Catalogue no. 11-522-XIE

## Statistics Canada International Symposium Series - Proceedings

# Symposium 2003: Challenges in Survey Taking for the Next Decade

2003


Statistics Canada Statistique Canada

Canada

Proceedings of Statistics Canada Symposium 2003
Challenges in Survey Taking for the Next Decade

# THE USE OF MOBILE COMPUTING DEVICES FOR DATA COLLECTION: CHALLENGES FOR IMPLEMENTING FIELD OPERATIONS

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## ABSTRACT

Field data collection activities for Census 2000 were primarily pencil and paper operations. Field staff used paper maps and listing pages for updating and locating their assignments and collecting interview data on paper questionnaires. For the 2010 Census, one of the three major goals is to contain cost. Reducing the production and the distribution of printed materials could realize significant savings in field data collection operations, as well as in data capture. The U. S. Census Bureau will conduct a census test in 2004. A major innovation that will be tested is the use of mobile computing devices, or hand-held computers, to conduct interviews during the nonresponse followup operation. The devices will contain an automated questionnaire in English and Spanish, map files, assignment management tools, and global positioning technology. The potential benefits of using a mobile computing device include reduction of paper; including printed questionnaires, maps and address listing pages, in addition to improved data quality through internal automated edits, reduction of data capture of paper questionnaires, and accurate assignment of housing units to their correct geographic location. The transition to automated data collection in a decennial census environment provides several implementation challenges for field operations that require rethinking the traditional roles and activities of the decennial field staff. These challenges include the workflow, the distribution and accounting of the devices, edit and review of work, training logistics, and tracking production.

KEYWORDS: Automated Data Collection; Field Operations Challenges; Mobile Computing Devices.

## 1. INTRODUCTION

### 1.1 Census 2000

The United States Census 2000 is recognized as the “best census ever.” It also was the costliest decennial census. At the height of Nonresponse Followup, our single largest field operation, we had close to 500,000 field staff attempting to conduct a personal interview with over 44 million housing units. Each enumerator was equipped with paper questionnaires, paper address assignment listings, paper maps, and paper daily payroll forms. In addition to the preprinted questionnaires and payroll forms, the 520 Local Census Offices (LCOs) printed an estimated 40 million map sheets, 25 million listing pages, as well as the daily paper production and progress reports. In addition, the paper questionnaires and assignment of new work, as well as reassignments, were shuttled by field staff between the enumerator and their supervisors, hand delivered to the LCOs and completed questionnaires were shipped via overnight delivery to the data capture centers. The production and distribution of printed materials for Census 2000 was a highly intensive and expensive manual activity.

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# 2. PLANNING FOR 2010 DECENNIAL CENSUS

The U.S. Census Bureau is undertaking an effort to re-engineer the 2010 Decennial Census that will enable us to: improve the relevancy of the census long form data, improve coverage of housing and population, contain costs and reduce operational risk. There are three major integrated activities associated with the re-engineered census. These are:

1. American Community Survey (ACS) will collect decennial census long-form data every month instead of once every ten years and provide detailed economic and demographic characteristics on a yearly basis rather than only once a decade. With the full annual sample of 3 million households expected to begin in late summer of 2004, we can eliminate the need for a long-form in the 2010 census.

2. The enhancement and improvements of our existing geographic and address file processing systems used to support all data collection, data tabulation, and data dissemination activities. In addition we expect to have the feature network in all 3232 counties to be positionally corrected to allow us to take advantage of Global Positioning Systems in 2010 Census.

3. Early 2010 planning, development, and testing designed to restructure the conduct and management of a short-form only census. This involves a multi-year of planning, field tests, and evaluations to design a decennial census that will reduce control costs, reduce risk, and improve coverage.

A major component of the early planning involved the conduct of field tests. Our first major field test is the 2004 Census Test to be conducted in two sites in the country.

## 2.1 Major Objectives of the 2004 Census Test

The 2004 Census Test will be conducted in two sites: one comprised of 3 counties in southern rural Georgia, and one in a portion of Queens Borough, New York. The test will not be a full census, it is designed to evaluate a few major methodological and procedural improvements that will help us design the re-engineered census. The major test objectives include;

1. Develop methods for implementing a Mobile Computing Device (MCD) which includes GPS technology for our Non Response Followup (NRFU) operation.

