FACTORS IN ACCEPTANCE OF COMPUTER-ASSISTED INTERVIEWING METHODS: A CONCEPTUAL AND HISTORICAL REVIEW

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Computer-assisted interviewing (CAI) methods are increasingly replacing paper-and-pencil (P&P) methods of survey data collection. In Europe and North America, most professional research organizations -- academic, governmental, and commercial -- now employ these new methods for much if not all of their survey data collection. Computer-assisted telephone and personal interviewing (CATI and CAPI) are most prevalent, but computer-assisted self-interviewing (CASI) and self-administered questionnaires (CSAQ) are also coming into increasing use together with newer forms of electronic data collection and capture using touchtone telephones, voice technology, character recognition, and the Internet.

This change did not come easily. In many organizations, the introduction of CAI methods was a long and much debated process. This paper presents a conceptual and historical review of some of the factors and processes influencing the acceptance of CAI methods, based on published reports and reported experiences of those who have long worked in the field. These factors include: (1) the historical context of change in computer technology and survey research; (2) factors which predisposed some organizations to take the lead in CAI implementation and events triggering those decisions; (3) beliefs about the advantages of CAI methods; (4) reasons for selecting CAI methods for specific surveys; (5) known disadvantages to be overcome; (6) the operational problems of CAI methods; and (7) factors which lent momentum to the transition to CAI methods.

The discussion will be limited in three ways. First, it will focus on the two most common forms of computer-assisted interviewing, CATI and CAPI. Second, it will not attempt to address decisions which involve a change of collection mode (such as between personal and telephone interviewing) as well as a change of collection technology (such as from P&P to CAI). And third, it will only sketch briefly the conceptual scheme proposed. The few pages ASA Proceedings allow a contributed paper do not permit a full description of the scheme nor sufficient documented evidence to be more than suggestive. A longer paper is being prepared that may overcome some of these limitations.

1. Historical Context

Computer-assisted interviewing developed during the last quarter century. The first CATI survey was conducted in 1971 by Chilton Research, a market research firm. Half a decade elapsed before CATI was used by an academic survey research center and a full decade passed before CATI was employed in a government conducted survey. Although early tests of computer-assisted personal interviewing (CAPI) occurred much earlier, it was not operationally feasible until the introduction of laptop computers in the mid-1980s. The first national CAPI survey occurred in the Netherlands in 1987; and by the 1990s CAPI become recognized as the method of choice for large-scale face-to-face surveys.

The rapid evolution of computing technology during this quarter century undoubtedly encouraged the development of CATI and CAPI in several ways. First, it provided increasingly appropriate computing hardware, operating systems, and data communication methods first for CATI and then for CAPI. Second, the computerization of many areas of society from banking and airline reservations to libraries and retailing undoubtedly persuaded many decision makers, including those in survey research, that computers could make many clerical tasks faster, more accurate, and less expensive. Third, the spread of desktop personal computers to survey research offices demonstrated their utility to a variety of survey activities and contributed to a basic level of computer literacy among survey professionals. Finally, the broad shift from batch oriented to interactive processing prompted and facilitated the movement of survey data capture and editing from office activities into the interview itself. With such developments in computer technology, the evolution of CAI seems a natural extension of broader trends in western society.

Survey research also experienced enormous growth and major changes in the same quarter century. The use of surveys proliferated to monitor economic, social, and health problems, to inform marketing and policy decisions, and to assess government and private sector programs. As a result, surveys increased in number, size, complexity, use of panel designs, and inclusion of sensitive items. This growing demand stimulated a major increase both in the number of surveys conducted by government statistical bureaus and in the number of academic and private survey research organizations. The number of US university and nonprofit survey organizations grew five-fold between the early 1970s and mid-1990s. Competitive pressures encouraged cost-efficiency, timely results, enhanced data quality, and sometimes the cooperation of more than one organization on the same survey.

In the US, this growth partly reflected the spread of centralized telephone interviewing. CATI was first invented as a means of managing and expediting centralized telephone interviewing, and the development of CATI in

turn encouraged the use of centralized telephone interviewing and the proliferation of new survey research organizations relying on it. In Europe, where telephone interviewing developed later, a move from batch to interactive capture and editing of P&P survey forms provided the computing context from which CAPI could later grow.

In the 1980s, government statistical offices outside the U.S., especially Canada, the Netherlands, Sweden, and the United Kingdom, came under increasing legislative scrutiny and demands for budgetary reductions. These external pressures often prompted a close internal examination of data collection and processing methods and a readiness to consider computerized alternatives.

