DEVELOPING COST MODELS FOR CATI SURVEYS

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1. INTRODUCTION

This is a first report on the development of cost models by the U.S. Bureau of the Census to help assess the costs of new data collection designs employing computer assisted telephone interviewing (CATI) in its current demographic surveys. A companion paper (Bushery et al, 1987) from the Census Bureau reports preliminary results of the effects of these designs on survey estimates and data quality.

CATI employs an interactive computer system to assist interviewers and their supervisors in conducting telephone interviews from centralized locations. Survey questions are displayed on a computer screen for interviewers to read to respondents, while their responses are keyed directly into the computer. Skip patterns are computer controlled and entries can be edit checked as they are recorded. The system also schedules the telephone calls and callbacks, and maintains records of sample progress and interviewer performance.

The Census Bureau has been investigating the use of CATI in survey data collection since the early 1970's (Ferrari, 1986, Nicholls, 1983, and Nicholls and Groves, 1986), and in 1985 opened a 40-station CATI facility in Hagerstown, Maryland. The Hagerstown Telephone Center (HTC) is employed both for production interviewing on small surveys and for evaluative testing of CATI for large current surveys, such as the Current Population Survey, the National Crime Survey, and the American Housing Survey. This paper focuses on the Current Population Survey (CPS).

The CPS employs a rotating panel sample of about 72,000 housing units per month with a 4-8-4 interviewing design. Households are interviewed for four consecutive months, excluded for eight months, returned for another four months, and then retired from the survey. The first and fifth interview at each housing unit is by personal visit, while the second through fourth and sixth through eighth monthly interviews are by telephone from the interviewers' homes when possible, or by personal visits when necessary.

The CATI interview design under consideration for CPS retains the personal visit interviews in the first and fifth months but replaces paper-and-pencil dispersed telephone interviews from interviewers' homes with CATI interviews from centralized sites, such as the HTC. Housing units which are not reachable by telephone, i.e., vacant, without a telephone, unanswered telephone in repeated calls, or refusals, are retained in or recycled to the regional offices for personal visit interviews. Six months of feasibility testing have demonstrated that recycling can be completed within the one week CPS interview period without a decline in response rates.

Interviewing in one week is feasible since the CPS questionnaire is simple, short, and unmutable. Some months contain relatively long and complex supplements (e.g., March) which extend to two weeks of interviewing, causing a substantial rise in costs for that month. The costs associated with the March supplement are not included in the current cost models.

A field test of the new CPS design using CATI, limited to the first four months of the 4-8-4 interviewing design, was begun in September 1986, and reached its full four month rotation group size of 3,000 housing units by November. The test employs a supplementary sample of metropolitan areas which are not included in the Census Bureau's published estimates. The current CPS sample from the same areas is used as the control for comparison of labor force estimates.

A major goal of this cost analysis study is to compare the cost per case of the new design which integrates CATI with that of current CPS (hereafter called CATI CPS) to the current CPS design (hereafter called regular CPS).

In the next section reasons for developing cost models and the major cost components for the telephone center and for the regional office are presented. Section 3 discusses the basic differences in cost between the two methodologies, and the final section describes future work to be completed.

2. DEVELOPMENT OF MODELS

To determine if CATI will be cost competitive with the current methodology cost models were developed for several reasons:

1. to adjust available cost reports which do not precisely fit needed cost estimates for a CATI based system. For example, field costs are reported as national averages for CPS; however, CATI CPS will initially be implemented only in multiple interviewer primary sampling units (PSUs) which differ in size and population density from the national average.
2. to prepare cost estimates expected to vary with the values of key parameters. For example, the HTC caseload will ultimately be four to five times larger than the current caseload being implemented there. The larger caseload will affect interviewer workloads both at the HTC and in the field.
3. to define relationships between variables which affect total costs. Equations used to calculate components of costs will show the effects of changes in individual variables on the cost components.

While these cost models were designed specifically for Census Bureau surveys, they may prove useful to other organizations if modified to those organizations' circumstances, and if values are substituted to reflect the designs of their surveys. Users are cautioned that the models presented are only preliminary and subject to a series of validation tests not yet completed.

This paper focuses exclusively on data collection costs. Although survey design and survey processing costs will be incorporated in future models they are not addressed here. This

paper also omits CATI's added costs of computer hardware and technical staff.

The first step in developing the models was to itemize the data collection activities carried out in the field and at the HTC. Currently budgeted costs were disaggregated into functions of as many variables as possible. Thus as the value of one variable changed, the effect of that change could be seen directly on specific costs.

