Census 2000 Evaluation R.2.a
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Operations Control System 2000 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.

Prepared by Titan Systems Corporation/
System Resources Division

Kevin A. Shaw, Project Manager
Planning, Research, and Evaluation Division

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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

The Operations Control System 2000 was perceived as a successful system that was deployed when needed, in spite of the lack of a standardized requirements definition process and the substantial changes in requirements that occurred during the life of the system. The overall objective of the system was to automate the management of field operations prior to and during Census 2000. This study presents information based on debriefings with personnel involved with the Operations Control System 2000 program.

The system assigned and controlled work to all census enumerators, tracked progress of assignments, produced cost/progress reports on field operations, printed a wide variety of enumeration related materials, and assisted with the management and tracking of shipping documents. The Operations Control System 2000 was operational between October 1997 and August 2000 and had six key interfaces with other systems, one of which was external to the U.S. Census Bureau (the FedEx interface). It provided support for several operations including Nonresponse Followup, the largest single field operation in Census 2000.

Its success was particularly noteworthy in view of the impact of a Supreme Court decision which changed the focus of the decennial census from a sampling-based approach to full enumeration. The decision was handed down at a very late point in the system development cycle. Although the Decennial Management Division provided a project oversight role to ensure that the right resources were applied to the project, uncertainty over which method the Supreme Court would favor resulted in a dual system approach (i.e., sampling and full enumeration) to development going into the Dress Rehearsal in 1998. Major results of the study include:

- **Some system deficiencies existed.** Primary system deficiencies centered around two areas: the need for a FedEx interface and difficulties encountered with obtaining test data. The FedEx interface worked moderately well; however, once a package was shipped the tracking data were not available in the Operations Control System 2000. This required operators to go to the FedEx web site to monitor shipping status. Data to sufficiently test interfaces to other systems were not always available. This lack of data was caused because some systems were still under development and some operations in the field were not yet complete.

- **Expanded access and high level reports were needed.** A perceived need for expanded system access and national level status reports was noted by some users during the interviews. Such capabilities could have been implemented but were problematic and inconsistent with fundamental system objectives. The inclusion of these capabilities would not have improved overall system functionality in a meaningful way.

These and other findings have led to the following recommendations:

- **Requirements process - establish agency-wide guidance.** While a Joint Applications Development method was used to develop system requirements, its execution was widely perceived as too complex and of limited usefulness. The requirements definition phase is an especially critical step in all generally accepted system development life-cycle methodologies in that it establishes the foundation for a system. Therefore, future systems would benefit from an agency-wide set of guidelines which outline the steps in the requirements definition process. It is recommended that the U.S. Census Bureau implement and adhere to such guidelines well in advance of the next application development effort to ensure success of the planning effort.

- **Development contractors - conduct contractor orientation.** The agency utilized contractor support to develop the Operations Control System 2000. Programming and database functions were performed by contractors working in-house under the direction of the Technologies Management Office. These contractors were well integrated with the staff, were highly competent, and performed extremely well. However, they did not always understand business practices at the U.S. Census Bureau. This issue may be addressed through an orientation program which would serve to introduce contractors to the nature and history of the census.

- **Contract management team - assign contracting officer to team.** The assignment of a dedicated contracting officer to the Operations Control System 2000 team proved to be an effective arrangement that facilitated the timely handling of contractual issues. Assigning a contractor officer as part of the overall team is a best practice that should be considered for large and/or critical system development projects.

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 Operations Control System 2000 (OCS 2000) system. 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.

A component of the Decennial Field Interface (DFI) system, OCS 2000 is an automated computer system that supported, managed, and controlled all field operations for Census 2000. OCS 2000 assigned work to all census enumerators, tracked progress of these assignments, and produced reports on field operations. It captured and provided timely data to assist with the management of regional and local field offices prior to and during Census 2000. OCS 2000 was not involved in post-census operations. The system had five main internal interfaces with other Census 2000 systems and one external interface with the FedEx Powership system, which provided Internet access to FedEx to facilitate shipping activities.

There were seven operations performed using OCS 2000 in the pre-census phase. During this phase, which began in October 1997 and continued through December 1999, operations were focused on address and map compilation and updating. The main operations during Census 2000, which began in January 2000, were focused on field data collection. OCS 2000 was used during this phase to control the workload to the field, and to provide materials (listings, labels, directories) that enumerators needed for followup activities. Census 2000 operations continued through August 2000.

