

Census 2000 Testing, Experimentation, And Evaluation Program

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Census 2000
Testing, Experimentation, and Evaluation Program
Summary Results

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U S C E N S U S B U R E A U

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1. Census 2000 Testing, Experimentation, and Evaluation Program Overview

As part of each decennial census since 1950, the Census Bureau incorporated a testing, evaluation, and experimental program to evaluate the current census and to facilitate planning for the next decennial census - two important activities that strongly support the Census Bureau's strategic plan. The objective of the Census 2000 Testing, Experimentation, and Evaluation (TXE)¹ Program was to evaluate Census 2000 and to help guide planning for the 2010 Census.

During Census 2000, the Census Bureau conducted evaluations, experiments, operational assessments, and Quality Assurance (QA) Profiles. Each of these components is briefly defined in the glossary shown in the Appendix.

This report provides a summary of all evaluation and experiment results. Section 2 provides a broad overview of the results from each evaluation category. Appendix A provides highlighted results from each evaluation and experiment. Note that since the Executive Steering Committee for Accuracy and Coverage Evaluation Policy (ESCAP) reports superceded the Accuracy and Coverage Evaluation (A.C.E.) evaluation results, this report does not contain A.C.E. evaluation results. For more detailed information on the evaluation and experiment methods, results, and recommendations, refer to the referenced documents which are included in the first web site shown in Section 1.1.

In addition to the individual evaluation and experiment reports, topic reports were prepared to synthesize relevant findings from evaluations, experiments, and other research on related census subjects and to make recommendations for the 2010 Census. Similarly, synthesis reports were prepared to summarize and merge the individual components of four experiments. The topic and synthesis reports are included in the web site for evaluation and experiment reports.

¹ Refer to Appendix B for a glossary of abbreviations and acronyms used in this report.

1.1 Evaluations

Using metrics from production activities and processes and data collected from field followup surveys, as necessary, evaluations analyze and measure the effectiveness of methods, procedures, operations, and processes and measure the impact of new initiatives on data quality and the core census processes. As part of the Census 2000 TXE program, some operational assessments were loosely included as evaluations. These operational assessments were accounting type reports that documented final total volumes and rates (typically broken out by demographics, by a variety of geographic levels, or between housing unit or person level data), for distinct operations, functions, or processes. Operational assessments did not analyze or evaluate project or program effectiveness or efficiencies. Some QA profiles were also included as evaluations. QA Profiles provided assessments of census operations based on data collected from the QA programs instituted for those operations. Many of the QA programs involved relisting or reinterviewing procedures that usually were conducted on a sample basis.

The Census 2000 evaluations were managed by an Evaluations Program Steering Committee (PSC). The Evaluations PSC solicited ideas for Census 2000 evaluations and requested a formal study plan for each of the proposed evaluations. At the time the census was conducted, there were over 140 planned evaluations. The number of evaluations was eventually reduced to 87. In early 2002, the Census 2000 Evaluation Program was refined and priorities reassessed due to resource constraints. In addition, some evaluations were found to overlap with corresponding ESCAP analysis and documentation and were therefore no longer needed as separate evaluations.

The evaluations were organized into 18 broad categories covering response rates and behavior analysis, content and data quality, data products, partnership and marketing, special places and group quarters, address list development, field recruiting and management, field operations, coverage improvement, ethnographic studies, data capture, processing systems, QA evaluations, A.C.E. operations, coverage evaluations of the census and of the A.C.E., A.C.E. statistical design and estimation, and automation of census processes. Section 2 and Appendix A of this report use the same structure for documenting the evaluation results.

For information on the Census 2000 TXE Program, the ESCAP documentation, and the individual evaluation reports, refer to the following web sites:

Evaluations [<http://www.census.gov/pred/www/>],
ESCAP [<http://www.census.gov/dmd/www/EscapRep.html>], and
ESCAP II [<http://www.census.gov/dmd/www/EscapRep2.html>].

1.2 Experiments

Experiments were quantitative or qualitative studies that had to occur during a decennial census to have meaningful results to inform planning of future decennial censuses. The decennial census provides the best possible conditions to learn about the value of new or different methodologies or technologies. These experiments typically involve national surveys with multiple panels. For Census 2000, experiments also included qualitative ethnographic studies.

Early in 1997, the Census Bureau formed a Program Steering Committee (PSC) to direct a program of testing and experimentation that would occur concurrently with Census 2000. Proposals were solicited from Census Bureau staff and underwent a review process. Roughly 37 proposals were evaluated on content and selection criteria were applied. The selection criteria were defined as follows:

Mandatory Criteria:

- The experiment must require testing in a decennial census environment.
- The experiment must provide measurable results.
- The experiment must not compromise the success of the census.
- The experiment should provide information that will assist in planning major components of future decennial censuses.

Recommended Criteria

- The experiment should be designed to minimize adverse effects of the experimental treatment on respondents and enumerators.
- The experiment should provide significant potential benefits in terms of cost reduction, improved coverage, improved data quality, improved operational work flow, and/or other measures of benefit.
- The experiment should introduce no or minimal additional respondent burden as part of Census 2000.

The six experiments² included in the Census TXE Program were:

- *Census 2000 Alternative Questionnaire Experiment (AQE2000)*
- *Administrative Records Census 2000 Experiment (AREX 2000)*
- *Social Security Number, Privacy Attitudes, and Notification Experiment (SPAN)*
- *Response Mode and Incentive Experiment (RMIE)*
- *Census 2000 Supplementary Survey (C2SS)*
- *Ethnographic Studies*

Note: The C2SS and the Ethnographic Studies were not included in the original selection process, but were later added to the Census 2000 TXE Program.

Documentation of the experiments can also be found on the evaluations web site:

Experiments [<http://www.census.gov/pred/www/>].

Highlights of the experiment results can be found in Section 2 of this report and more detailed summaries can be found in Appendix A.

² *Use of the Employee Reliability Inventory File for Nonresponse Followup Enumerators (ERI 2000)* was originally planned as a component of the Census 2000 TXE Program, but was later removed.

