Census 2000 Evaluation R.1.a
December 9, 2002

Telephone Questionnaire Assistance System Requirements Study

FINAL REPORT

This evaluation study reports the results of research and analysis undertaken by the U.S. Census Bureau. It is part of a broad program, the Census 2000 Testing, Experimentation, and Evaluation (TXE) Program, designed to assess Census 2000 and to inform 2010 Census planning. Findings from the Census 2000 TXE Program reports are integrated into topic reports that provide context and background for broader interpretation of results.

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PREFACE

Purpose of the System Requirements Study

The main objective of the System Requirements Study is to assess the efficacy of the requirements definition processes that were employed by the U.S. Census Bureau during the planning stages of the Census 2000 automated systems. Accordingly, the report's main focus is on the effectiveness of requirements methodologies, including processes for coordination, communication, and documentation, and their impact on overall system functionality. The report also addresses certain contract management issues and their effect on system development and/or operational considerations.

The System Requirements Study synthesizes the results from numerous interviews with a range of personnel--both U.S. Census Bureau staff and contractors--who were involved with the planning, development, operations, or management of Census 2000 systems. Our findings and recommendations in this report are qualitative in nature; they are based on the varied opinions and insights of those personnel who were interviewed. The intent is to use the results from this study to inform planning for similar future systems.

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EXECUTIVE SUMMARY

Telephone Questionnaire Assistance was a large-scale program that provided telephone assistance to the public during Census 2000. A network of 22 call centers used a combination of automated technologies and agent responses to handle calls from households within the 50 states, the District of Columbia, and Puerto Rico. This study presents information based on debriefings with personnel involved with the Telephone Questionnaire Assistance program. A separate customer service survey evaluation will provide the user perspective of this system.

Telephone Questionnaire Assistance was the first time that Census had outsourced a call center operation; the program is considered the largest operation of its kind implemented in the call center environment. The system was designed to accommodate 11 million calls and received slightly over 6 million throughout its operation. Telephone Questionnaire Assistance operated from March 3, 2000 through June 30, 2000. An outbound service for Coverage Edit Followup started while Telephone Questionnaire Assistance was still in operation. This program used some of the same technologies and a subset of the call centers. Coverage Edit Followup will be addressed in a separate system requirements study. Major results of the study include:

- Program was successful. A number of issues confronted the Telephone Questionnaire Assistance development team such as the high call volume, call distribution across centers, the range of questions and topics that would require responses, and the completion of the automated short form questionnaire by call center agents. Despite the challenges and short timeframe for development, the program is considered extremely successful. Both Electronic Data Systems and Census personnel provided exceptional support and dedication to ensure that Telephone Questionnaire Assistance was successfully implemented.

- Some requirements were not included. Compromises on some requirements to collect certain data were made because of the limited time to develop the system. Although many compromises were made through negotiations with subject matter experts and program managers, the lack of some data from Telephone Questionnaire Assistance may impact the completeness of post Census evaluations. Some requirements were dropped because of timeline and resource constraints, but the majority of the missing management and evaluation data can be attributed to the GeoTel Intelligent Call Router.

- Product fell short of expectations. The provision of required data through the Intelligent Call Router proved to be a significant deficiency. The requirements for performance and evaluation data apparently exceeded what the Intelligent Call Router typically provides. The U.S. Census Bureau requirements necessitated customized programming which

apparently exceeded the system's technical capabilities. It was also not clear that the technical support involved in programming the application completely understood the implications of those requirements. The product was intended to meet the call routing and information tracking requirements that had been clearly specified by Census, but the product fell short of its expectations and either did not provide the data or provided the data too late in the process.