2. Predisposing Circumstances and Triggering Events

Decisions to replace P&P methods with CAI were not made by the survey industry as a whole but by individual market research firms, university survey research centers, and governmental statistical agencies. Which moved first to embrace the new data collection technologies and which held back until they were better established may be partly understood by their exposure to some of the trends just mentioned. For example, survey organizations that led in the move from mainframe computers to mini-computers and then to micro-computers were typically among the first to implement CATI and CAPI systems. A forward looking information technology department must be viewed as one major predisposing factor in acceptance of CAI.

Similarly, organizations that embraced centralized telephone interviewing were naturally led into adoption of CATI, while those committed to geographically dispersed field staffs were more likely to await the development of CAPI and decentralized CATI conducted from interviewers' homes. Organizations willing to attempt complex new survey designs as a means of attracting new work or to enhance continuing surveys undoubtedly were more receptive to change than their less venturesome competitors. At times, the preferences of customers and contracting agencies may have encouraged or required a change. Government statistical agencies under legislative scrutiny were more likely to consider new technologies than those with stable budgets and satisfied clients. A strong, stable leadership also may have been crucial to an organization's ability to change its collection methods or, in some cases, to resist such changes.

Special triggering events often affected the timing of a survey organization's first attempt at CATI or CAPI. The most common undoubtedly was the design of a new survey thought likely to benefit from CAI's special capabilities and of sufficient size to spread start-up procurement, development, and training costs over many cases. A generous survey budget or development funds from other sources undoubtedly helped. Redesign or expansion of a continuing survey also could serve as a triggering event, especially if it entailed a panel design, more timely reporting, or greater survey complexity. New leadership committed to modernization or the availability of appropriate computing hardware, acquired for other or shared purposes, also could serve as triggering events.

3. Potential Advantages

Much of the debate between the advocates of computer-assisted methods and skeptical survey managers focused on three questions: (1) Do these new methods actually live up to their potential advantages?; (2) What will they contribute to the specific survey for which CAI is being considered?; and (3) Will they perform well in practice without problems from respondents, interviewers, hardware, and software?

The most frequently discussed potential advantages of CAI over P&P methods have been its anticipated ability to **reduce costs**, **increase timeliness**, and **improve data quality.** These are the same benefits commonly recognized for the computerization of other clerical activities in industrialized societies. The challenge was set in one of the earliest papers on CATI, by Nelson, Peyton, and Bortner (1972), which described the invention and first use of CATI in the 1971 AT&T Telsam Survey. This paper claimed that "cathode ray tube interviewing" (as CATI was then called) did reduce costs, increase timeliness, and improve data quality; but these claims were unsupported by detailed comparative data and were presented in a talk intended in part as a sales promotion for Chilton's new CRT facility.

Papers on CATI written during the next dozen years continued to cite CATI's reported success in reducing costs, increasing timeliness, and improving survey accuracy in market research but also mentioned other potential benefits at well. One was the value of CATI for the **management of large telephone surveys**, including control and management of the sample, automated scheduling of telephone calls, assignment of cases to interviewers, and maintenance of sampling, calling, and call outcome records for supervisory and management purposes. A second was CATI's introduction of **new interviewing capabilities** not easily available with P&P interviewing, such as on-line access to data bases, automatic arithmetic calculations during the interview, randomization of question and response category order, and controlled dependent interviewing using previously collected data. When combined with CATI's ability for automatic routing between questions and its ability to tailor questions based on prior data, these capabilities permitted **surveys of greater complexity** than were possible with P&P methods. By committing most survey processes to computer programs, including sampling procedures, call scheduling, callback rules, and the questionnaire, CATI also could help to **standardize** survey procedures. Differences in survey practices between survey organizations therefore could be sufficiently controlled to permit joint work on the same survey. Many writers also believed that the use of CATI

would provide many opportunities to **advance the study of survey methods** by making survey procedures more explicit and observable, permitting automatic record keeping of survey events, and permitting easy randomization of survey items, interviewer assignments, and other elements of the survey process.

Despite this longer list of potential CATI advantages, the CATI literature continued to focus primarily on issues of costs and data quality. For example, as a discussant of papers on CATI, Daniel Horvitz (1985) argued that "The **real** value of a given survey design can **only** be measured in terms of total error for a given total survey cost [emphasis supplied]." Unfortunately, the primary conclusions of the CAI literature were not especially encouraging on either count. Nicholls and Groves (1986) observed that "information on the costs of CATI data collection is largely anecdotal and fragmentary." The goal of many CATI surveys, they noted, was not cost savings but cost parity with P&P telephone methods. In a companion article Groves and Nicholls (1986) asserted that "with a few exceptions, there is little reliable empirical evidence that CATI affects data quality." Fifteen years after CATI had been invented, two of its most discussed potential advantages were undemonstrated.