2. Evaluation Category Overviews and Summary of Results

2.1 Category A - Response Rates and Behavior Analysis

Category Overview

The twelve evaluations in the Response Rates and Behavior Analysis category examine various modes for providing responses to the census. The evaluations focus on respondent behavior and how that behavior impacts response rates. Findings from these evaluations identify methods that can be used to improve response rates in future censuses.

To understand the rates reported in this category, it is important to understand the definitions of mail response rate and mail return rate.

The **mail response rate** is defined as the number of mail returns received prior to the cut date for the Nonresponse Followup (NRFU) universe divided by the total number of housing units in mailback areas that were eligible for NRFU. The inverse of the mail response rate is used as a measure of the NRFU universe. The final mail response rate is similar, but includes all mail returns through the end of the year.

The **mail return rate** is defined as the number of mail returns received prior to the cut date for the NRFU universe divided by the total number of occupied housing units in mailback areas that were on the Decennial Master Address File (DMAF) prior to NRFU. The mail return rate is a more useful rate for determining respondent cooperation. The final mail return rate is similar, but includes all mail returns through the end of the year.

Mail returns included in these rates are paper questionnaires that are mailed back to the Census Bureau, interviews completed during the Telephone Questionnaire Assistance program, Internet data captures, Be Counted Forms, and Coverage Edit Followup (CEFU) returns.

Response Rates and Behavior Analysis Highlights

- The mail response rate as of April 18, 2000 was 64.3 percent. Therefore, 35.7 percent of the mailback universe required contact during NRFU. The final mail response rate was 67.4 percent as of December 31, 2000.
- The mail return rate as of April 18, 2000 was 74.1 percent. The final mail return rate was 78.4 percent as of December 31, 2000.
- During the mailout of Census 2000 questionnaires, the U.S. Postal Service (USPS) designated each questionnaire as Undeliverable as Addressed if it could not be delivered successfully to the labeled address. The most common reason Census 2000 questionnaires were not deliverable was that the housing unit was identified as vacant by the USPS.
- Nationwide, the Census Bureau redelivered questionnaires to nearly 600,000 occupied housing units in the redelivery operation.
- Census 2000 was the first time that residents of Puerto Rico were asked to complete and return their questionnaires by mail. Both the mail response and mail return rates were lower in Puerto Rico than the stateside mail response and return rates.
- The Census 2000 advance letters provided households an opportunity to request an alternative language questionnaire in one of five languages. There were over 2.2 million requests for non-English questionnaires. Fewer than half of the households requesting an alternate language form returned these forms by mail.
- The Telephone Questionnaire Assistance program was implemented to assist the public in completing their census forms. The Telephone Questionnaire Assistance program received six million calls.
- Census 2000 was the first U.S. census to include an Internet on-line reporting capability. The Census Bureau received 89,123 initial on-line requests for an Internet census form.
- There were 560,880 people added to the census through Be Counted Forms. There were higher percentages of groups traditionally undercounted than were observed in the census overall. This means that Be Counted Forms increased coverage in groups that have been traditionally hard-to-count.

2.2 Category B - Content and Data Quality

Category Overview

For Census 2000, the public had five ways of providing census data. These modes included mailing back a questionnaire, filling out a census short form on the Internet, picking up and returning a Be Counted Form, completing a short form census interview via telephone questionnaire assistance, or completing a personal visit interview with an enumerator.

The evaluations in the Content and Data Quality document the 100 percent data item nonresponse by response mode and the data quality of each mode. This category also includes a Content Reinterview Survey study that measured response variance, documentation of the Master Trace Sample database, and an evaluation of multiple responses to the Census 2000 race question.

One method of measuring data completeness is by imputation. Imputation is divided into three categories. An *assignment* is performed when a response for a data item is either missing or not consistent with other responses and an item value can be determined based on information provided for that same person. *Allocations* are performed when a response for a data item is either missing or is not consistent with other responses and an item value cannot be determined based on information provided for that same person. A *substitution* occurs when all the 100 percent characteristics for every person in the household are either missing or are not consistent with other responses. In addition to these three types of imputation rates, a data completeness statistic was produced to determine the number of 100 percent population items within each person record that were not imputed.

Content and Data Quality Highlights

- Almost 1.5 million households were substituted in Census 2000. These represent 1.39 percent of the 105.5 million occupied housing units. Within substituted households, there were over 3.4 million substituted people. These people account for 1.26 percent of the 273.6 million people in housing units.
- Total item imputation rates (assignments plus allocations) for the 100 percent person data items in Census 2000 range from 1.98 percent for the sex item to 5.08 percent for the age item. The tenure item imputation rate was 5.48 percent.
- Overall, the data completeness statistic shows that about 97 percent of nonsubstituted person records have at least four of the five 100 percent population items with nonimputed data.
- Item nonresponse occurs when there is no answer provided to an item on the questionnaire. Item nonresponse for the 100 percent items ranged from 1.13 percent for the sex item to 3.74 percent for the age item. The tenure item nonresponse rate was 4.14 percent.
- Forty percent of the non-Hispanic respondents who reported Two or More Races in Census 2000 also reported Two or More Races in the initial contact of the Census Quality Survey . Similarly, 41 percent who reported Two or More Races in the census also reported Two or More Races in the recontact of the survey. In contrast, 97 to 98 percent of those who reported a single race of White, Black, or Asian in Census 2000 reported the same race in the Census Quality Survey.
- Of the 58 population characteristics evaluated by the Content Reinterview Survey, 16 showed low inconsistency, 26 showed moderate inconsistency, and 16 showed high inconsistency. Of the 36 housing characteristic items measured, five showed low inconsistency, 15 showed moderate inconsistency, and 16 showed high inconsistency.
- The residents of Puerto Rico identified themselves as overwhelmingly of Hispanic origin and of a single race. There was unanimous agreement among focus group participants that the question on race was inappropriate to the Puerto Rican context.
- Results from an exact match between Census 2000 and the Current Population Survey (CPS) show that Census 2000 and the CPS are reasonably consistent in classifying people to the employed and not in labor force categories, but they exhibit considerable variability in classifying people to the unemployed category.
- The Master Trace Sample database contains a sample of Census 2000 housing unit records that allow Census Bureau researchers to trace response and operational data through stages of Census 2000 processing.

