forms for all the persons who had been living together the previous year were transferred. These manipulations greatly increased the risk of error. Transfers of cases between tracing levels are also done more quickly. In addition, each call is recorded automatically along with its result. While there was a similar procedure with the paper and pencil approach, the information was seldom entered. It was also hard to analyse the information for determining the most useful tracing sources.

Tracing is a key factor in maintaining data quality. With current tracing procedures, cases requiring tracing can be kept in the field a little longer, but the collection window remains limited. It is possible that more effective procedures can be established if the efforts of the various longitudinal surveys are integrated. Increased functionality, combined with central tracing, is currently being examined. This would make it possible to combine the tracing efforts of the various surveys, and it might also make it possible to have batch entries to try to link cases requiring tracing to databases.

3.3 New Quality Indicators

The CAI approach adopted by Statistics Canada for its household surveys features a complex system capable of monitoring survey activities during the collection period to ensure their smooth operation. This system called the "case management system" (CMS), is a sophisticated system that manages all survey activities from the beginning to the end of the survey cycle. This system is flexible, since it can be adapted to the requirements of the different household surveys that use it. The CMS performs three main functions: (i) routing of cases, (ii) reporting of activities and (iii) assisting interviewers. The routing component directs the movements of cases during the survey, whether from an interviewer to the regional office, from the regional office to head office, *etc.* The second component of the CMS produces different reports for describing the status of the survey at a given point in time, evaluating the performance and progress of the survey, and describing the status of interviews. A whole range of information is generated by this second component of the CMS. Lastly, the third module enables interviewers to perform their tasks more effectively, by giving options for making appointments, recording notes and so on.

As a result, this system provides a mass of information on what is actually happening in the field during a survey; every action taken on a case is recorded by the CMS. The main challenge with such a system is to avoid getting lost in the great mass of information available. Work teams have been set up to master these information sources, develop new quality indicators using this information or combining it with information already available, find uses (*e.g.*, additional training, improvement of the collection instrument), and develop ways to present these indicators effectively.

A large number of quality indicators have been produced (see Simard *et al.* 1995; Allard, Brisebois, Dufour and Simard 1996) on a regular basis at different levels of interest (geographic, interviewers, administrative). These indicators may be grouped into two categories: informational and for monitoring purposes. Examples of informational indicators are: number of attempts before completing a case, distribution of interviews completed per day of collection, best day-hour combination for reaching a respondent, median duration of interviews, and number of edit rules triggered and ignored or triggered and acted upon (see Brisebois, Dufour, Lévesque 1997). Information indicators are used to improve or make changes to the collection strategy or process.

In terms of monitoring, a series of indicators are used to trace irregularities, technical or human, in the field. Among these are: calls and visits done after the date of transmission but before the survey week, calls and visits done after Sunday of survey week, working period too early, working period too late, interviews too short, *etc.* This information serves to show whether instructions issued by head office are followed, and whether some interviewers require additional training. However, all data need to be analysed with caution to determine the cause of the irregularity. For example, an interview conducted at 4:30 am may well be at the request of a respondent, like a farmer, or due to an incorrect time on the computer clock (see Brisebois *et al.* 1997).

CAI also offers interviewers the opportunity to include a comment for each question or to explain the reason for the code used. It is therefore possible to develop adequate training, to better understand the surveys and accordingly to adapt them to realities in the field. For example, this feature made it possible to conduct a special study on the reasons for refusal to participate in one of Statistics Canada's household surveys; to conduct such a study would have formerly required a great deal of effort (see Allard, Dufour, Simard and Bastien 1996).

4. ONGOING CHALLENGES OF CAI

This section describes long-term challenges in developing, implementing and understanding the use of CAI for survey applications. The powerful tools provided by CAI have led us to degrees of complexity in content, software and electronic communications that may not be widely appreciated. The conversion to CAI has implied a new dependence on informatics. This dependence is one of the major challenges that Statistics Canada has to face with CAI, since the technology is changing so quickly.

4.1 Workload of Interviewers

A common infrastructure requires the sharing of limited resources, such as trained interviewers equipped with portable computers, by different surveys. As a consequence, any increase in either the number of surveys or the amount of information collected must be carried out jointly with the

other surveys. It should be noted that the same interviewers tend to be used by a large number of surveys, which can result in fairly large workloads, exacerbated by a short collection period. While response rates have recovered since the introduction of CAI, a heavy workload for interviewers can lead to deterioration in data quality, owing to fewer follow-ups and higher nonresponse.