These and other findings have led to the following key recommendations:

- **Project planning - begin development early. Development efforts must be initiated early enough so that fully tested, robust systems are available for Dress Rehearsal. Although requirements may change from the lessons learned in Dress Rehearsal and from external forces (e.g., Congress), there would be a higher chance that all requirements would be identified and implemented.**

- **Project planning - establish realistic development timelines. For each development effort, timelines must consider the complexities associated with translating and implementing high-level user requirements into a functional system. In addition, time for testing and rework is required to ensure that each system is sufficiently stable for production. Electronic Data Systems planned a development timeline and methodology based on the system requirements and one year timeframe available for development and testing. The decision to delay outsourcing, the lack of funding for development until fiscal year 1999, the complexity of requirements, and other factors limited the team's ability to implement all steps required of a systematic methodology.**

- **System development methodology - establish agency-wide guidance. A standardized methodology provides the agency with guidance for project planning and management and provides a contractor with direction for the technical approach, types of documentation, and level of detail appropriate for each phase of the development life-cycle. It is recommended that the U.S. Census Bureau establish an agency-wide system development life-cycle methodology using input from other federal agencies and established industry standards.**

1. BACKGROUND

The Titan Systems Corporation, System Resources Division (Titan/SRD) was tasked by the Planning, Research, and Evaluation Division (PRED) of the U.S. Census Bureau to conduct system requirements studies for 12 automated systems used in the decennial census. This report is a study of the Telephone Questionnaire Assistance (TQA) program. It addresses the extent to which the requirements definition process was successful in identifying the needed system functionality and offers one of several evaluation approaches for examining these automated systems. The report results are intended to assist in the planning of similar systems for the 2010 census.

The TQA program provided telephone-based assistance to the public during Census 2000. The primary goal was to provide a user-friendly, responsive telephone service designed to:

- Provide answers to questions about the census.
- Respond to questions about any of the census forms.
- Fulfill requests to mail a census questionnaire and/or language guide.
- Allow callers who met certain criteria to complete a census questionnaire short form via a telephone interview; i.e., Reverse Computer Assisted Telephone Interview (RCATI).

The TQA program consists of three primary components: a telecommunications network linking 22 call centers, automation including Interactive Voice Response (IVR) and the Operator Support System (OSS), and call center agents. The telecommunications network included AT&T enhanced services, intelligent call routing, and automatic number identification (ANI). The public used toll free numbers to access the telecommunications network. These calls were routed using the GeoTel Intelligent Call Router (ICR) to the appropriate IVR or next available agent regardless of the location of the IVR or call center. The IVR used a main menu of prompts to provide information to the caller. In cases where a caller requested a questionnaire or language guide, the ANI attempted to match the caller ID to a residential database. If ANI did not find a match or the match was incorrect, the caller was prompted for a mailing address. The residential database was provided through a commercial application.

The IVR was available in both English and Spanish. Bilingual agents supported callers in Spanish and in four Asian languages: Chinese, Korean, Vietnamese, and Tagalog. The OSS was a web-based application accessed via a secure, Intranet (i.e., TQANet). The OSS provided the information and tools to facilitate the agent's interaction with the caller. The system provided agent scripts, access to the Knowledge Data Base (KDB) that contained material from the Questionnaire Reference Book (QRB), and the automated short form census questionnaire. TQA also included a Customer Satisfaction Survey (CSS) component. The ICR selected a small sample of calls to participate in a brief survey to measure customer satisfaction through the use

of an IVR. Survey results were intended to be used to monitor the TQA program and to support post TQA evaluation studies. However, the information collected may be of limited value due to problems encountered with the call routing technology. Data collected through TQA were sent to one of two enterprise database servers. Extract procedures were used to handle form requests, prepare production and evaluation data extract files, and to produce reports regarding activity at the IVR, call center, or enterprise level.

TQA was designed to support 11 million calls with the ability to handle 70,000 to 100,000 agent calls per hour. The recorded IVR portion of the program was available 24 hours per day, 7 days per week. Call center agents were available from 8AM to 9PM for each of 7 time zones, 7 days per week.

2. METHODOLOGY

The Titan/SRD Team interviewed key personnel for each of the Census 2000 automated systems using a structured approach centered around four fundamental areas. A set of questions under each of those areas was designed to explore: (1) the effectiveness of the requirements definition process; (2) how well the systems were aligned with business processes; (3) identification of any deficiencies in functionality or performance relative to actual operational needs; and (4) how effective the agency contract management activities were in regards to contractor performance.

A similar, but separate set of questions, was designed for contractors who were identified as key personnel. The contractors were asked about the following areas: (1) the clarity of the statement of work and the impact of any changes to the specifications; (2) their interactions with government personnel and the technical direction they received; (3) the timeline for completing the work; and (4) their impressions of the system's suitability and operational effectiveness.