2.3 Category C - Data Products

Category Overview

There is only one evaluation in this category. The focus of the evaluation on disclosure limitation procedures was to determine the effects of disclosure prevention measures on Census 2000 data products. The Census Bureau examined the limitations and effects of data swapping and the confidentiality edit – a combination of strategies used to prevent the disclosure of data that can be linked to an individual – on data products.

The full report for this evaluation is not available because it contains proprietary information and is available only to Census Bureau personnel on a need-to-know basis. Abridged information is primarily descriptive and qualitative. Quantitative information can only be found in the unabridged evaluation.

Data Products Highlights

- The data swapping procedure was conducted correctly and consistently. Minimum, but necessary, changes were made to the data in such a way that maximized data quality.
- The Census Bureau should include confidentiality protection as part of the census process and should continue future research on disclosure limitation techniques.

2.4 Category D - Partnership and Marketing

Category Overview

The Census 2000 Partnership and Marketing Program combined public awareness, promotion, and outreach activities to generate clear and consistent messages about the importance of participating in Census 2000. The plan consisted of five components: direct mail pieces, media relations, promotions and special events (including *Census in Schools*), partnerships with businesses, non-governmental organizations, and government entities, and paid advertising.

The primary goal of the comprehensive marketing plan, including the first ever paid advertising campaign coupled with an expanded partnership program, was to increase the mailback response rate, especially among historically undercounted populations. The advertising marketing strategy included messages delivered through print media, radio, television, and out-of-home media (billboards, bus shelters, mobile billboards). The partnership program built partnerships with state, local, and tribal governments, community-based organizations, and the private sector. Partners were asked to assist in three major areas: field data collection support, recruitment, and promotion. In addition, a major school-based public information campaign was launched to inform parents and guardians about the census through their school-age children. The three evaluations in this category assess the effectiveness of these activities as part of the integrated program components of the Census 2000 Partnership and Marketing Program.

Partnership and Marketing Highlights

- Overall awareness of communications about Census 2000 increased significantly over time. It was greater after the Census 2000 Partnership and Marketing Program than before the onset of the program.
- Awareness of communications about Census 2000 increased for all six of the targeted race/ethnicity populations, including historically hard-to-enumerate populations such as Hispanics, non-Hispanic Blacks, and American Indians.
- Principals were an important conduit for transferring information about Census in Schools Program materials as well as for ordering the materials. For those using the Census in Schools Program materials, satisfaction was high.
- Most partners responding to a survey-based study placed “Moderate emphasis” or “A lot of emphasis” on each of five Partnership Program goals. Also, the majority of responding partners that used each of the 18 types of materials rated the material as "Moderately Helpful" or “Very Helpful."
- Non-English materials were used by more than 90 percent of all organizations that received them and these materials were also rated as "Moderately Helpful" or "Very Helpful" by more than 80 percent of partners that used them.
- Across all partners, every activity was considered to be at least “Moderately Helpful” in achieving Partnership Program goals.
- Overall, partners were satisfied with the process in place to furnish them with Partnership materials.

2.5 Category E - Special Places and Group Quarters

Category Overview

The vast majority of U.S. residents live as families or individually in houses, apartments, mobile homes, or other places collectively known as housing units. However, there are millions of people in the U.S. who live or stay in group situations such as college dormitories, nursing homes, correctional facilities, convents, group homes, migrant worker dormitories, and emergency and transitional shelters. Evaluations in this category document and analyze the effectiveness of procedures to enumerate people living in group quarters.

Group quarters enumeration was an operation designed to enumerate people living in group living situations. The group quarters enumeration operation was conducted from April 1, 2000 to May 6, 2000.

The Census Bureau developed a specialized operation to enumerate selected service locations that served people experiencing homelessness. The service-based enumeration (SBE) operation was conducted from March 27 to March 29, 2000, at shelters, soup kitchens, regularly scheduled mobile food vans, and targeted nonsheltered outdoor locations. One of the evaluations focuses on enumeration at service based locations.

Special Places and Group Quarters Highlights

- In Census 2000, 7.8 million people were tabulated in group quarters, representing 2.8 percent of the total population. These people were enumerated in 192,286 group quarters in 100,358 special places.
- Colleges and universities, correctional institutions, and nursing homes were the largest special places, as measured by number and percent of population. About 2.1 million people were tabulated in college dormitories (26.4 percent), 2 million in correctional facilities (25.5 percent), and 1.7 million in nursing homes (22.1 percent).
- The SBE operation appears to be a successful method of including in the census people experiencing homelessness. There were 14,817 SBE sites in Census 2000. More than half of the locations were shelters. Most of the data captured person records were from shelters, soup kitchens and regularly scheduled mobile food vans.
- Almost all of the SBE data captured person records had at least two or more data characteristics (name, sex, age and/or date of birth, Hispanic origin, and race). Approximately 87 percent of the people enumerated completed the questionnaires with enough information that the questionnaire could be included in the unduplication process. There were 16,787 person records matched and unduplicated during data processing.
- A total of 38,415 people completed a Be Counted Form and marked the "No Address on April 1, 2000" box on that form or indicated they were homeless in the address section. Of these, the Census Bureau was able to match and unduplicate 3 percent to people enumerated during the SBE operation. Over thirty-five thousand people were added to the SBE population as a result of the Be Counted Program.
- A total of 283,898 people were tabulated in Census 2000 as a result of the SBE operation, including imputed people and people enumerated on Be Counted Forms and excluding person records matched and unduplicated during data processing.
- Future evaluations should focus on the group quarters type code instead of, or in addition to, the special place type code. A group quarters type code comparison is more appropriate since it is the classification by which data are tabulated in census products.