A similar situation existed for CAPI five years later. In a review of the CAPI literature and of CAPI development at the National Center for Health Statistics (NCHS), Thornberry and his colleagues (1991) reported that NCHS had become pessimistic about the possibilities of cost savings with CAPI. They also concluded that firm evidence was lacking to demonstrate that CAPI enhanced data quality in comparison with P&P personal interviews. And Thornberry was only one of several senior survey managers (Lyberg, 1985; Brackstone, 1985) who had observed that hard evidence was not available to justify a conversion from P&P to CAI methods based on cost reductions and data quality enhancements.

Today, we have a much better understanding of the conditions under which computer-assisted methods may (and may not) reduce total survey costs (Martin and Manners 1995) and enhance survey data quality (Nicholls, Baker, and Martin 1996). When appropriately used, they can achieve either goal and sometimes both. However, throughout the quarter century since computer-assisted data collection methods were first invented, the movement of individual surveys (or even classes of similar surveys) from P&P to CAI methods was rarely based on hard evidence of major cost and data quality benefits. Why then were CAI methods adopted and how were these decisions justified?

4. Reasons for Adoption

To better understand the decision-making process, an attempt was made to review all papers written in English describing the introduction, testing, and implementation of CATI and CAPI. Many of these papers listed the just discussed potential advantages of CAI in their introduction or literature review. But 22 of the papers also provided a sufficient description of their decision making process to suggest specific reasons why these new methods were chosen *for the specific survey or class of surveys to which they were applied.* The interpretation of these reasons is, of course, somewhat subjective and partly depends on the concepts brought to this review. The results in Table A are presented more as a summary of interpretations than a statistical analysis. Nevertheless, they suggest that the reasons given for the choice of CAI for specific surveys differed in priority or emphasis from the potential CAI advantages most frequently cited in the literature. They also suggest a key distinction within the concept of data quality.

Table A -- Reasons for the Choice of CAI in 22 Papers

Major Reasons	Papers
Timeliness (especially post interview processing)	(18)
Management of sample, assignments, cases, records	(13)
Operationally evident data quality improvements	(13)
Survey complexity or new CAI capabilities	(10)

Other Reasons (5 or less mentions)

Prospects of long-run cost reductions or equivalence
Prospects of methodologically verifiable reductions in response error or measurement error
Increased opportunities for field quality control
Standardization of survey practices
Desire to be "leading edge," up-to-date, competitive

The most common reason mentioned for the choice of CAI was **timeliness**, especially reduction of the time necessary for post-interview transmission and processing of data prior to analysis, publication, or the next wave of data collection. At times, the same concept was expressed as an increase in post-interview processing efficiency. A few writers also anticipated that CAI would assist in setting up a survey more quickly, although this generally has not proved true for complex academic and government surveys. The early literature also suggested that CATI might accelerate the pace of telephone interviewing, but evidence on this possibility has not been consistent. The primary time savings for CAI are in facilitating (or totally eliminating) post-interview processing. In CAPI, electronic transmissions between survey headquarters and geographically dispersed field staff may save additional time compared with the mailing of field assignments, questionnaires, and completed interview data.

The second most common reason mentioned for moving a survey to CATI or CAPI was their **managerial convenience** for controlling large samples, handling random digit dialing or sequential sampling methods, screening large numbers of cases to find eligible respondents, keeping track of cases and data records in panel surveys, and maintaining records for supervisory and managerial purposes. CAI's management convenience seemed equally important in market research, academic studies, and government data collection.

Another common reason for the choice of CAI was its ability to **enhance data quality in operationally demonstrable ways**, such as by eliminating skip pattern errors through automatic routing and the errors of transcription and data keying in a separate capture step. CAI's on-line editing features also could ensure an in-range response to every applicable item and test for logical or arithmetic consistency between items. Built in or especially written CAI prompts could ensure that identified omissions or errors were reconciled with the respondent during the interview. These options not only reduced (or eliminated) post-interview recalls, editing, and imputation but meant that corrections were made by the person typically best able to provide the information, the respondent.

These data quality improvements rely primarily on reducing interviewer mistakes and shifting the locus of correction of identified errors and inconsistencies to the interview. This is true whether the errors originated with poor questionnaire design, inadequate interviewer training, or the interviewers themselves. These operational improvements are immediately obvious to survey managers because they reduce the post-interview correction burden for which survey managers are responsible. Moreover, this gain generally can be confirmed with a simple feasibility study or pilot survey. From an operational point of view, CAI methods definitely can improve survey data.