The purpose of the system requirements study is to summarize the results of interviews with key personnel by system. A variety of related system documentation was reviewed in connection with the interviews. The assessments provided in Section 4., Results, reflect the opinions and insights of key personnel associated with TQA who were interviewed by the Titan/SRD Team in September 2000. Those personnel had varying levels of knowledge about the TQA system based on their involvement with system planning, development, implementation, or operational issues. Section 5., Recommendations, provides value-added perspectives from the Titan/SRD Team that seek to illuminate issues for management consideration in the planning of future systems.

Quality assurance procedures were applied to the design, implementation, analysis, and preparation of this report. The procedures encompassed methodology, specification of project procedures and software, computer system design and review, development of clerical and

computer procedures, and data analysis and report writing. A description of the procedures used is provided in the "Census 2000 Evaluation Program Quality Assurance Process."

Study participants reviewed the results of this system requirements study. Comments have been incorporated to the fullest possible extent.

3. LIMITS

The following limits may apply to this system requirements study:

- The perception of those persons participating in the interview process can significantly influence the quality of information gathered. For instance, if there is a lack of communication about the purpose of the review, less than optimal results will be obtained and the findings may lack depth. Each interview was prefaced with an explanation about its purpose in order to gain user understanding and commitment.

- In some cases, interviews were conducted several months, even years, after the participant had been involved in system development activities. This extended timeframe may cause certain issues to be overlooked or expressed in a different fashion (i.e., more positive or negative) than if the interviews had occurred just after system deployment.

- Each interview was completed within a one to two hour period, with some telephone followup to solicit clarification on interview results. Although a detailed questionnaire was devised to guide each interview and gather sufficient information for the study, it is not possible to review each aspect of a multi-year development cycle given the limited time available with each participant. Although this is a limitation, it is the opinion of the evaluators that sufficient information was gathered to support the objectives of the study.

- Every effort was made to identify key personnel and operational customers who actively participated in development efforts. In the case of TQA, all government personnel who participated in the TQA study are still with the Census Bureau. The contractor interviewed for the study is no longer active on the TQA program.

4. RESULTS

This section contains findings that relate to the effectiveness of the requirements definition process used during the development of TQA. The requirements process establishes the foundation for a system and, as such, must be designed to thoroughly consider all technical and functional aspects of development and operation of the system.

4.1 Requirements definition

An inbound calling service was used in the 1990 Census. This service provided agents within the Census Bureau's call centers located in some processing offices to field questions from the public. There was no intelligent call routing and agents relied on a hardcopy QRB to locate the

necessary information. The telephone vendor, MCI, reported the number of calls offered at 7.9 million; this is in contrast to the Census Bureau's clerical records showing 3.25 million calls answered. The call centers received 70 percent of total calls in one week; this caused instances in which local telephone companies were overloaded and calls were dropped or unanswered. Calls were routed to local district offices based on area code and not percent allocation. This method was not sufficient to handle the call volume.

An inbound calling operation was tested during the Census 2000 Dress Rehearsal in 1998 using a combination of in-house resources and contracted IVR support. Call routing was handled by a straight allocation of calls to each call center. Once the call was received, agents used the desktop tool to answer some questions, and a hardcopy of the QRB and Frequently Asked Questions (FAQs) to look up other necessary information. Automated instruments for both long and short forms were tested during Dress Rehearsal. These forms had been fine-tuned from earlier tests conducted in 1995, 1996, and 1997. Cognitive testing was conducted on the census forms automated in the TQA instrument prior to their use in Census 2000.

The Census Bureau decided in 1994 to outsource development of TQA given its experience from the 1990 Census. The Census Bureau wanted to avail itself of the experience and information technology (IT)/telecommunications infrastructure of the call center industry rather than develop a system in-house for a short duration, one-time operation that would not be able to accommodate the projected workload of 11 million calls. However, the Census Bureau used its own call centers and instrument authoring staff for TQA during the Dress Rehearsal because funding for an outbound effort was not available. It was realized that the system used in Dress Rehearsal would need substantial requirements and design changes prior to Census 2000.