OCS 2000 provided support for Nonresponse Followup (NRFU), which is the largest single field operation in Census 2000. This operation does the followup for those people at housing units that did not return questionnaires in the mail. NRFU used OCS 2000 to extract listings from the Oracle databases at the 12 Regional Census Centers (RCCs); the listings were printed for use by field personnel when conducting the NRFU operation. OCS 2000 was also used to control the checkin and checkout of work to track operational progress. NRFU was completed ahead of schedule.

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 specifications; (2) their interactions with government personnel and the technical direction they received; (3) the timeline for 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 who were interviewed by the Titan/SRD Team in October 2000. Those personnel had varying levels of knowledge about the OCS 2000 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 OCS 2000, all government personnel who participated in the study are still with the Census Bureau. The contractors interviewed for the study are no longer active on the OCS 2000 program.

4. RESULTS

This section contains findings that relate to the effectiveness of the requirements definition process used during the development of OCS 2000. 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

The requirements definition process for OCS 2000 started in 1995 and involved about 20 subject matter and information technology (IT) experts. This early effort was heavily influenced by the VAX-based mainframe application that was the forerunner of OCS 2000. The overall objective was to have a system maximize the information available to the Local Census Offices (LCOs). A contractor was brought in to perform "up-front" work and to facilitate subsequent efforts at refining requirements through a work flow model. The contractor was engaged for a period of about two years, supporting the requirements methodology using what could be termed an "academic approach." A Joint Application Development (JAD) technique[1] that utilized a "Use Case" approach was applied as the basis for the requirements definition methodology. The JAD sessions were facilitated and included representatives from Field Division (FLD), Technologies Management Office (TMO), and Decennial Management Division (DMD). This approach did not prove to be effective due to its unsuitability for non-technical personnel who were involved in the JAD process. The unsuitability resulted from the highly complex output and use of technical jargon that was employed.

Requirements from the Field Division were drafted and then sent to TMO, who would incorporate them into a demo version for validation. This approach afforded the Field Division

[1] Joint Application Development, or JAD, is an effective group technique for achieving consensus on requirements, procedures, policies, designs, and other elements of software development. JAD sessions promote cooperation with all parties impacted by the project and involve them in cooperatively identifying underlying business processes and agreeing on ways to apply technology to address and implement workable solutions to meeting mutually agreed upon system functionality. A fundamental tenant of the JAD approach is that it establishes a team of both business users and systems analysts rather than relying solely on IT personnel to assess requirements.

the opportunity to “fine tune” the requirements. TMO’s overall flexibility in accommodating the Field Division’s flow of requirements was considered to be very supportive. The change request process was initially informal, but later evolved into a more structured one that was based on the submission of requests through a standardized type of form. This approach also worked well.

4.2 Requirements issues

4.2.1 Standardized guidelines were not available

There were no agency-wide standards in place to define an approach to conducting the requirements definition process or to serve as a guide for personnel engaged in this process.

4.2.2 RAD model used to demonstrate work-in-progress

Software development followed the Rapid Applications Development (RAD) model. Working modules were demonstrated, which turned out to be a double-edged sword. On the one hand, the models illustrated how sections of the application worked and provided reassuring evidence of progress. On the other hand, RAD demos often provided an opening for even more changes as additional features/enhancements could easily be envisioned after having seen the code in action. On balance, RAD was perceived as an effective methodology for the OCS 2000 development process.

4.2.3 Court decision changes census design

An event which significantly impacted the scope of OCS 2000 was the Court decision which resulted in a fundamental change to the anticipated sampling approach that the Census Bureau had planned on. For a period of time, uncertainty as to which way the Court would decide on the matter required that the Census Bureau work on both systems "in parallel." This dual effort was necessary in order to provide full system functionality whatever the outcome of the decision. Ultimately, the assumed sampling approach was abandoned when the Court called for the Census Bureau to perform a traditional census instead. Thus, the assumed OCS 2000 design had to be changed to accommodate this new reality of full enumeration.

4.2.4 Changing requirements impact development

OCS 2000 development was characterized by constantly changing requirements. Mini-JADs were used to periodically assess these "fluid" requirements. Consequently, contractor personnel took a generic approach to building the OCS 2000 application to make the software adaptable to constantly changing requirements, many of which stemmed from the need to accommodate new operations.

4.2.5 Development efforts yield valuable insights

The expected life span of most census automated systems is specific to the decennial process. OCS 2000 was developed using a very structured approach, and all requirements were generally perceived by the interviewees as having been fully implemented. Although OCS 2000 was used

for over three years by field staff, the expectation was that future technology would necessitate a redesign of the current application for use in 2010. Regardless of the life-span of a system, valuable insights can be learned from each system development effort. Even applications with a temporary life-span can be seen as having long term collateral benefits.