2.6 Category F - Address List Development

Category Overview

The evaluations in this category cover a broad spectrum of activities involved with building address files and the related geographic database, including field operations from which address information and related map updates are gathered. The address list development category includes various evaluations of the MAF and the TIGER database. These include examination of the completeness and accuracy of address information in the MAF. A variety of census field and local/tribal partner operations were evaluated to measure the impact of each operation on the MAF and the TIGER database. These include, but are not limited to: Address Listing, Block Canvassing, Update/Leave (U/L), List/Enumerate (L/E), and multiple cycles of the Local Update of Census Addresses (LUCA). Combined, these field operations offered comprehensive address checks in rural and urban areas and were a primary source of address information used for MAF and TIGER database enhancement. Additional evaluations focus on the geocoding accuracy of addresses in the census.

The series of operations used to build the address list in Mailout/Mailback areas included the use of the 1990 Census address list, information from the USPS, Block Canvassing, and information from local governments. Subsequent operations, such as NRFU, contributed to the completeness of the address list as well.

Areas with mail delivery to predominantly city-style addresses were referred to as “inside the blue line.” Areas with mail delivery to predominantly noncity-style addresses were referred to as “outside the blue line.” These areas were further delineated by specific types of enumeration area. Different procedures were used to develop the Census 2000 address lists, depending upon the designated type of enumeration area (TEA). This category includes evaluations of many of the address list development methods.

Address List Development Highlights

- There were approximately 115.9 million addresses in the final Census 2000 counts (92.8 million addresses inside the blue line and 23.1 million addresses outside the blue line).
- About 91.6 million addresses were in the universe of addresses to be verified in Block Canvassing. Block Canvassing listers added about 6.4 million addresses and deleted about 5.1 million addresses.
- There were 17,424 governmental units eligible to participate in the LUCA 98 program. About 53 percent participated; they covered approximately 92 percent of the housing units in eligible areas. There were 30,375 governmental units eligible to participate in the LUCA 99 program. About 36 percent participated; they covered approximately 68 percent of the housing units in eligible areas.
- Nationwide, 12,843 blocks were covered by Urban U/L. About 85 percent of the Urban U/L addresses in the DMAF were enumerated in the census as either occupied or vacant housing units. Urban U/L demonstrated that hard-to-enumerate areas were successfully targeted.
- Stateside, about 22 million housing units were listed in the Address Listing operation. An additional 1.4 million addresses were listed in Puerto Rico. Approximately 94 percent of all Address Listing adds were included in the final Census 2000 counts.
- There were 23,525,257 addresses in stateside U/L operations. Stateside U/L operations added 1,644,174 addresses and corrected 9,045,814 addresses. Of the 1,644,174 U/L adds, 85.2 percent, were in the final Census counts. The number of deletes, either as nonexistent or as nonresidential, was 1,228,987.
- There were 1,471,225 addresses in Puerto Rico U/L. Puerto Rico U/L added 111,787 addresses and corrected 751,156 addresses. Of the 111,787 U/L adds, 83.7 percent were included in the final Census counts. The number of deletes, either as nonexistent or as nonresidential, was 122,815 in Puerto Rico.
- Nationwide, 183,889 blocks were covered by U/E. About 41.2 percent contained housing units.
- List/Enumerate (L/E) was responsible for adding 389,749 addresses nationwide to the final census count.
- The Census Bureau split 915,794 blocks (out of more than 5 million total blocks) for tabulation purposes. Based on a sample of split blocks, it was determined that fewer than 4 percent of the housing units affected by block splitting were allocated to the wrong side of a tabulation boundary.

2.7 Category G - Field Recruiting and Management

Category Overview

Prompted by the difficulties in recruiting applicants and high turnover of employees in the 1990 Census, the Census Bureau redesigned its recruitment, staffing, and compensation programs for Census 2000. Several new programs were developed to address the 1990 issues and to help the Census Bureau successfully recruit several million applicants, hire several hundred thousand employees, and retain this staff through the decennial census. Some of these programs included frontloading, higher pay rates, and paid advertising. The purpose of Evaluation G.1 was to study the effects of these new program activities on recruitment, staffing, and retention.

Field Recruiting and Management Highlights

- Enumerator pay, relative to locally prevailing pay, was a key determinant of recruiting performance. The overall high levels of pay, relative to local pay scales, greatly facilitated recruiting.
- The NRFU workload also strongly influenced recruiting. An increase in caseload of about one standard deviation was associated with a 13 percent increase in qualified applicants. An unanticipated result is that a one standard deviation increase in test scores was associated with a decrease in the number of applicants of almost 11 percent.
- Resignations, terminations for cause, or leaving for any other reason by Local Census Office (LCO) management during the recruiting period correlated with a reduction in the number of recruits by about 12 percent.
- By far, the largest source of variation in recruiting performance was associated with an LCO being in one of three Census 2000 administrative regions. Even after taking other key factors into account, LCOs in the Seattle, Denver, and New York regions recruited more applicants than LCOs in other regions.
- Hourly pay was increased by 37.8 percent on average relative to 1990 (adjusted for inflation) and the associated increase in enumerator retention was 22.6 percent. This increase in retention, coupled with introducing frontloading, permitted the average LCO to complete the NRFU in 7.19 weeks compared to 9.72 weeks in 1990.
- Differences in factors outside of the control of census managers had small effects on completion time and productivity. In contrast, factors largely within census management control had large effects on performance.
- The degree to which LCOs exceeded schedules was largely a function of the amount of frontloading they achieved.
- Setting pay competitively was essential to recruiting sufficient numbers of well-qualified applicants and to retaining enumerators as long as they were needed.

2.8 Category H - Field Operations

Category Overview

This category includes studies of various field operations and strategies whose goals were to curb questionnaire delivery and enumeration problems and to obtain census data from individuals who did not respond to the census by a specified date. Evaluations in this category analyze whether field operations were conducted as planned and assess their effectiveness. Analyses in this category also examine efforts to count populations categorized as hard-to-enumerate and evaluate targeted enumeration methods such as blitz enumeration (use of a group of enumerators to conduct enumeration in a compressed time frame), team enumeration (two enumerators working together where safety is a concern), and the use of local facilitators (long-time neighborhood residents or church leaders who assist the enumerator in gaining entry to the neighborhood).