An original draft Statement of Work (SOW) was available in February 1998; however, due to a shift in project responsibilities, some serious concerns about the SOW's content and funding constraints, it was not released to industry at that time. A Streamlined Acquisition Process (ASAP) Team, with cross-divisional membership, reworked the SOW. This team involved representatives from the Decennial Systems and Contracts Management Office (DSCMO), Decennial Management Division (DMD), Population Division (POP), and Decennial Statistical Studies Division (DSSD). Specialists in the call center industry were also asked to participate in order to identify and clarify issues for the ASAP Team. The final Request for Proposal (RFP) was released in August 1998. A contract was awarded to a single prime contractor who, in turn, subcontracted portions of the work to numerous other vendors.

The SOW outlined the required functionality for the system and provided sufficient requirements information to begin design and development activities. The scope and technical complexity of the project however required clarifications and further definition of these requirements as the work progressed. The prime contractor provided a Functional Requirements document to

establish the requirements baseline. A Change Control Board (CCB) consisting of DSCMO and contractor staff was organized to manage any additions or changes that were necessary to implement the required TQA functionality. The CCB evaluated each change with input from the contractor and then made the determination as to whether the change would be implemented. Decisions from the CCB were documented.

Project management staff and contractor personnel formed a close working relationship and were in constant communication throughout the project. Several types of meetings were conducted including a Monthly Status Meeting and an Executive Oversight Meeting. The project management staff provided weekly briefings for DMD, DSSD, POP, and PRED. During operations, daily briefings were provided to DMD staff who then communicated to all divisions at the Operational Status Assessment Meetings. The intent of these meetings was to share status and schedule information with team members as well as identify and resolve critical issues. However, some team members expressed concern that only a limited number of subject matter experts were included and information from these meetings was not always communicated. Communication problems within Census Bureau may have stemmed from a misinterpretation of the roles and responsibilities with respect to the flow of information.

4.2 Requirements issues

4.2.1 Agency endorsed methodology was not available

There is no agency-wide standard that addresses the methodology needed for requirements definition or system development within the Census Bureau. For TQA, a cross-divisional team approach was used to define the requirements. Team meetings were conducted to identify and resolve issues and meeting minutes were prepared and distributed. No guidance was available as to the steps necessary for a successful development effort, the required documentation, and the level of detail for each required document. Census Bureau personnel relied on their own experiences and common sense to plan and manage the program. The prime contractor did have internal procedures and methodologies to plan and manage large-scale development and integration projects. These techniques benefited the Census Bureau personnel by providing exposure and insight into acceptable industry standards.

4.2.2 Specialized expertise solicited from call center environment

The ASAP Team used the services of independent call center experts to guide development of the SOW. This was an important step since the Census Bureau did not have sufficient in-house expertise with commercial call center operations to fully specify their needs and to understand the functional limitations that may exist within that environment.

4.2.3 Technical complexities created challenges

It was a significant challenge for Census Bureau personnel to learn the complexities of the private industry call center environment and, conversely, for consultants and contractors to learn the complexities of the census process. The project was the largest single effort ever initiated within the call center industry, yet the complexity of the environment was underestimated on

both sides. The one year timetable for development indicates a lack of recognition for these complexities and for the sheer magnitude of the project. This was further exacerbated because not all requirements were available at the time of contract award.

4.2.4 Communication methods were not always effective

During the development, there were many conference calls between the contractor and the Census Bureau team. However, due to the complexity of the specifications being discussed, these conference calls did not always provide an effective means of communication. Other modes of communication such as video conferencing, if available, or on-site visits might prove more effective when finalizing requirements and validating in-progress efforts. TQA was a decentralized effort with planning and development work occurring at numerous locations throughout the country, in addition to call centers and IVRs. The desired level of on-site presence was not achieved due to staffing limitations at the Census Bureau.

Some Census Bureau subject matter experts believe they could have added significantly to the development process and prevented the misinterpretation of certain requirements had they been provided more direct and frequent access to the development team. Allowing subject matter experts increased access to the contractor staff could have put the project at risk in meeting the primary objectives of the program. Recognizing this, the program manager must establish priorities to ensure that the contractor meets the critical objectives within the schedule and time allowed. The project plan must balance the needs of the subject matter experts with the needs of the program management function.