Summary costs were separated into those associated with the first month of interviewing and those associated with the second through fourth months of interviewing. The major components of the two data collection methods may be represented as follows:

	1st month	2-4 month	
CATI CPS	C_1	C^H_{2-4}	$=C_T$
		C^R_{2-4}	
Regular CPS	R_1	R_{2-4}	$=R_T$

For the first month of interviewing, both the CATI procedure (C_1) and the regular CPS procedure (R_1) consist of only regional office personal visit costs. For the second through fourth months, the CATI procedure contains both HTC costs (C^H_{2-4}) and regional office costs (C^R_{2-4}), the latter including recycled cases and those never sent to the HTC, e.g., households with no telephone. The regular CPS procedure (R_{2-4}) will consist only of the costs from personal visit and telephone interviews conducted from the interviewers' homes.

2.1 Hagerstown Telephone Center

Current budgets for the HTC were studied to produce the majority of the cost factors. Some variables, such as hours required by supervisors, pay rate per hour, and payroll time per case, were determined from payroll records. Others are functions of a set of variables. For example, the required number of interviewers depends on the caseload, payroll time per case, and the length of the data collection period. If the number of cases were to increase, the number of interviewers also would have to increase to permit completion of the interviews in the one week CPS interviewing period. Alternatively, if the number of interviewers were to remain the same, the total interviewing time would have to be extended, by increasing the interviewer shift length, and/or the number of shifts to permit completion of CPS interviewing in one week.

The HTC cost model (Appendix A) consists of several major components of costs:

A. salaries
   - interviewers
   - shift supervisors
   - facility supervisors

B. training
   - initial
   - refresher

C. communications

D. benefits and overheads

The functions of interviewers and facility supervisors are obvious from their titles. Shift supervisors monitor interviewers' calls for evaluation purposes, perform interviews, and keep account of weekly progress. Each new interviewer must undergo a number of hours of initial training before he/she can perform "live" survey interviews. All continuing interviewers and shift supervisors must have refresher training several times a year. This familiarizes them with the content of supplemental questions and maintains the quality of interviews.

Communications include both telephone charges and a leased computer line from the HTC to headquarters. A number of local lines also must be maintained for everyday use and as a backup for nonfunctioning long distance (WATS) lines. Benefits and overheads are based on salaries.

As an example of developing models for these costs, the communications charges were subdivided into costs charged to outgoing long distance lines and incoming long distance lines. Six months of telephone expenditures were averaged to determine the total minutes used for CPS per month and to obtain the percentages of incoming and outgoing long distance line charges. The cost was then partitioned into fixed charges and WATS charges. Local line costs are considered an overhead and thus not charged to individual surveys at this time.

2.2 Regional Office

Cost and performance reports, interviewer performance records, and current budget models were used to determine many of the costs involved in the field, just as they were used to assist in determining HTC costs.

The regional office costs (Appendix B) include major components paralleling the HTC model, but also include costs for additional types of cases, staff levels, and activities. Thus the major components are listed in a slightly different order:

A. salary and mileage
   - interviewers
     - regular interview cases
     - recycled cases
   - supervisory field reps., supervisors
     - reinterview cases
     - observation cases

B. training
   - initial
   - refresher

C. additional salaries
   - supervisory field representatives
   - supervisors
   - coordinators
   - clerks

D. postage and shipping

E. benefits and overheads

The field staff conduct regular interview and reinterview cases both for regular CPS and CATI CPS. Cases that are not sent to the HTC or are recycled from the HTC are interviewed in the field in CATI CPS. Personal interviewing costs include mileage as well as salaries. At least once a year each interviewer is observed in the field by supervisory personnel, and mileage and/or per diem are charged for these observations. Additional salary costs for supervisory and other staff members occur for quality control activities, coordination of interviewing personnel, mailing and keying of questionnaires, and other duties. Postage and shipping costs are paid for transmitting the questionnaires from the regional office to the field interviewers, and returning the questionnaires to the regional office. This is required both for regular interview cases and recycled cases. Training, benefit, and overhead costs are similar to those for the HTC.

Regional office interviewing costs for both CATI and regular CPS were divided into categories based on the type of case, i.e., regular field, recycled, and reinterview. Each was then defined by the following parameters: number of cases, average distance travelled per personal visit, average interview time per personal visit, average interview time per telephone case, percent of cases which are personal visit, percent of cases which are by telephone, and minutes per office edit. These parameters were then used in conjunction with mileage rate and pay rates to estimate some of the direct costs involved in both methodologies. For example,

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cost for regular personal visit cases =
   number of cases * percent which are
   personal visit * [(average interview
   time for personal visit * pay
   rate) + (average distance travelled
   * mileage rate)]
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This cost was analyzed further by multiplying the percentage of cases completed by the different types of interviewers, i.e. intermittent and part-time.