Because some respondents were able to provide data without a Census identification number (ID), it was possible that respondents submitted addresses that were not on the MAF. The Census Bureau conducted a field verification of these types of addresses. If an enumerator verified that the address was a valid housing unit, then it was added to the DMAF. The Census Bureau also conducted an evaluation of the effectiveness of this operation.

Field Operations Highlights

- There were 119,090,016 housing units in mailback areas (including Puerto Rico) that were potentially eligible for NRFU. The NRFU workload (including Puerto Rico) was 35.6 percent of the eligible universe. Of the NRFU addresses, 62.3 percent were occupied, 23.3 percent were vacant, and 14.3 percent were deleted.
- NRFU officially ended early, ten days ahead of schedule.
- Of the 26.4 million occupied housing units, 0.4 percent had no population count. Approximately 4.2 million housing units were enumerated multiple times, most of these were enumerated in NRFU and by a paper mail return questionnaire. Some housing units had an unrealistically large number of continuation forms attached, as many as 99.
- About half of the recommendations from the Census 2000 Dress Rehearsal NRFU training evaluation were incorporated into the Census 2000 training package, either completely or partially. The recommendations that were incorporated contributed to an improved training program. The recommendations that were not incorporated did not seem to negatively impact the effectiveness of the training in preparing the enumerators to collect Census 2000 information.
- An analysis comparing how respondents answered the age and date of birth questions showed that 89.8 percent of people had their reported age consistent with their calculated age. The Census 'average' date of reference moved from May 5 in 1990 to April 20 in 2000.
- During the Be Counted/Telephone Questionnaire Assistance Field Verification operation, enumerators verified information for 884,896 assigned addresses. Of the assigned addresses, enumerators coded 51 percent as valid living quarters, 35 percent as nonexistent, and 14 percent as duplicates.
- A total of 23,556 Questionnaire Assistance Centers were established during Census 2000. Data were collected and processed from about 60 percent of the centers. Of the respondents who needed assistance, most asked for help in completing the short form. Of the people who needed assistance on a specific questionnaire, most (64.6 percent) required assistance on the English short form.
- Census 2000 was the first time that U/L mailback methodology was used to conduct the enumeration in Puerto Rico. Working with maps and map spots was reported as the most challenging situation due to using rural procedures in an urban location.

2.9 Category I - Coverage Improvement

Category Overview

The coverage improvement evaluations examine various Census 2000 operations that were intended to improve the coverage of both housing units and people in the census. Following the mailback efforts to complete the census, a series of operations were conducted to ensure that people were counted at their correct Census Day address, to confirm the status of housing units that were deleted or enumerated as vacant, and to ensure the inclusion of all people in a household when the returned form showed discrepancies in the number of people enumerated (i.e., count discrepancy cases).

Coverage Improvement Highlights

- The CEFU operation was used to increase within household coverage and improve data quality. The CEFU workload included 2,544,072 cases; large household cases made up almost 55 percent of the cases and count discrepancy cases made up the rest.
- The CEFU operation resulted in a net loss of 105,199 people compared to the originally completed Census 2000 self-response forms. While the net improvement to the census was a decrease in the population, it improved the accuracy of Census 2000.
- The Whole Household Usual Home Elsewhere (WHUHE) probe was used to determine if all members of a household had another residence where they lived most of the time (their Census Day address). A total of 151,775 questionnaires were completed for WHUHE households for their usual place of residence. Of these returns, 58,027 matched to an existing address on the DMAF, 55,286 were geocoded but did not match to an existing address, and 38,462 could not be geocoded or matched to an existing address. About 29,300 people were not enumerated by other operations and were added to the census as a result of the WHUHE probe.
- The mover probe on enumerator questionnaires allowed enumerators to identify households that moved into the housing unit after April 1, 2000 and did not return a census questionnaire for their census-day addresses. Of the 105,480,101 occupied housing units enumerated in Census 2000, 22,850 would not have been enumerated without the mover probe. This represents 0.02 percent of the total U.S. occupied housing unit count.
- CIFU was designed to improve coverage of housing units in the mailout/mailback, U/L, and urban U/L areas. The workload (including Puerto Rico) consisted of 8,854,304 housing units. Most of this workload consisted of units classified as vacant or delete in NRFU. Approximately 21.9 percent of the vacant units were converted to occupied and 24.6 percent of the deletes were converted to occupied. These converted units resulted in a net gain of approximately 3.1 million people. Approximately 18.1 percent of the deletes were converted to vacant.
- The intent of coverage questions C1 and C2 on enumerator questionnaires was to identify people who would have been missed or included in error. However, about one-third of the time, enumerators left these questions blank. Approximately 1.1 percent of the responses were “Yes” for C1, meaning that someone had been missed, and 0.7 percent were “Yes” for C2, meaning that someone should be counted elsewhere. Only 21.8 percent of the returns that had the “Yes” box marked for C1, had at least one person added. Only 43.4 percent of the returns with C2 marked as “Yes” had at least one person deleted.

2.10 Category J - Ethnographic Studies

Category Overview

These evaluations study certain aspects of coverage for various populations and attempt to identify areas where methods of collecting census data for these populations can be improved.

Ethnographic Studies Highlights

- The Ethnographic Social Network Tracing Project researched social networks which include highly mobile people. Various associations were found between the character of individuals' mobility, their positions in the interacting social networks and matrices of co-residence, and "census outcomes." In the social networks traced, fewer of the residentially and habitually mobile individuals were found enumerated in Census 2000 than those who remained sedentary.
- If census operations did not list or enumerate the unit that was the census residence or did not place the unit in accurate census geography, then it was unlikely that any census records could be found for anyone living in that unit. Similarly, if census operations listed and correctly placed a census residence in geography, but then did not enumerate it or enumerated it as vacant or with entirely different people, it was unlikely that records of any of its co-occupants could be found. If a unit had been listed and enumerated more than once, then all or most co-residents might be duplicated.
- Most of the habitually and residentially mobile social network participants who were enumerated shared certain traits: they had census residences in conventional housing and maintained ties with and repeatedly and routinely returned to the same set of residentially sedentary co-residents in one locality. As long as their census residence was listed and enumerated, records for habitually and residentially mobile people with all these traits were found, no matter how often or how far they went away.
- Across the four populations studied in the Comparative Ethnographic Research on Mobile Populations, many common barriers to enumeration were found, including residential mobility, distrust and/or fear, irregular and complex household arrangements, and disinterest.
- Colonias, located along the border between the U.S. and Mexico, are generally unincorporated and low income residential subdivisions, lacking basic infrastructure and services. Ethnographers, from the four colonias studied, identified and documented the presence of four major barriers to census enumeration: irregular housing, little or no knowledge of English and limited formal education, concerns regarding confidentiality, and complex and fluid households.