This differs from **methodologically verified data quality**, defined by an absence of nonsampling survey bias and error and measured by differences between survey estimates or variances in a controlled experimental study. Survey estimates obtained from a CAI data set with detected errors corrected in the interview may not differ that much from estimates from a P&P data set which has been clerically edited in the office, key entered, and run through a series of batch edits and imputation routines. Summaries of the research literature, e.g., Nicholls et al. (1996), suggest that comparable CAI and P&P split-sample treatments of the same survey typically yield very similar survey estimates and distributions with relatively few exceptions. CAI data sets also differ little from P&P data sets in such indicators of measurement error as response variances, interviewer variances, and panel response stability.

These split-sample comparisons generally were undertaken to compare results from an existing P&P survey with those of a CAI version of the same survey designed to closely emulate the original P&P survey questionnaire and field work methods. It is perhaps not surprising, therefore, that the CAI and P&P results generally differed little in fundamental measures of survey bias and error.

As shown in Table A, the hope that CAI methods would in time contribute to methodologically verifiable reductions in response bias or measurement error was an infrequent reason for the choice of these methods. (Of course, few of the papers explicitly acknowledged the distinction between interviewer mistakes and more basic forms of survey error.) Major reductions in survey bias or measurement error may require more than moving a P&P survey to CAI. It may require a redesign of the survey to utilize CAI's special computer-based capabilities to address the sources of bias and error.

The fourth major reason for the choice of CAI was to utilize its capabilities for such purposes or to **extend the range, detail, or type of data that a survey may collect** with a reasonable assurance of quality. In part these capabilities derive from CAI's standard features, such as automated routing, tailoring of question wording based on prior information, and on-line editing and arithmetic. They permit questionnaires with additional levels of contingency, survey items written for various specific subsets of respondents, and additional cross-checking of provided information during the interview. New surveys of unusual **complexity** become natural candidates for CAI as do existing surveys which have placed unrealistic burdens on P&P interviewers or have required extensive and costly post-interview processing steps.

CAI methods also permit new (or extended) forms of interviewing that are virtually impossible (or at least very difficult) with P&P interviews. These **new capabilities** include sequential sampling, the use of controlled dependent interviewing, access to on-line data bases, and the ability to randomize otherwise biasing question or response category order or other components of the interview process. All these new interviewing tools have been effectively used in market research; and they are increasingly applied to university and government surveys. They add further to the complexity of surveys that CAI may support.

Less than a quarter of the papers mentioned **survey costs** as an explanation of their choice of CAI, and only two gave reduced survey costs as a major reason for its choice. Others mentioned cost reduction (or cost equivalence) only as a long-term goal. Other less frequently mentioned reasons for the choice of CAI included hoped for reductions in measurement error, increased opportunities for field quality control and standardization of survey practices, and the desire to be (or remain) at the forefront of new survey developments. While the advancement of survey methodology was often cited as a benefit of CAI, it does not seem to have been a factor in its choice for specific surveys.

5. Disadvantages

A number of continuing disadvantages of CATI and CAPI have been identified in the literature. Many seem to be common problems of implementing any new computer-based method of performing an organization's work. They include: (1) the need to meet start-up costs for hardware and software; (2) the need to retrain the staff to use the new method confidently and effectively; (3) the need to hire (or train) additional technical staff expert in the new technology; and (4) the occasional need to restructure the organization to better accommodate the new flow or arrangement of work.

Other reported CAI disadvantages are more specific to surveys, although perhaps similar to the disadvantages of other computer applications. They include the length of time required to design, author, test, and debug CAI questionnaires and other survey components that change from survey to survey. They also include the related difficulty of making major changes in the questionnaire and/or design once they are programmed and in operation. The degree of control CAI methods exerts over survey interviewers and supervisors, combined with the difficulty of changing computerized procedures, is sometimes summarized by describing CAI methods as inflexible relative to those of the older P&P tradition.

Whether these or other potential disadvantages actually discouraged many survey managers from using CAI methods for their surveys is difficult to say since those choosing to remain with P&P methods rarely wrote papers about their decisions. We do know that once survey organizations gained some experience with CAI methods, many continued to use P&P methods for small surveys or surveys estimated to require too heavy an investment in CAI survey design relative to savings that might be recovered during post-interview processing (Weeks, 1992).

6 Operational Concerns

Early papers on CATI and CAPI devoted a great deal of attention to operational concerns, i.e., the possible ways in which these new data collection technologies might harm smoothly running survey operations. While survey managers are always interested in costs and timeliness, they typically are more interested in avoidance of such potential disasters as broad respondent resistance, upset or dissatisfied interviewers, missed deadlines, major losses of interview data, or unwelcome changes in survey results that might be attributed to overlooked problems in field procedures. Before entrusting important data collection activities to any new collection method, survey managers and their superiors typically want strong assurances that the change will not leave them vulnerable to such potential failures.