Two sets of values were obtained for each variable in the regional office cost model: one set representing the values associated with regular CPS and the other set pertaining to CATI CPS.

3. COMPARISON

Under full implementation, approximately half the cases will be CATI eligible under CATI CPS. Therefore, the months 2-4 field caseload size will be reduced by a half.

This will have three major effects on field interviewing:

i) the proportion of personal visit cases per interviewer will be greatly increased;

ii) fewer interviewers in a PSU will increase average interview time and distance per personal visit case; and

iii) the same increased costs will apply to cases recycled to the field for interviews not obtained at the HTC.

Although the number of field cases will be reduced by half for the months 2-4 caseload size, interviewing costs will not be reduced proportionately because the percent of personal visit cases per interviewer will increase, along with the cost per case. Recycled cases add somewhat disproportionately to costs both in interviewer time and mileage since they are conducted later in the week when fewer geographically contiguous CPS cases remain for completion. However nearly half of the recycled cases are completed by telephone in the field.

Recruiting and training new interviewers is much more expensive in the field than at the HTC. Each regional office is responsible for training its own interviewers, which requires travel to a central location for several days of instruction. Thus travel, per diem, and salaries must be paid. Also, travel and per diem payments for the supervisory personnel doing the training may be necessary if the training is outside of the regional office city. If not, then only the salaries of the supervisory personnel are added to the training costs. Under CATI, HTC interviewers and training personnel live near the facility and training is completed at the HTC. Thus, only salaries constitute training costs. Refresher training also is less expensive at the HTC for the same reasons.

Experienced field interviewers are observed once a year and for new field interviewers three times per year. The average cost per observation is fairly high because a supervisor or supervisory field representative must travel to the interviewer's location and observe the interviewer on personal visits. Salary, per diem, and travel are charged for these trips. Total costs for observations under CATI CPS are decreased due to the reduction in the number of interviewers in the field. Observations at the HTC are equivalent to the shift supervisors' monitoring, so a separate calculation of this cost is not necessary.

A reduction in the field workload size will have an effect on interviewer turnover rate. Even if field turnover increased slightly under CATI CPS, overall interviewer turnover would be reduced if the retention of interviewers is high at the HTC. Total turnover and training costs would decline if all CATI sites, are located in areas where the labor markets are good, and/or the training is made more effective by centralization.

Postage and shipping costs are less under CATI CPS because fewer questionnaires are mailed to and from the field. Clerical editing will be reduced proportionately with the reduction of the number of field interviews. Editing costs do not occur at the HTC since editing is automated as the interviews occur. Also fewer interviewers in the field will decrease the costs pertaining to coordinators and clerks since fewer of these personnel will be required under CATI CPS.

These cost reductions under CATI CPS are partially offset by HTC operating costs, e.g., communications costs and office space costs. Overall, the cost for CATI CPS appears to be slightly less than regular CPS at this time.

4. FUTURE WORK

A thorough evaluation of the costs associated with CATI is currently limited by the lack of detail of available cost reports. Now that the cost factors have been determined, a concentrated effort can be made to acquire the data collection costs in the form needed for analysis. Also, processing and perhaps design costs need to be incorporated before a decision can be made to determine whether an integrated system is cost competitive with the current collection system.

These models will be used as a basis for future study to determine the effect of specific variables on survey costs. The cost factors, the equations, and the assumptions that are used to calculate the costs in the models, are items which require further investigation.

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1. FOOTNOTE
This paper reports the general results of research undertaken by Census Bureau staff. The views expressed are attributable to the authors and do not necessarily reflect those of the Census Bureau.

HAGERSTOWN TELEPHONE CENTER — APPENDIX A

Description	Variable
number of cases	D10
payroll minutes / case	D15
number of days in survey period	D20
minutes per shift	D25
interview rate/hour	D30
initial interviewer rate/hour	D35
shift supervisor rate/hour	D40
program supervisor rate/hour	D45
hours required by shift supervisor	D50
hours required by program supervisor	D55
quality circle meetings	D60
self-study exercise	D65
monthly interviewer turnover rate	D70
initial training hours	D75
refresher training hours	D80
frequency of refresher training per year	D85
night differential rate	D90
work load affected by night differential	D95