2.11 Category K - Data Capture

Category Overview

The Data Capture System for Census 2000 (DCS 2000) processed more than 120 million census forms by creating a digital image of each page and interpreting the entries on each image using Optical Mark Recognition (OMR), Optical Character Recognition (OCR), or keying. The evaluations in this category were designed to assess components of DCS 2000, the Data Capture Audit Resolution (DCAR) process, and to measure the impact of the data capture system on data quality.

The DCAR consisted of three phases: an automated review of data used to set person panel³ status and roster entry⁴ status; an edit to compare respondent or enumerator responses on household size to a household population count derived from a tally of person panels and roster entries; and a clerical review of images and an update of data for questionnaires whose response records had conflicting household size information. There were two types of review: the Audit Count Check required that clerks review and correct the OCR interpretation of respondent or enumerator responses on household size only. The Audit Status Review also required that clerks review and correct the OCR fields. In addition, they required the review and correction of the status of person panels and roster entries.

³ The number of person panels equals the number of person records associated with a return.

⁴ The number of roster entries equals the number of names listed in the questionnaire roster.

Data Capture Highlights

- The DCS 2000 successfully captured the response data that was input to determine household size. It successfully captured numeric responses and accurately identified the presence of responses in check boxes.
- Of the 126,866,759 returns sent to DCAR, 124,194,637 (97.89 percent) passed the edit. Of the failed cases, the Count Check process included 33.03 percent and the Status Review process included 66.97 percent.
- As the check-in date of the return became further removed from Census Day, the percent sent to Count Check and Status Review increased for mail returns faster than for enumerator returns, indicating more consistent quality for enumerator returns over time.
- The DCAR corrected the data on a large number of cases that would have been included in the CEFU without the corrections made by the DCAR process.
- Evaluation K.1.b was intended to see how well the reading of census forms could be delegated to automated data capture and imaging technology. Both the evaluation and production automated technology were prone to any one of the following errors: failure to read a field on the form, picking up content that was not really there (as in trying to interpret a stray mark), incorrectly capturing the content on the paper, or correctly capturing what the respondent wrote but not what the respondent intended.
- The performance of the automated technology depended on whether the character recognition algorithm determined the content was clear enough to process. If the automated technology determined the content of a write-in field was clear, it processed it with a typical error rate of 1.0 to 1.1 percent. If the automated technology determined the content of a check-box field was clear, it processed it with a typical error rate of 1.2 to 1.5 percent.
- If the automated technology rejected content as unclear, the typical error rate after remedial keying by human operators was 4.8 to 5.3 percent. The Key From Image (KFI) mode tends to deal with content particularly hard for human or machine to interpret and therefore the error rate is not necessarily a poor reflection on the automated technology
- The most frequent causes for failing to capture the intended response were an extra check-box, missing characters, or a wrong character. The most common reasons found for these problems were poor handwriting, no reason found, or rules not followed.

2.12 Category L - Processing Systems

Category Overview

Once census data from all sources were captured by the DCS 2000, they were put in a standard format and stored in a file known as the Decennial Response File, stage 1. Several processes then were applied before the data were used to produce official census counts and tabulations. Following all these processes, the Decennial Response File, stage 2 was merged with key elements of the DMAF to create the 100 Percent Census Unedited File and the Sample Census Unedited File.

A variety of post-census activities were needed to prepare the data from the original responses to releasing the official counts and tabulations. These activities include editing and imputation to create the 100 Percent Census Edited File and the Sample Census Edited File, coding of write-in response items (such as race, language, industry and occupation, and place of work/migration), conversion to tabulation geography, tabulation recoding, and applying disclosure avoidance techniques.

The Beta Site was a software testing site for Census Bureau application developers. It was used as an integration center for Regional Census Center (RCC) and LCO systems, a testing center for all systems, and a support center for RCC, LCO, and the National Processing Center systems.

There were two evaluations of the Primary Selection Algorithm. Full reports are not available because they contain proprietary information. Analysis of a reinterview of multiple questionnaire addresses was designed to determine if the Primary Selection Algorithm methodology and rules for resolving these cases accurately identified the Census Day household members. Analysis of Census Unedited File creation documents the number of times specific rules were applied. The Beta Site analysis includes information on whether the data collection systems were successfully integrated and the benefits of the software testing and release process.

Processing Systems Highlights

- Of 129,389,529 returns, 1.07 percent were linked; that is, they were returns comprised of two or more forms. Of these, 2.82 percent had three or more forms. Most linked returns were comprised of an enumerator first form and an enumerator continuation form.
- For occupied self-response and enumerator returns, setting the expected household size was usually straightforward. For 93.71 percent of self-response returns, the number of valid person records and roster names corresponded to the reported household size.
- Less than 10 percent of all Census IDs on the Decennial Response File were enumerated by more than one return. Most of these were enumerated by two returns.
- Most Primary Selection Algorithm households at Census IDs with multiple returns consisted of one or two returns. Two-return Primary Selection Algorithm households were most often formed by two enumerator returns or one mail return combined with one enumerator return. When two enumerator returns formed a Primary Selection Algorithm household, over 91 percent were the result of one return from NRFU and one return from CIFU. This was expected due to the design of the CIFU operation.
- Of the 8,716,359 Census IDs with two eligible returns, over 70 percent had a redundant return (a return containing only person records represented on the basic return of a Primary Selection Algorithm household).
- At Census IDs with residents in two Primary Selection Algorithm households, the “best” household or a household which was identical in terms of net residents to the other household at the Census ID was selected about 80 percent of the time.
- Nearly 128 million addresses were either on the DMAF as Census 2000 began or were added to it in the course of Census 2000 operations. Prior to unduplication procedures, approximately 117.3 million were ultimately resolved as housing units. Of these, 106.7 million were determined or imputed to be occupied and the remaining 10.6 million were determined or imputed to be vacant.
- Roughly half a million addresses had their status resolved by imputation. There were 195,245 addresses determined to be valid Census addresses whose occupancy status could not be determined and status had to be imputed as a result. There were 296,617 addresses whose validity as Census addresses could not be determined. As a result, their validity and their occupancy status were both imputed.
- Given the success of Census 2000 and the unprecedented reliance on automated systems, the Beta Site contributed significantly to the success of Census 2000.