4.2.5 Change control board used to review and prioritize changes

A CCB was used as the forum to review proposed changes and assess the cost, technical, and schedule risks associated with those changes. As Census Bureau subject matter experts identified problems with the system or proposed changes, the CCB asked the contractor to assess the technical implications, cost impacts, and schedule risks of those changes. The results of this analysis were then presented back to the CCB. The CCB reviewed and prioritized the changes and determined what changes would be implemented by the development contractor. The CCB consisted of DSCMO and contractor staff. Some stakeholders perceived that there was inadequate representation on the CCB.

4.3 Alignment with business processes

This section contains findings that relate to how well TQA supported the specific business processes that were associated with the Census Bureau's need to provide inbound calling services to answer questions about Census 2000.

4.3.1 System perceived as effective by study participants

Although some evaluation requirements were not provided in TQA because of time constraints,

individuals involved with the system definition and development consider it a significant technological achievement and highly effective in meeting the business needs of the Census Bureau.

4.3.2 Multiple means were available to respond to public inquiry

TQA was the primary means of responding to public inquiry regarding Census 2000. Internet Questionnaire Assistance (IQA) was a supplemental process that provided another avenue for a large segment of the public (i.e., those with access to the Internet) to gain immediate access to census information via the world wide web. The Universal Resource Locator (URL) for the IQA program was included as part of the initial greeting in TQA's IVR system. Additional help was available through the Field Questionnaire Assistance Centers.

4.4 System deficiencies

This section contains findings that relate to any specific issues that were identified with respect to the system's ability to accomplish what it was supposed to do or impediments encountered during the development and support processes. Recognizing that 100 percent success is rarely achievable, it is still worthwhile to assess deficiencies in the spirit of constructively identifying "lessons learned." Such insights can greatly contribute to improvements in future system development activities.

4.4.1 GeoTel product falls short of expectations for statistical reporting

The GeoTel ICR provided a combination of hardware and software that enabled the 22 call centers to act as one site. It was intended that this product also provide the system usage statistics that would have enabled the Census Bureau to conduct near real-time management of the inbound calling operation. The requirements for performance and evaluation data apparently exceeded what the Intelligent Call Router typically provides. It was also not clear that the technical support involved in programming the application completely understood the implications of those requirements.

The lack of information from the GeoTel ICR also affected other census activities. For example, limited and untimely information on the cost and progress associated with the TQA operation affected the accuracy and currency of data in the Management Information System (MIS) 2000 software. Although it was not able to provide some of the planned data to the MIS, TQA was able to provide Census Bureau management with critical data such as the number of calls received, IVR resolution, calls successfully handled, and language information. These data allowed Census Bureau management to understand the progress of the operation, except for the number of forms requested and short form CATI interviews completed, even though it was not through the official system as originally intended.

Also, data for post-census evaluations were affected; critical record linkage data and time stamps for each segment of the call were specified but not always provided. For example, the system

was intended to link evaluation data between the IVR, OSS, and GeoTel; however, less than 30 percent of the records were linked due to insufficient linkage data. Thus, a non-scientific sample will be used in cases where completed linked IVR, OSS, and GeoTel records are needed for analysis. It appears that the concepts and requirements for evaluation data may have been incomplete, or may have been specified but not included because of the short development time available. An analysis is being conducted on TQA that may provide insight into some of these issues: A.1.a, Telephone Questionnaire Assistance (TQA) Operational Analysis.

4.4.2 Commercial center quality assurance differs from Census Bureau

The standards for the call center industry are different than those used by the Census Bureau. The Census Bureau conducts surveys and requires hard data for analysis. Call center operators are either pollsters soliciting public opinions, salespeople soliciting for sales of various products, or customer service representatives. Call center agents were trained on telephone etiquette, census concepts and objectives, and survey instruments. Although care was given to ensure the quality and consistency of each script, call center agents reported that the scripts were cumbersome and repetitive. Monitoring of call center operations indicated that some agents were not following the scripts as closely as the Census Bureau had specified. It is not known the extent to which this variance affected the quality of data collected or information provided.

4.5 Contract management practices

This section contains findings that relate to the effectiveness of contract administration activities. Even when system requirements are well defined, ineffective management of contractors can lead to less than optimal results when the system is deployed. Consequently, it is beneficial to evaluate past practices in order to gain insights that can lead to improvements in system development efforts. Contractors played a pivotal role in the development of TQA. In December 1998, Electronic Data Systems (EDS) was selected as the prime contractor. EDS, in turn, worked with numerous subcontractors to establish the call center infrastructure and develop the interactive voice response and operator support system software.