DIRECT COSTS

D100	no. of interviewers	D10 * D15/D20 * D25
D105	no. of new interviewers	D100 * D70
D110	no. of shift supervisors	D100/10
D115	no. of program supervisors	D115
D120	interviewers salary	D10*D15*D30/60 min.
D125	interviewer night differential	D120 * D90 * D95
D130	shift supervisor salary	D40 * D50 * D110
D135	shift supv. night differential	D130 * D90 * D95
D140	program supervisor salary	D45 * D55 * D115
D145	program supv. night differential	D140 * D90 * D95
D150	quality circle for interviewers	D100 * D30 * D60
D155	quality circle for shift supv.	D110 * D40 * D60
D160	quality circle for program supv.	D115 * D45 * D60
D165	initial training	D35 * D75 * D105
	refresher training:	
D170	interviewers	D30*D80*D85*D100 /12 mo.
D175	shift supervisors	D40*D80*D85*D110 /12 mo.
D180	program supervisors	D45*D80*D85*D115 /12 mo.
D185	Total full-time salaries	D140+D145+D160+D180
D190	Total part-time salaries	D130+D135+D155+D175
D195	Total intermittent salaries	D120+D125+D150+D170
D200	Total Salaries	D185 + D190 + D195
D250	Applications and Overheads	function of salaries

TELEPHONE CHARGES

	Connect time per case	D265
D270	CPS total minutes	D10 * D265
	MCI Access Charge	D275
	AT&T Access Charge	D280
	% of Access Charge used by CPS	D285
	MCI cost/minute	D290
	AT&T Out-WATS / min.	D295
	AT&T In-WATS / min.	D300
	% of MCI WATS charges affected	D305
	% calls used by MCI	D310
	% calls used by AT&T Out-WATS	D315
	% calls used by AT&T In-WATS	D320
D320	MCI fixed charges	D275 * D285
D325	MCI WATS charges	D270*D290*(1+D305)*D310
D330	AT&T fixed charges	D280 * D285
D335	AT&T WATS charges	D270*D295*D315+D270*D300*D320
D340	Total Telephone cost	D320+D325+D330+D335
D345	Overall Total	D200+D250+D340
D360	Cost per case	D345 / D10

REGIONAL OFFICE APPENDIX B

Description	Variable
caseload per interview	D8
intermittent (INT) interviewer rate/hr	D14
part-time (PT) interveiwer rate/hr	D17
superivsory field rep.(SFR) rate/hr	D20
full-time (FT) supervisor rate/hr	D22
coordinator rate/hr	D23
office clerk rate/hr	D24
senior office clerk rate/hr	D25
% of interviews by INT	D26
% of interviews by PT	D29
mileage rate	D32
% of cases requiring callbacks	D34
cost per call	D37
% of work by PT at night diff.	D39
night differential	D42
cost / interviewer	D44
turnover rate for interviewers	D46
initial training hours	D47
refresher training hours	D48
% of field cases keyed	D49
keying cost	D52
keying time	D54
postage	D56
frequency of refresher training per yr.	D57
average distance travelled for training	D58
REGULAR FIELD CASES	
no. of field cases	D60
average distance travelled-personal	D62
average interview time-personal	D65
average interview time-telephone	D68
% personal visit interviews	D71
% telephone interviews	D74
minutes per office edit	D77
RECYCLED CASES	
no. of recycled cases	D82
average distance travelled-personal	D85
average interview time-personal	D87
average interview time-telephone	D91
% personal visit interviews	D94
% telephone interviews	D97
minutes per office edit	D100
REINTERVIEW	
no. of reinterview cases	D105
average distance travelled-personal	D108
average interview time-personal	D111
average interview time - telephone	D114
communications cost/case	D123
% performed by SFR	D125
% performed by FT	D127
% personal visit interviews	D130
% telephone interviews	D133
OBSERVATION	
cost per case	D138
D140 travel cost/case	function of D138
D142 salary cost/case	function of D138
D144 communications cost/case	function of D138
% performed by SFR	D146
% performed by FT	D148

DIRECT COSTS

D150 no. of INT and PT interviewers	D60 / D8
D151 no. of SFRs	D150 / 10
D152 no. of FT supervisors	D150 / 100
D153 no. of office clerks	D60 / 1250 cases
D154 no. of senior office clerks	D154
D156 no. of new INT interviewers	D150 * D46 * D26
D157 no. of new PT interviewers	D150 * D46 * D29