2.13 Category M - Quality Assurance Evaluations

Category Overview

Census 2000 involved more than 20 major field operations and, at its peak, more than 500,000 temporary workers. Managing the quality of the deliverables produced by this large, decentralized, and transient workforce was a major challenge for the Census Bureau. The quality assurance (QA) programs were designed to minimize significant performance errors, to prevent the clustering of significant performance errors, and to promote continuous improvement.

One evaluation determined the effectiveness of the QA programs used in the address list development and enumeration operations. The effectiveness of variables that were used to detect discrepancies was measured in the second evaluation.

Quality Assurance Evaluations Highlights

- Consistent with its mission statement, Census 2000 continued the tradition, initiated in the 1960 Census, of incorporating into Census 2000 field operations numerous activities described as QA. This commitment to quality and QA certainly is a significant “strength.” Most operations had some form of QA process in place.
- Given the many developments, it is not surprising to find that the overall perception throughout the Census Bureau, and at all levels, is that the Census 2000 QA field program was an important element in preventing significant errors and in preventing the clustering of significant errors.
- Based on the evaluations and comments from those involved, many of the Census Bureau’s early activities in preparing for Census 2000 are seen as having utilized a full QA approach that met the Census Bureau’s stated goal of promoting timely and continuous improvement. However, in the context of what actually transpired during the data collection phase, the perception is less clear and decidedly mixed.
- A vital aspect of the QA program for promoting continuous improvement (real-time capture and dissemination of data during the data collection process, with which to monitor, evaluate, and react) was not implemented.
- The Census 2000 NRFU Reinterview program included three components: a random reinterview, an administrative reinterview, and a supplemental reinterview. The purpose of the reinterview program was to identify faulty data collection, both intentional and unintentional. Random reinterviews represented 93.09 percent of the cases selected for the reinterview program. The remainder of the reinterview cases were administrative and supplemental reinterview cases (4.34 percent and 2.57 percent, respectively).
- Over the entire NRFU operation, 291,441 enumerators were identified as outliers based on a comparison of questionnaire characteristics of each enumerator against the average for their area. This was 62.57 percent of enumerators with completed work.
- Supplemental cases with complete reinterview information showed a higher frequency of enumerator error between the original enumeration and the reinterview (11.30 percent) than random and administrative cases (9.42 percent and 9.67 percent, respectively). This higher incidence of error identification shows the effectiveness of the supplemental reinterview component.
- Of the characteristics reviewed for the administrative sample, the high delete variable had the biggest impact for identifying enumerators with error.

2.14 Category N - Accuracy and Coverage Evaluation Survey Operations

The studies in this category were designed to measure how well the Census Bureau carried out different components of the A.C.E. The results from these evaluations are superseded by results from the ESCAP II. To review the ESCAP II reports on the Internet, go to <http://www.census.gov/dmd/www/EscapRep2.html>.

2.15 Category O - Coverage Evaluations of the Census and of the Accuracy and Coverage Evaluation Survey

The evaluations in this category include a group evaluating A.C.E. coverage and a group evaluating census coverage. These studies identify person and housing unit characteristics that are related to being missed or erroneously enumerated. Analyses in this area also study the quality of data from proxy respondents and the frequency and patterns of geocoding error. Furthermore, census counts and dual system estimates are compared to demographic benchmarks to evaluate accuracy and completeness. The results from these evaluations are superseded by results from the ESCAP II. To review the ESCAP II reports on the Internet, go to <http://www.census.gov/dmd/www/EscapRep2.html>.

2.16 Category P - Accuracy and Coverage Evaluation Survey Statistical Design and Estimation

The evaluations in this category were designed to examine the quality of A.C.E. estimates. Because of resource reallocation and ESCAP analyses and documentation that informs evaluations, the evaluations for this category were not conducted.

Some of the reports that were developed in an expedited manner to inform ESCAP decisions were sufficiently complete and informative to answer research questions from the planned evaluation reports. To review the ESCAP reports on the Internet, go to <http://www.census.gov/dmd/www/EscapRep.html> for ESCAP reports and to <http://www.census.gov/dmd/www/EscapRep2.html> for ESCAP II reports.

2.17 Category Q - Organization, Budget, and Management Information System

Category Overview

Research in this category documents headquarters' decision making processes and the impact of headquarters' organizational structure on the decennial census.

Organization, Budget, and Management Information System Highlights

- Key performance indicators reveal that, in certain respects, Census 2000 was the most successful U.S. decennial census ever conducted. In Census 2000, the net undercount estimate of the household population was minus 0.49, meaning that there was a small estimated overcount. Achievement of a small net coverage error that is close to zero is an important success factor.
- The national response rate that determined the Census 2000 NRFU workload was 65 percent, which matched the 65 percent response rate from the 1990 Census indicating that the Census Bureau had stemmed the decline in response that had been the trend over recent decades.
- The NRFU effort was completed ahead of schedule.
- Post 1998, the Census Bureau operated within an organization that was well structured to support its performance objectives. The decennial organization was organized by business process drawing from functional capabilities residing within the participating divisions as required. In many of the sub-structures and teams within the decennial organization, however, the leaders of the teams and decision-making bodies were not given or did not choose to exercise true decision-making authority. Although the intent behind the creation of these organizational bodies was to push decision-making to the lowest management levels technically possible, there was no decision-making authority in place at these lower levels to support that intent.
- A knowledge management capability to retain corporate knowledge, to support responses to external reporting requirements, and to communicate programmatic changes to decennial census participants in a timely manner would assist in improving communications and in stabilizing and maintaining the decennial census knowledge base throughout the decade.