4.2.6 TMO workshops were effective

TMO ran workshops to gather requirements and share development information with the field. Valuable feedback was exchanged through this forum that was especially beneficial to the field because graphical based interfaces were seen as a new automation concept to them. Adapting to the "newness" of the interface was a consideration which had requirements implications (i.e., the workshops provided a means for identifying needed changes in OCS 2000's user interface). Overall, the field found the workshops beneficial.

4.3 Alignment with business processes

This section contains findings that relate to how well OCS 2000 supported the specific business processes that were associated with managing and controlling field operations. Designing OCS 2000 to fully support this objective, in the decennial census environment, was a difficult challenge in view of: (1) the nationwide data management requirements during the census; (2) five Census Bureau system interfaces (and one external interface with FedEx); and (3) the seven complex operations that it supported during the pre-census phase. Because of Census Bureau's reliance on this pivotal system, it was essential that OCS 2000 be the "right system for the job."

The system was considered to be successful in terms of supporting business processes in the field. Additionally, it had a high degree of operational reliability. OCS 2000 generated timely exception reports as well as cost and progress reports. Though not considered a system deficiency, it was noted that real-time access to data would have been “nice to have” with respect to monitoring progress. This type of capability–had it been provided–might well have hampered efforts at programming essential system functionality because it would have required a substantial increase in time and resources to implement. The trade-offs would make it difficult to justify the convenience of having real-time data.

4.4 System deficiencies

This section contains findings that relate to any specific shortcomings 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 System tuned to address performance issues

Testing prior to production confirmed that OCS 2000 would not be a responsive system considering the projected 900 users and 35-40 million cases it would have to handle. Consequently, the Oracle database design was modified and tuned to address performance concerns and improve system responsiveness.

4.4.2 System design changed after dress rehearsal

Although the requirements definition process was deemed to be effective, their "fluidity" and the need to prepare for two different scenarios (sampling vs. full enumeration) required development of parallel systems going into Dress Rehearsal. Major changes were required in OCS 2000 after Dress Rehearsal because of changes in the Census 2000 design. This further complicated the task of addressing requirements within a rapidly compressing timeframe.

4.4.3 Some problems encountered with data exchange

One area of system complexity was its interface with other Census Bureau systems. OCS 2000's primary function was to provide a control and tracking system, and as such, was both a recipient and feeder of data in the census environment. The system interfaces provided by OCS 2000 occasionally encountered problems exchanging data, and this was attributable to a certain extent to the fact that production level test data that were needed to support OCS 2000 could have been provided on a more timely basis. An example of interfacing problems occurred with the Pre-Appointment Management System/Automated Decennial Administrative Management System (PAMS/ADAMS) data. Specifically, the records imported into OCS 2000 which contained the "crew leader" field were often unreadable or inaccurate. Another problem involving PAMS/ADAMS related to OCS 2000's difficulty in handling employees who live in one region but work in another. In spite of these minor problems, there were no serious system interface issues. Test data were somewhat problematic due to: (1) other systems being under development and therefore not able to provide data, or (2) operations in the field were not yet complete.

4.4.4 Full ad hoc query capability not available

Though many standard reports were accessible through OCS 2000, the system lacked an ad hoc query capability to permit creation of custom reports. It is unclear whether this was specified as an initial requirement. A data filtering feature was available to all users, but required advanced knowledge relating to report generation techniques.

4.4.5 Package tracking done outside of OCS 2000

The FedEx interface with OCS 2000 worked moderately well in that it generated shipping labels and manifests. However, once shipped, package tracking was not accomplished through OCS 2000. The shipping information was available, but an operator had to "go outside of the system" to the FedEx web site to monitor the status of packages. Receipts were initially received from Data Capture Centers and were eventually posted in OCS 2000 by TMO. This function was an important aspect of OCS 2000 in that 490,000 boxes were sent via FedEx. The FedEx contract was negotiated and administered outside the decennial area. When decennial negotiated with FedEx for automated tracking data, they were unwilling to provide services not already contracted. Consequently, this interface was never fully integrated into OCS 2000. Given this large number of shipments, a more effective interface would likely have reduced the effort required to monitor shipping status. In this regard, it is important to note that, because Census Bureau personnel are not trained in the intricacies of shipping large numbers of packages, this effort was inherently inefficient and should have been automated to the extent possible to improve productivity.