REGULAR FIELD CASES

D158 travel cost by PT and INT interviewers	D32*D60*D62*D71
D161 cost for personal visit cases by INT interviewers	D14*D26*D60*D71*D65/60min.
D164 cost for phone cases by INT interviewers	D14*D26*D60*D74*D68/60min.
D167 cost for personal visit cases by PT interviewers	D17*D29*D60*D71*D65/60min.
D170 cost for phone cases by PT interviewers	D17*D29*D60*D74*D68/60min.
D173 night differential for PT interviewers	(D167+D170)*D39*D42
D176 communications cost including callbacks	D37*D60*(D34+D74)
D179 Total costs for Field Cases	D158+D161+D164+D167+D170+D173+D176

RECYCLED CASES

D184 travel cost by PT and INT interviewers	D32*D82*D85*D94
D188 cost for personal visit cases by INT interviewers	D14*D26*D82*D94*D87/60min.
D191 cost for phone cases by INT interviewers	D14*D26*D82*D97*D91/60min.
D194 cost for personal visit cases by PT interviewers	D17*D29*D82*D94*D87/60min.
D197 cost for phone cases by PT interviewers	D17*D29*D82*D97*D91/60min.
D200 night differentrial for PT interviewers	(D194+D197)*D39*D42
D203 communications cost	D37 * D82 * D97
D205 Total Cost for Recycled Cases	D184+D188+D191+D194+D200+D203

REINTERVIEW CASES

D209 travel cost by SFR and FT	D32 * D105 * D108 * D130
D213 cost for personal visit cases by SFR	D20*D105*D130*D125*D111/60min.
D216 cost for phone cases by SFR	D20*D105*D133*D125*D114/60min.
D219 night differential for SFR	D213 + D216 * D39 * D42
D222 cost for personal visit cases by FT	D22*D105*D130*D127*D111/60min.
D225 cost for phone cases by FT	D22*D105*D133*D127*D114/60min.
D228 night differential for FT	(D222 + D225) * D39 * D42
D231 communications cost	D105 * D123
D234 Total Cost for Reinterview cases	D209+D213+D216+D219+D222+D225 +D228+D231

OBSERVATION CASES

Initial Observation:	
D235 for SFR	(D156+D157) * D142 * D146 * 3
D236 for FT	(D156+D157) * D142 * D148 * 3
D237 travel cost	[(D156+D157)]*D140*(D146+D148)*3
Follow-up Observation:	
D239 travel cost by SFR and FT	D150 * D140 /12 mos.
D242 cost for cases by SFR	D150 * D142 * D146 / 12 mos.
D245 cost for cases by FT	D150 * D142 * D148 /12 mos.
D248 communications cost	D150 * D144 /12 mos.
D251 Total Cost for Observation Cases	D239 + D242 + D245 + D248
D252 Turnover Cost for INT	D150*D26*D44*46/12 mos.
D253 Turnover Cost for PT	D150*D29*D44*D46/12 mos.
Initial Training:	
D254 for INT	D156 * D47 * D14
D255 for PT	D157 * D47 * D17
D256 for SFR	D47 * D20
D257 for FT	D47 * D20
D258 travel cost	(D156+D157) * D58 * D32
Refresher Training:	
D259 for INT	D48*D57*D150*D14*D26/12 mos.
D262 for PT	D48*D57*D150*D17*D29/12 mos.
D265 for SFR	D48*D57*D151*D20/12 mos.
D268 for FT	D48*D57*D152*D22/12 mos.
D271 Total for Turnover and Training	D252+D253+D255+D256+D257+D258 +D259+D262+D265+D268
D275 office clerk editing cost	D24*D60*D77*D153/60 min.
D276 senior office clerk cost	D25*D60*D77*D154/60 min.
D277 Total communications cost	D176 + D203 + D231 + D248
D279 Total travel cost	D158+D184+D209+D237+D239+D258
D281 Total cost for INT	D161+D164+D188+D191+D252+D254+D259
D284 Total cost for PT	D167+D170+D173+D194+D197+D200 +D253+D255+D262
D287 Total cost for SFR	D213+D216+D219+D235+D242+D256+D265
D289 Total cost for FT	D222+D255+D228+D236+D245+D257+D268
D290 Total cost for clerks	D275 + D276
D291 Cost for other work by SFR	(D10*D20* ? hr.) - D287
D292 Cost for other work by FT	(D12*D22* ? hr.) - D289
D293 Total salary cost	D281+D284+D287+D289+D290+D291+D292
D296 Subtotal #1	D277 + D279 + D293
D300 Applications and Overheads	function of salaries
D370 OVERALL TOTAL	D296 + D300
D374 Cost per Field Case	D370 / D60
D376 Cost per Case (includes HTC cases)	(HTC total cost + D370)/total cases