2.18 Category R - Automation of Census Processes

Category Overview

For Census 2000, the Census Bureau implemented a series of automated systems to aid the conduct of the decennial census. These systems included, but were not limited to, data collection and capture, cost and progress reporting, management controls, customer reaction, QA and analysis, and the Internet. Many of these systems were implemented for the first time in Census 2000.

Titan Systems Corporation was engaged in June 2000 to conduct the automated systems category of evaluations. The main focus of the evaluations was to determine the effectiveness of requirements methodologies that were employed during the planning stages and their impact on overall system functionality. The evaluations also addressed certain contract management issues, as applicable, and their effect on system development and/or operational considerations. The evaluations were based to a large extent on 145 interviews with both Census Bureau staff and contractors who were involved with the planning, development, operations, or management of Census 2000 systems. The findings and recommendations were therefore qualitative in nature; that is, they reflect the opinions and insights of those personnel, some of whom were interviewed in connection with more than one system. The intent is to use the results to inform planning for similar future systems.

A total of twelve systems were evaluated. In general, the contractor assessed whether the correct requirements and proper functionality were specified for each of these twelve systems, whether the systems performed adequately in terms of either impact on data quality or in providing useful management information, and whether the Census Bureau specified requirements in a timely manner. The contractor also examined any contract management issues, as applicable. The twelve systems evaluated are as follows: Telephone Questionnaire Assistance; CEFU; Internet Questionnaire Assistance; Internet Data Collection; Operations Control System 2000 (OCS 2000); Laptop Computers for the A.C.E.; Accuracy and Coverage Evaluation 2000 (ACE2000) Control System; Matching and Review Coding System for the A.C.E.; Pre-Appointment Management System/Automated Decennial Administrative Management System (PAMS/ADAMS); American FactFinder; Management Information System 2000; and Census 2000 Data Capture.

Automation of Census Processes Highlights

- Despite the considerable managerial, technical, and contractual challenges facing the Census Bureau, all of the decennial systems for 2000 were successfully deployed.
- **Process Improvement Recommendations** - From a systemic perspective, certain supporting processes and methodologies should be in place to provide a sound framework for system development activities. The absence of such a framework permits development on an ad hoc, rather than a structured basis, and usually leads to poor planning and inefficient use of resources. The evaluation reports present recommendations to improve internal processes so that systems can be designed, developed, and managed using a disciplined approach.
- **Requirements Definition Issues** - Because the requirements definition phase is critically important, it should be performed in accordance with an agency approved methodology or set of guidelines that proscribe the steps inherent in the process. These guidelines need not be inflexible; they can be written to allow for various circumstances and constraints, but should, in any case, identify all requirements issues that can impact system functionality. The evaluation reports present suggestions on ways to improve the requirements definition function.
- **Outsourcing and Contract Management** - Due to its long standing reliance on in-house resources for programming support, Census Bureau staff were not sufficiently prepared to make the transition to outsourcing. This policy shift required that Census Bureau personnel who either managed, or were working closely with, contractors have a basic understanding of contracting principles and an awareness of the legal/contractual issues inherent in the statement of work. Given that information technology contracts are typically far more complex than other types of contracts, the potential for misinterpretations in the scope of work and content of deliverables could easily have given rise to contract disputes and performance problems. Fortunately, the Census Bureau succeeded in avoiding many problems by awarding contracts to many qualified vendors. The automated systems evaluations include findings that can help the Census Bureau to better manage the risks associated with outsourcing in the future.
- **Best Practices** - The success of the Census 2000 automated systems was due, in part, to the employment of some highly effective techniques, or what is generally known as “best practices.” The evaluation reports identify best practices that were found to be very beneficial in terms of their contributions to furthering sound system development methodologies.
- Two recommendations were repeated in at least half of the Category R evaluations. They are: begin development early and establish agency-wide guidance.

3. Summary

The results, lessons learned, and recommendations from the Census 2000 evaluations and experiments are being used in the planning process for the 2010 Census. Some of these results serve as primary sources in identifying areas for improvements. The twelve 2010 Census Research & Development (R&D) Planning Groups are chartered to use the Census 2000 results to define 2010 Census research, development, and testing activities.

For example, the following indicate how the Census 2000 results are being used in the process of planning the tests leading up to the 2010 Census:

- The self-response options objectives for the 2003 National Census Test were identified based on a review of Census 2000 results from evaluations of mail response and return rates, telephone questionnaire assistance, and Internet data collection, and from the RMIE.
- Input from Census 2000 for defining the race and Hispanic origin questions objectives for the 2003 National Census Test came from the AQE.
- Input from Census 2000 for defining the coverage improvement objectives for the 2004 Census Test came from the AQE, the coverage edit followup evaluation, and the synthesis of coverage improvement operations and evaluations in the Coverage Improvement Topic Report.
- Input from Census 2000 for defining questionnaire content objectives for the 2004 Census Test came from the evaluation of item nonresponse rates, the AQE, a comparison of results from the C2SS and Census 2000, and a demonstration of the operational feasibility of the American Community Survey.
- Results and recommendations from Census 2000 special place/group quarters evaluations, quality assurance profiles, and operational assessments were used to plan the 2004 and 2006 Census Tests, including the need to revise group quarters' definitions and to design a method to integrate the group quarters' inventory development into the overall address file development process.

Overall, what we learned from the Census 2000 TXE program should help us to accomplish the 2010 Census objectives to improve the relevancy and timeliness of census data and to develop and implement more cost-effective operations, as well as to implement an even more rigorous and beneficial research and evaluation program for the 2010 Census.

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