Given the nature of the CMS, an administrative structure for communication, based on the needs of a given survey (based on the response codes), must be put in place to provide for the routing of cases between the interviewers, their supervisors and the regional offices. Since CAI was first introduced, there have been great improvements in the communications process to ensure that all interviewers correctly receive their assignments, the latest version of the application or various changes; nevertheless, this process must be constantly monitored. For example, after the end of the collection period, cases must be transmitted and deleted from the interviewers' computers. Often, the cases that were not transmitted consist mainly of nonresponse cases. The fact that these cases are not transmitted to head office after the end of collection means that the reasons for nonresponse are sometimes lost. While many of these problems can be detected during testing, the fact remains that a few exceptional cases still remain.

4.2 Control Procedures for CAI

The CMS and survey applications have the potential to generate many databases. The quantity of data is often overwhelming, and the data are not currently being used to their maximum potential. In addition, the speed inherent in CAI sometimes does not allow for sufficient time and resources to analyse and control this mass of information. For the moment, this information is used after the fact, but it would be highly desirable to be able to use it while the survey is in the field.

This information should be made available to interviewers in an integrated format. However, a balance is needed to avoid excessive surveillance where interviewers focus more on the quality indicators than on the quality of the data. Ideally, analysis across several surveys could identify specific problems, which could then be dealt with in training kits that are brief and focused. In addition, response rates and coverage rates could be integrated for surveys. All this information could be used to achieve more efficient time management or to develop training in specific interview skills.

4.3 Editing During Collection

While CAI offers the possibility of including a great number of edit rules at the time of the interview, it is important here as well to maintain a balance between the rules programmed into the collection instrument and the rules applied during batch processing at head office. The rules programmed into the instrument prolong the interview, which results in an increase in both costs and response burden. Over time, and with rapid changes in technology, it should be possible to apply a larger number of edits during the interview without interfering with its flow. On the other hand, clarifications at the time of the interview undeniably result in better quality data. The NPHS obtains better quality data in the second quarter by using information from the first quarter to feed the edit system. For example, clarifying with the respondent at the interview, led to the discovery that, for the arthritis variable, of the 7.0% of individuals who indicated a change in condition between the two quarters, 3.3% actually experienced a change while 3.5% represented errors. For further details, see Catlin, Roberts and Ingram (1996).

With CAI, it is also possible to store information to identify which edit rules have been triggered and what corrections were made. A study of the most frequently triggered edit rules would determine which rules most affect data quality, with the results of these studies serving not only as information but also as inputs, for changing overly strict edit rules and also for sustaining a dynamic correction system. Another aspect that is just as important is the ease with which the interviewer can make the necessary corrections. If the corrections can be made to the actual response or the preceding response to a question, the interviewer can easily identify the changes to be made. If the correction involves editing between several answers, then the need to determine which one requires correction, and to move between the various answers in which there may be an error, sometimes makes the process too complex for the edit to be carried out during the interview.

Apart from technical problems, there are methodological problems associated with the effect of edit rules on data quality. At what stage are the different edit rules the most effective? The rules that affect the flow of the questionnaire and those that determine which persons are outside the scope of the survey, are critical edit rules. The key variables used for poststratification and key estimates are best resolved at the time of the interview. The quantity of edit rules that can be incorporated into the CAI system must be balanced with the speed of the portable computer. In addition, when some edit rules are being developed for the instrument and others for central processing, care must be taken to ensure that the two types of rules are not contradictory.

4.5 Data Confidentiality

Maintaining data confidentiality, as stipulated by the *Statistics Act*, is one of the fundamental requirements of the use of CAI and the systems that support it. To meet such a requirement, a number of procedures have been developed including a computing environment with two communication networks, one external and the other internal. The data are transferred physically, by tape, from the external network to the confidential internal network since there is no link between these two networks. It is impossible to access the internal network using a public modem. Confidentiality is also ensured by encryption of data whenever they must be transmitted over telephone lines. In addition, an access control system is incorporated into all portable computers, enabling only the interviewer to access

the information. The data are also encrypted while residing on the notebook.

The challenges relating to confidentiality in a CAI environment are quite different from those encountered with PAPI. Dependent interviews offer such a challenge for SLID. Information available from the preceding wave family unit may become sensitive in the case of, say, a family break-up. Thus, while the new technology offers the benefits of dependent interviews, these are accompanied by drawbacks that must be analysed for the specific situation.

With the arrival of audio-CASI (known by the acronym CASI-A), sensitive subjects may be handled more easily. With this interview technique, respondents are linked to the computer with earphones, and the questions are read by a digitised voice. Since the question is heard via the headset, the respondent can choose whether or not to display the question on the screen. With these features, the respondent can complete the questionnaire in total anonymity. The NLSCY is planning to begin using this collection instrument by the year 2000.