A list of some of the more common operational concerns raised for CATI and CAPI is presented in Table B. They will not be individually discussed in this paper. Instead a few generalizations will be offered about their apparent place in the decision-making process for CATI and CAPI implementation.

Table B -- Illustrative Operational Concerns of CAI

1. Respondent objections, mistrust of computers
2. Interviewer concerns:
   a. Objections to use, loss of professionalism
   b. Trainability or turnover
   c. Laptop weight, eyestrain, heat, radiation
   d. Concerns with computer theft, vandalism, safety
3. Hardware concerns:
   a. Response time between items
   b. Computer durability, downtime, crashes
   c. Screen visibility
   d. CAPI computer battery life, need to plug in
   e. Procurement cycles, replacement methods
4. Major data loss through hardware or system crashes or transmission failures
5. Distortion of the interview process or data from:
   a. Unusual settings, e.g., doorstep, bad weather
   b. Lack of eye contact disrupting rapport
   c. Interviewer miskeying of responses
   d. Truncation of open-end responses
   e. Limitation on interview instrument navigation
6. CAI survey design, setup, testing, and correction
   a. Recruiting, training, retention of CAI authors
   b. Interfacing CAI authors with content experts
   c. Speed of authoring
   d. Debugging and testing of CAI instruments

First, many of these concerns, especially those near the top of the list, have now been fully resolved by field testing, growing experience, and advances in computer hardware and operating systems. It is now known, for example, that respondent and interviewer resistance to CAI is rarely if ever a problem. Of the remaining operational concerns listed in Table B, survey organizations have found methods of minimizing their effects, coping effectively with them, or working around them. None proved continuing impediments to the adoption of CAI methods.

Second, while feasibility and pilot testing at each survey organization was probably most effective in persuading survey managers that CATI and CAPI could be used with relative safety, such operational information also was widely shared among university and government data collection organizations across the world at professional meetings and user groups. The profession worked collectively at these issues.

Third, because operational concerns generally could be allayed by simple feasibility or pilot testing, such tests tended to preempt research funds that might otherwise have been available for methodological studies to compare CAI and P&P methods in costs and data quality. As so often happens, operational priorities took precedence over methodological interests. Even when fully controlled methodological studies comparing CAI and P&P were undertaken, the operational success of the CAI treatment may have been more important to decision making than the methodological conclusions reached. This is especially the case when, as typically happened, the comparative study found little if any difference between the CAI and P&P treatments in total costs, estimates, and measures of data quality.

Finally, once the operational concerns were satisfied, many survey managers and their superiors may have felt ready to move toward an implementation decision, provided estimated CAI costs (although not fully known) appeared to be manageable. Once it was clear that CAI prosed little threat of serious failure and had feasible costs, CAI's operational advantages of reduced processing time, reduced correction burden, efficient case management, and ability to take on surveys of greater complexity may have been sufficient to prompt a move to implementation.

7. Bringing Additional Surveys into CAI

Once a survey organization has its first large-scale success with CATI or CAPI, it typically proceeds to move additional surveys into the same system. This is often a matter of financial necessity. The hardware, software, training and related costs of establishing a CATI telephone facility or equipping a CAPI field force with laptop computers are best met by spreading those costs over multiple surveys. Thus, adding further surveys to the system is typically in the survey organization's best interest even if the added surveys do not find their individual costs reduced. In many cases, of course, individual survey managers ask to be among those using the most modern methods.

And once a survey organization begins moving multiple surveys into CATI or CAPI, there also are strong pressures to continue until all (or virtually all) P&P surveys are eliminated. Maintaining parallel survey systems, one for CAI and another for P&P methods, is awkward and costly. Interviewers cannot easily be transferred between these methods without double training and sometimes have resisted P&P work once experienced in CAI methods. Separate staffs may be required for CAI and P&P questionnaire design, and separate case management systems may be necessary. Moreover, until the data keying and clerical editing staffs necessary for P&P methods can be eliminated, the long-range cost savings of CAI methods may not be attainable.

While such economic and organizational considerations can be seen as forces encouraging the growth of CAI methods, they also can be viewed as further disadvantages of moving to CAI that are rarely recognized in advance.

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Note

[1]This paper reports the general results of research undertaken by staff members of the U.S. Census Bureau and Statistics Netherlands. The views expressed are attributable to the authors and do not necessarily reflect those of the Census Bureau or Statistics Netherlands.