2. Develop new methods for improving coverage of population and housing.

3. Gain insight on respondent reaction to new race and Hispanic origin questions, including the elimination of the “some other race” option.

4. Improve our definition and methods for identifying and distinguishing between housing units and group quarters and develop an integrated update mechanism for our Master Address File.

This paper will focus on the challenges of the first objective related to the challenges of developing and implementing an MCD system for a major field operation. The basic research questions related to this objective:

1. Did the operational design (data transmission, workflow, control system, file interfaces, and security) support the successful implementation of NRFU?

2. Were the enumerators able to conduct an interview on the MCD (in both English and Spanish), receive and transmit their completed interviews, navigate to and locate their assignments using the maps on the device, obtain GPS coordinates, and what effect did the MCD have on their productivity?

3. What was the impact on field and office staffing levels, position requirements, management/staff ratios, space and training needs?
4. What is the effect on data quality using an MCD for data collection during NRFU?

The functionalities currently being developed for the MCD for the 2004 Census Test will help us answer those questions. Ideally a full and complete data collection operation using a computing device will eliminate the need for most paper products and much of the manual intervention, however due to constraints of time and resources, priorities were given to those functionalities necessary to answer the research questions. Some of the basic functionalities include:

1. automated instrument (in English and Spanish)

2. assignment management system

3. display address list and ability to add new housing units

4. map display with GPS functionality to show “you are here” and the ability to collect GPS coordinates for housing units

5. ability to receive and transmit cases

6. ability to receive updated assignments (late mail returns)

7. internal edits to improve data quality

Development work on the following continues, but will not be developed specifically for the 2004 Census Test and will remain paper-based:

1. personnel and payroll

2. daily progress reports

3. make updates to the maps

## 3. CHALLENGES FOR IMPLEMENTING FIELD OPERATIONS USING MCDs

### 3.1 Census 2000 Workflow

For Census 2000, our field staffing structure and workflow was very hierarchical (Figure 1). The LCO workload, including the paper questionnaires flowed from Headquarters to the LCOs. A highly intensive, manual assignment preparation operation was conducted in the LCO, including the printing and assembly of over one million assignments containing over 44 million maps sheets and 25 million address listing pages, and delivered to the Field Operations Supervisor (FOS), who in turn gave them to their Crew Leaders. Following their training, each Crew Leader was responsible for the training and supervision of approximately 16 enumerators. Upon completion of enumerator training, the enumerators received their initial assignments from the Crew Leader, complete with the paper questionnaires, register containing paper address listing pages, paper maps, as well as their paper daily pay roll records.