4.5.1 Close working partnership established with contractor

The project management staff and the contractor established a close-working partnership to meet the project requirements and implement the system within the time constraints. Constant communication and information exchange were necessary between the two groups. This was accomplished via meetings, teleconferences, and extensive documentation. The establishment of a true partnership allowed the Census Bureau and contractor staffs to achieve the primary program objectives despite the accelerated timeline for development.

4.5.2 Logistics impacted prime's ability to manage subcontractors

As the prime, EDS was responsible for the selection and performance of all subcontractors involved in the development of TQA. These subcontractors were located throughout the country. Because of the logistics involved, EDS was not able to maintain a stringent enough review on subcontractor activities and work products. Close to deployment, it was discovered that some products were insufficient to meet program needs; this caused EDS to send specialists to the subcontractor sites to provide both oversight and direct technical support to correct deficiencies.

4.5.3 Contractor performed well despite challenges

Overall, the EDS Team performed exceptionally well to provide a high quality product within a very short timeframe. Although some personnel were replaced over the course of the project, most prime and subcontract personnel were technically qualified, highly-motivated professionals capable of meeting and even exceeding development requirements and Census Bureau expectations.

5. RECOMMENDATIONS

This section synthesizes findings from the above sections and highlights opportunities for improvement that may apply to the Census Bureau's future system development activities. The recommendations reflect insights from the Titan/SRD analysts as well as opinions regarding "lessons learned" and internal "best practices" that were conveyed by Census Bureau personnel during interviews.

5.1 Project planning

The contract for the inbound calling service was put into place in December 1998 for a system that was required in March 2000. The development for TQA was accomplished under an extremely aggressive schedule and was developed with the same Census Bureau and contractor staffs being used to develop the outbound service. The Census Bureau's project team was understaffed, only through the Herculean effort of the people involved did the program get completed successfully. The Census Bureau's decision to contract only for Census 2000 coupled with the fact that the program did not have funding until fiscal year 1999 for development work resulted in the tight development schedule. This type of development schedule is unrealistic because it does not allow for the full development of requirements, adequate testing, or any opportunity to accommodate unexpected program changes. Contracts must be in place early enough so that systems planned for the decennial census can be available for the Dress Rehearsal

and necessary changes can be implemented and tested well before actual deployment.

Recommendation: Initiate development efforts early enough so that fully tested, robust systems are available for Dress Rehearsal. The purpose of the Dress Rehearsal should be to evaluate a fully functional system and fine tune system features, not to identify major changes in system functionality. Although some requirements may change from the lessons learned in Dress Rehearsal and from external forces (e.g., Congress), there would be a higher chance that all requirements would be identified and implemented for the actual census. In addition, establish realistic project timelines that incorporate sufficient time for requirements definition, contract award, system development, testing, and enhancements.

5.2 System development methodology

A standardized methodology provides the agency with guidance for project planning and management and provides a contractor with direction for the technical approach, types of documentation, and level of detail appropriate for each phase of the development life-cycle. A typical methodology covers requirements definition, system design, development, testing, deployment, and on-going maintenance phases. A standardized methodology for system development and requirements documentation would benefit the Census Bureau by establishing the structure and procedures for the specification and development of complex systems. A standardized methodology would also help to ensure the consistency and completeness of system development efforts and provide a consolidated means for the development and delivery of technical specifications.

Recommendation: Establish an agency-wide system development life-cycle methodology using input from other federal agencies and established industry standards. This methodology should be implemented in conjunction with an organization devoted to standards and methodology development and to project management. This organization should provide training and documentation to Census Bureau personnel and representatives should be available to coach development teams through each phase of the development life-cycle.

5.3 Leading edge technologies

Technology changes dramatically between each census. Although planning and development activities should be initiated mid-decade; technologies available at that time may be significantly different than the technologies available when the census is actually conducted. There is a risk in delaying project development simply because new technologies may be introduced. There is also a risk that newer technologies may be unproven and not sufficiently stable for the large-scale needs of future censuses.