4.6 Re-Interview Programs

CAI offers some enhancements over PAPI-based re-interview programs. Firstly, the rapid electronic transmission of data reduces discrepancies due to recall and memory problems since re-interview can be conducted quicker after the initial interview. Strict adherence to reconciliation procedures built into the software provides more accurate estimates of measurement error. This would eradicate the problem of interviewers peeking at the questionnaire before starting the re-interview. As well, reconciliation can be done after a subset of questions, a section or at the end of the questionnaire and as many times as desired. Re-interview cases are easily automated and integrated into a quality control process based on characteristics of the interviewer or the interview (*e.g.*, specific cases related to training issues, cases belonging to a specific group, *etc.*). The quality of the data is better since a great number of edit rules, identical to the ones used during the interview, are programmed for the re-interview. The features available from the CMS are also an asset for the re-interview program: progress of the re-interview program, performance and progress of the re-interview, easy transfer of cases, *etc.*

4.7 Interviewer Training

With the adoption of CAI, interviewers had to cope with a major change in their work method. Training was therefore an essential stage in enabling them to adapt effectively to the computerised collection method. They became familiar with new work tools, including the keyboard, the portable computer and all the computer procedures, such as saving data, charging batteries and transmitting by modem. They also had to adapt their interview style to the requirements of CAI. New interviewers, for their part, had to familiarise themselves with survey concepts, interview techniques and the collection instrument. To meet this challenge, Statistics Canada developed a training strategy based on the experience acquired during the previous testing, as well as on the experience of British and American colleagues.

Interviewer training will always be one of the key factors in the success of Statistics Canada surveys, and the agency is continually innovating in this field. For example, one of the initiatives for the LFS is a training strategy to enable senior interviewers to regularly receive a small CAI assignment (approximately 15 cases), just so they can practice collection by this method and thereby stay abreast of changes in the CAI application. In addition to the regular practice cases that are always available on the computer, the CAI system will provide interviewers with modules integrated into the collection system, dealing with such complex subjects as coverage and multiple dwellings, to enable them to always be updated or to review various difficult concepts.

5. FUTURE OF CAI AT STATISTICS CANADA

In the new environment of limited resources and high response burden, collection is becoming increasingly customised. While business surveys have been doing it for some time, mixed collection is beginning to be in demand for household surveys. Centralised collection outside the collection window for a limited number of respondents can be used to improve response rates (to focus on tracing for example). The environment necessary for this type of collection more closely resembles a CATI environment in which shared database functions for a small sample are available, with call planning functions.

A complete redesign of the CAI application and the case management system is expected to be completed by the turn of the century. In this redesign, work teams must take account not only of computer capacity but also of the human factor. The latter factor is important since data collection and data quality depend on it. Interviewers must read the screen and enter the responses, tasks that call for perceptual and motor skills different from those required for pencil and paper interviews. The wording of questions is also harder to read on the screen, and interviewers mention that it is now harder to visualise the overall structure of a questionnaire. Hence special attention must be paid to screen design, the choice of colours, the amount of text displayed, the key functions pre-programmed and the ease of moving between screens. Since interviewers are also asked to work on several surveys, an effort should be made to standardise screen formats as much as possible.

As regards the hardware and software components, work teams are currently concentrating on choosing the best combination. At present, different softwares are used for different components of some surveys. In order to standardise the applications available as much as possible, there are plans to use a uniform platform for all surveys in a Windows environment. The Windows environment should give both interviewers and programmers greater

flexibility. The security systems must also be redesigned to conform to the technology adopted and to satisfy the requirements of Statistics Canada. Harmonisation of questions among surveys should be attempted, which would allow CAI programming to become more modularised. Respondent burden would also be reduced.

The new system will have to be able to take account of both past and present requirements. For example, system features are re-examined in the light of the progress reports provided to operational staff in order to determine which areas need improvement. As noted in Section 4, a number of other possibilities are being considered such as, interactive training of interviewers, special training modules, the possibility of conducting re-interviews and better tracing tools. These procedures should make it possible to make better use of the flexibility resulting from the automation of the process.

The case management system is also being redeveloped. One major consideration here is to obtain a robust communications system, in which changes can be sent out uniformly with a replication capability. While we still hope to develop a computer system that will be used for many years, the current reality seems to suggest that CAI is likely to continue to evolve rapidly. One challenge, then, since the technology is changing quickly (one need only think of the Internet), is to develop a new system that is flexible, so as to allow for adaptations without requiring a complete overhaul.

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