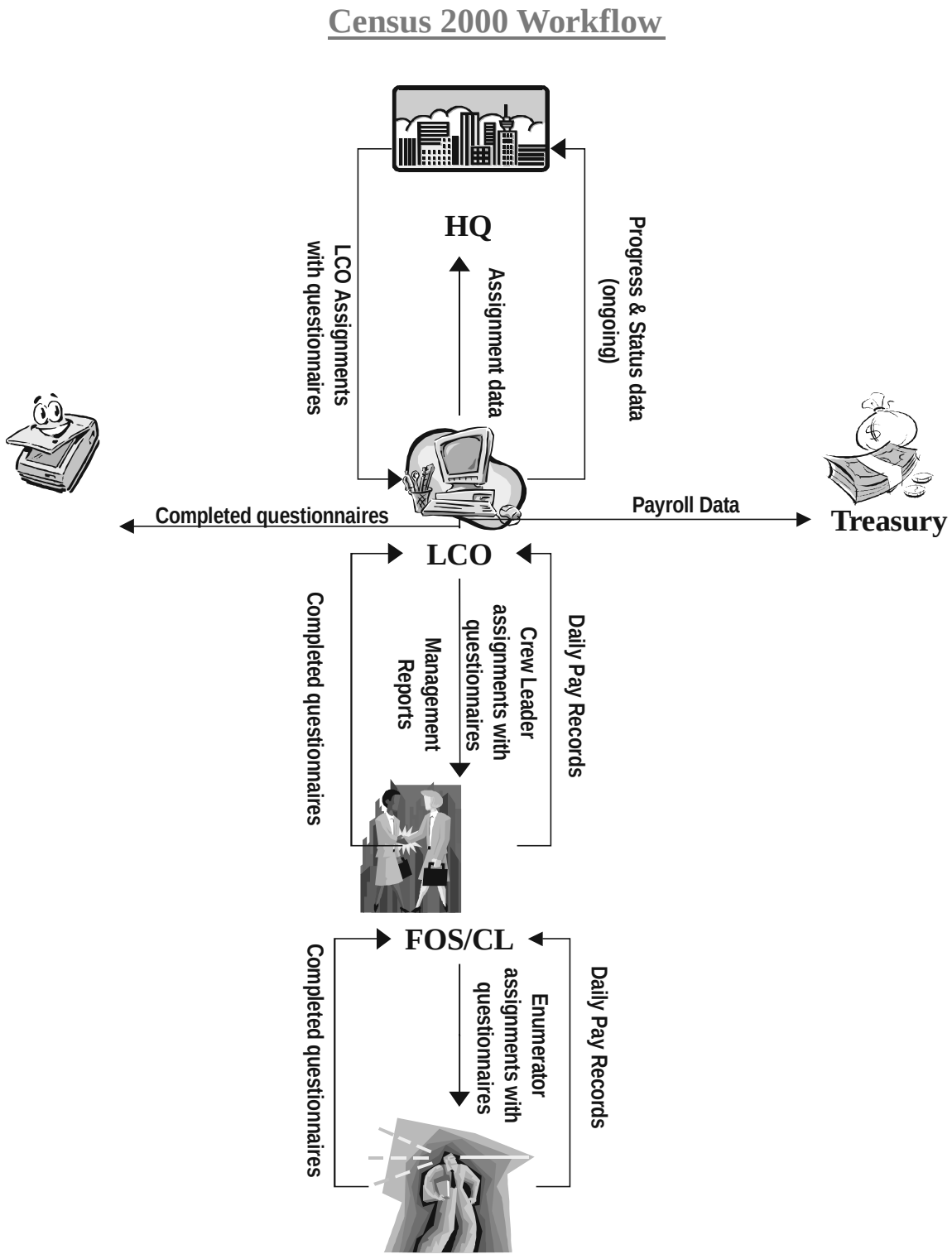


**Figure 1. Census 2000 Workflow**

From the group of enumerator trainees, the Crew Leader selected two to become Crew Leader Assistants. The Crew Leader Assistants helped the Crew Leader shuttle completed work, deliver new assignments and reassignments.

Verbatim training was conducted in a classroom style setting using paper manuals and workbooks. Space requirements for training were minimal and there were no special requirements for electrical or telephone hookups. The FOSes and Crew Leaders were encouraged to look for free spaces such as libraries, community centers, and fire stations.

During the first day of the training the enumerators completed several personnel forms and were sworn in, both of which must be completed, were delivered (by courier or overnight shipping) to the LCO, keyed into the personnel system before they were given an employee ID and considered official Census Bureau employees and could get paid.

As production began, the Crew Leader met on a daily basis with their enumerators to review their progress, certify and collect their daily pay records, review and collect their completed questionnaires, give them any new assignments or if necessary, collect their incomplete work to reassign to another enumerator for completion. Reassignment work was manually recorded and physically transferred to another enumerator. The reviewed, completed questionnaires, along with the daily pay records were hand delivered or shipped via overnight delivery to the LCO. Paper questionnaires were wanded into the control system, daily pay records were keyed into the personnel and payroll system, and new daily progress reports were printed and given to the FOS and CL. The questionnaires were again reviewed in the LCO, and reassigned back to the field if necessary. After review in the LCO, the paper questionnaires were shipped to the data capture centers. The keyed payroll data was transmitted to treasury for processing the payroll checks.