Recommendation: Select proven, state-of-the-art technologies early enough to ensure sufficient time for testing and integration with other technologies. The selected technology should be stable (i.e., not in beta testing) and, if possible, currently in production with other customers that have similar large-scale, geographically disperse requirements. Each product should be benchmarked at a production site. Although not a guarantee, these data will assist program managers in determining whether the product can meet the needs of the Census Bureau. In addition, backup and contingency plans for all hardware and software components should be developed in advance of deployment.

5.4 Internal team coordination

For Census 2000, the roles and responsibilities of various Census Bureau organizations were never clearly defined in advance. Also, this was the first time that the Census Bureau had done such extensive contracting to accomplish census projects. Although a cross-divisional team was convened to develop the TQA requirements, some of these individuals perceived they were not involved in the continued specification and translation of the requirements to the contractor. Individuals working most closely with the contractor were not always the individuals who had defined the initial requirements. This may have resulted in some confusion and lack of understanding of the true intent of the requirements. In some cases, the contractor perceived these clarifications as new or changing requirements when, in fact, the requirements had been defined early in the development process.

From the program manager's perspective, efforts were made to include subject matter experts in the process, despite the time and resource constraints. In the case of TQA, many issues were identified and resolved in a very short development life-cycle with little time available to fully coordinate and brief all members of the team. It is apparent that better communications, including more timely status reporting, could have improved internal team coordination for the TQA program.

Recommendation: Ensure that subject matter experts stay actively involved in the continued translation of requirements and the resolution of technical issues throughout the development effort. Subject matter experts must remain an integral part of the development team to ensure that the initial intent of the requirements carry forward into the actual product. Technical issues and change request information should be circulated to appropriate parties with specific guidelines and timeframes for response. The need for internal coordination between the program managers, subject matter experts, and contractors must be addressed in the project planning stages, with roles and responsibilities clearly identified.

5.5 Access to development staff

TQA was a decentralized effort with developers located throughout the country. Much of the communications between Census Bureau personnel and the contractor was conducted via teleconference. Although this means is suitable to discuss many issues associated with development, it was not suitable for a review of interim or prototype products being developed. The contractor did establish a web site to allow review of interim versions of the OSS; however, subject matter experts needed direct access to the developer to more effectively review, evaluate, and recommend changes to works in progress. It is understandable that user changes must be controlled and face to face meetings tend to identify many "great ideas" that do not specifically relate to the approved requirements. In these cases, the methods to capture and prioritize recommendations used by the CCB can also be implemented to manage the recommendations from subject matter expert/contractor development sessions.

Recommendation: Increase the use of Joint Application Development (JAD) and Rapid Application Development (RAD) concepts for development efforts. JAD sessions bring subject matter experts and information technology specialists together to discuss and define business policies and procedures and to identify the supporting system's function, data, and performance requirements. A RAD session provides opportunities for the developer to demonstrate work in progress directly to the subject matter experts. These sessions demonstrate progress against the schedule but more importantly, provide an interactive means to solicit and record feedback on actual products. Both techniques should be included in the system development methodology and addressed in each project plan. The development process can also be improved by co-locating developers of critical components with the program managers and subject matter experts. This can enhance communications by facilitating interaction between developers and subject matter experts and improve the effectiveness of the project management function.

5.6 Change control board

Census Bureau staff are used to having the freedom to make changes and provide multiple versions of the specifications because they are used to working with in-house development staff. Regardless of whether development and operation is outsourced, changes must be managed closely to avert risks and additional costs. Historically, development projects within the Census Bureau have not been held to schedules for the delivery of specifications or any stringent change control process. In the case of TQA, all changes were subject to review by the CCB. The concept of a CCB is an effective means of identifying, assessing, prioritizing, and approving changes both in a development and production environment. Although a CCB can add some layer of bureaucracy to the process, it is essential to ensure that any changes are considered in light of the original requirements and available resources.

Recommendation: Continue the use of formalized change control processes as part of all development efforts. Include representatives from each stakeholder organization on the board to ensure a fair assessment of the business and technical risks involved with each change. Changes should be systematically assessed in light of programmatic goals. The requirements for change control and supporting documentation should be described in the system development methodology. The CCB also must have adequate resources to address programs with large and complex scopes.

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