Assignments and reassignments flowed from the LCO down through the line of field supervision to the Crew Leaders to the enumerators. Completed work was reviewed, pay records certified, and flowed up from the enumerators back up through the line of supervision until it reached the LCO.

## 3.2 2004 Test Workflow

The development of an MCD system to collect data during the NRFU operation poses several challenges and rethinking of our traditional roles and activities of the decennial field staff. The 2004 Test workflow has been modeled after our Computer Assisted Personal Interviewing (CAPI) model that the Census Bureau has used since we first began the transition to automated interview on laptop computers for our current survey program which began in the early 1990s (Figure 2).

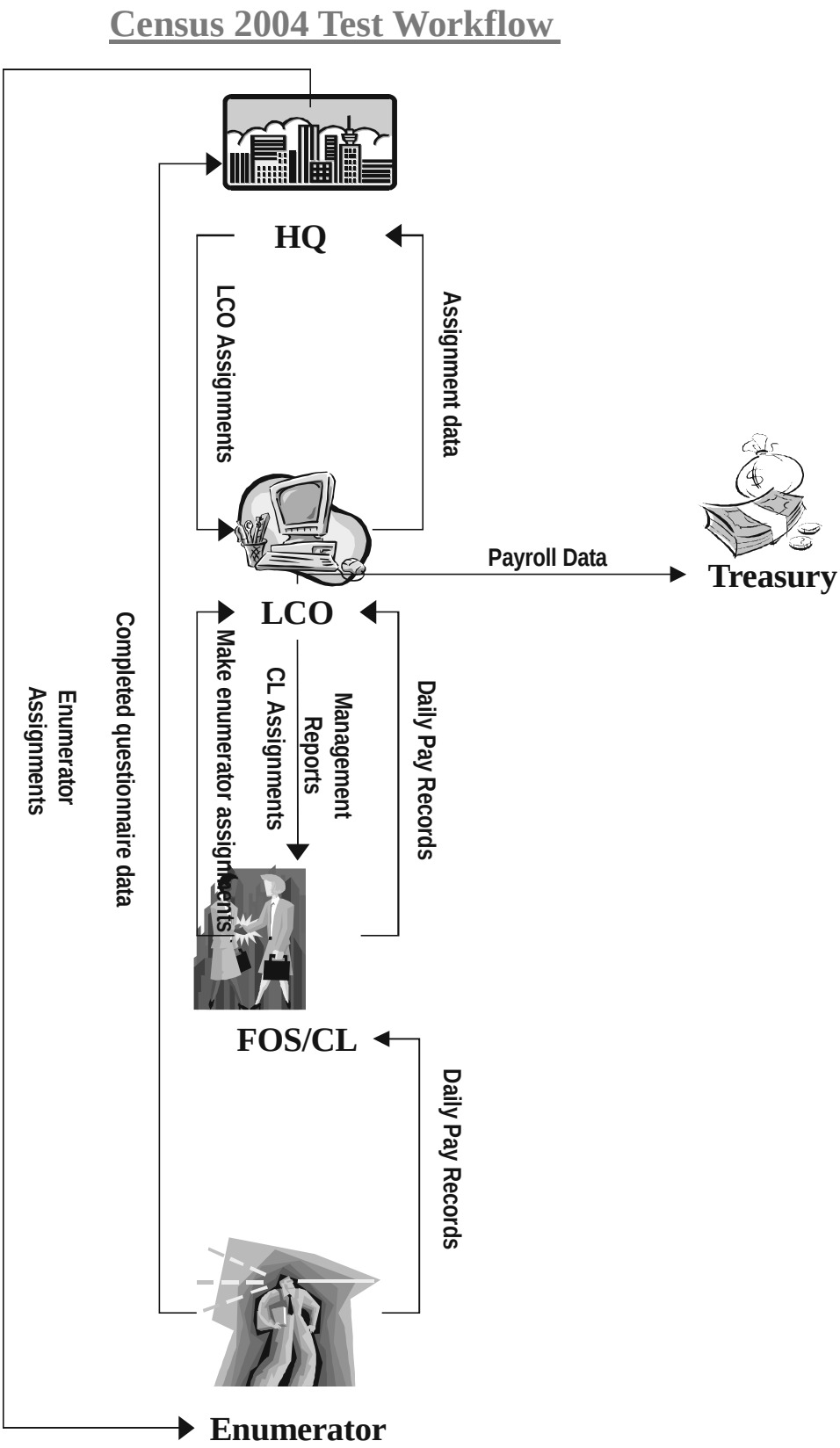


**Figure 2. Census 2004 Test Workflow**

Since the maps and assignments will be on the MCDs, there will no longer be a need to print paper address listing sheets and maps. We will no longer have a highly intensive manual assignment preparation operation in the LCOs. We expect the MCD will contain the software, as well as the appropriate map files before the device arrive in the LCO. We still anticipate the FOSes to train the crew leaders and crew leaders to train the enumerators.

We expect to conduct a verbatim training for the 2004 test but one of our requirements for training space will be more complex. A significant portion of the training will be on the use of the device itself, thus increasing the needs for multiple electrical outlets to avoid depleting the MCD batteries. Prior to assigning a device to a trainee, they must first be an official Census Bureau employee. During the first day of training the trainees must be sworn in, as well as fill out several personnel forms. Because we will not have the personnel and payroll functionality developed on the MCD in time for the 2004 test, it will be necessary to hand deliver the paper forms to the LCO for keying into the personnel and payroll system before the enumerators can be assigned an employee ID and assigned the equipment.

We expect the personnel documents to be delivered to the LCO following the first day of training and by the beginning of the third day of the anticipated five day training the crew leader will be able to assign the devices to the individual enumerators. The devices will contain the necessary software and map files, but will not initially contain the individual assignments. Once a device has been assigned to an enumerator, they will be instructed on transmissions, so they can receive their assignment cases. Thus, creating a need for telephone lines in the training site, and possibly eliminating the acquisition of free space. In addition, in several of our smaller MCD map usability tests conducted earlier this year and last, we discovered that it is necessary to have at least one, if not two training assistants to roam the room to ensure that the trainees are following the correct instructions for the device. This may require that the selection and training on the crew leader assistants to take place prior to the enumerator training.

Once enumerators begin production work, they will make daily transmissions via the telephone lines. The transmissions will send to a computer server at headquarters all completed cases, as well as receive any updates for that enumerators assignment. This can include reassigned cases, as well as disabling any existing cases for which we have received a late mail return. Although the enumerator and Crew Leader will continue to meet on a daily basis and discuss progress and performance, and certify their daily pay record, the Crew Leader will not review the work of the enumerator. They will rely on daily paper management reports from their LCO to manage the work of the enumerators. The daily reports on each enumerator will include such things as cases completed, hours worked per day, miles driven, in addition to several outlier items such as the number of households containing a population of one, number of vacants and deletes compared to the rest of the Crew Leaders district, and so forth. This is perhaps one of the biggest fundamental changes to the role of the Crew Leader. The job will require management by the data in the reports, rather than by examining and accepting the actual completed work.

The instrument on the MCD will have a limited number of internal edits programmed to prevent transmission of incomplete cases. For example, any case that is identified as occupied, but has an "unknown population count" will be sent to the control system in the LCO and will appear on a report for the Crew Leader for a possible reassignment. The Crew Leader can reassign the case to another enumerator or determine it is an acceptable case and certify that it has been checked and should be accepted for transmission and data capture.

Because we will not have the functionality for automated reports on the MCD developed in time for the 2004, the FOSes and Crew Leaders will receive daily management reports from the LCO. They will also in turn, make new assignments and reassignments on paper that will be delivered to the LCO for entry into the control system. When the new assignments and reassignments are Entered into the system, they will automatically be transmitted when the enumerator conducts their daily transmission. Thus, the Crew Leader instructs the control system by way of sending paper listings to be keyed in the LCO on all assignments given to the enumerator. The completed questionnaires are sent directly to the headquarters for data capture.

The use of the MCD in the data collection process potentially can provide a number of exciting opportunities for the Census Bureau to help improve housing and population coverage, contain costs, and ensure data quality. It also poses a number of challenges for our field staff in the implementation and conduct of the field operations.