4.4.6 Formalized design document not used for changes

The original Oracle database design was modified (re-designed) due to performance issues when testing confirmed that OCS 2000 would not be able to handle the 35-40 million case workload. The re-design work was performed by contractors without regard to any formalized design document.

4.4.7 User interface mirrors organizational structure

The system design and interface mirrors the Census Bureau’s organizational structure and therefore assumes that users have knowledge of the census environment. OCS 2000 is not intuitive or "fancy," but it is very responsive for trained/knowledgeable users. For those users who were not familiar with the Windows' graphical user interface (GUI), OCS 2000 would present a double challenge (i.e., learning how to use the GUI interface and navigate the application). Job aids were provided by TMO to assist users working with the application.

4.4.8 National level reports not specified for some operations

In general, all the reports that were needed were provided by the system. However, due to time constraints and limited development resources, certain system reporting functionality trade-offs were inevitable. For example, report requirements for some large field operations such as Nonresponse Followup had included a national level report but it was a conscious decision that national level reports would not be provided for smaller operations. A national report is a D-Series report that shows regional totals with an aggregated national total in the same report. The reporting capability for smaller operations was always desired; however, requirements were not documented because programming and system limitations would have required substituting these reports for essential production reports for the larger operations. Requirements such as those for List Enumerate (L/E) and Update Enumerate (U/E) were implemented in OCS 2000 at a later date.

In the interim, users had to access 12 separate databases to compile national totals. This was a very cumbersome process associated with OCS 2000. Likewise, progress reports for the re-interview program would have been helpful as they would have negated the need for hand calculations. Periodically, reports lacked data because local offices missed the daily update cycles. Some of this was due to delays attributed to multiple time zones–a problem that was recognized up front when reporting requirements were being developed. Though not perceived as deficiencies per se, it would have been helpful if OCS 2000 reports would have been implemented at the outset to provide national totals in addition to regional totals for all operations.

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 that will increase the likelihood of successful system development efforts. Contractors played a major role in the development and design of OCS 2000 and brought expertise to bear in the areas of GUI interfaces and object oriented programming and related tools.

4.5.1 Contractors help bridge technology gap

Contractors were utilized due to Census Bureau's lack of expertise in several technical areas (e.g., GUI, object oriented programming, software development tools). The contractors were Client Network Services, Inc. and Total Services Solutions. Also, contractors helped to bridge the technology gap that had occurred since the last decennial census. Census Bureau personnel were highly satisfied with the contractor's performance and the contractors felt that the Census Bureau was highly supportive of their efforts. In fact, they were essentially an extension of the government staff by virtue of their working on-site. Coordination between Census Bureau and this particular set of contractors was very good.

4.5.2 Change control board used to manage changes

A Change Control Board (CCB) was effectively used to assess and prioritize changes in requirements, and to schedule software releases to LCOs. (OCS 2000 was released numerous times due to the different operational parts of the application.) At least one contractor was a member of the CCB.

4.5.3 Contracting officer was part of team

A Census Bureau contracting officer was assigned to the OCS 2000 team and was very supportive.

4.5.4 Contractors lacked understanding of census operations

Notwithstanding the benefits of using contractors for OCS 2000 development, Census Bureau personnel expressed concern that some contractors did not fully understand the "whys and ways" of census business processes. For example, quality assurance (QA) measures are used in the business community and information technology industry; however, the Census Bureau has a strong focus and unique requirements that are not always understood by contractors.

4.5.5 Contractor team was cohesiveness unit

The team of contractors working on OCS 2000 was unusually cohesive owing to the fact that it was comprised mainly of programmers who had previously worked together. The existing familiarity and working relationships promoted a highly unusual degree of team cohesion.

4.5.6 Beta testing impacted development

The mandatory Beta Site testing was a significant time drain in that it consumed valuable resources and slowed development efforts. The Beta Site's primary function is to evaluate OCS 2000's compatibility with Census Bureau's information technology environment. Beta Site was perceived by the development contractors as a certification function, not as a testing of functionality.

Census Bureau staff noted that there were several occasions when new software versions were released by Beta Site to the regional offices, but not to headquarters. This was the source of some confusion and was characterized as a major issue because headquarters was not always synchronized with the current software that was being used by the field.

4.5.7 Technical direction to contractors considered supportive

Contractor personnel interviewed perceived the technical direction provided by Census Bureau personnel/subject experts as very supportive.

5. RECOMMENDATIONS

This section synthesizes the findings from above and highlights opportunities for improvement that may apply to Census Bureau's future system development activities. The recommendations reflect insights from 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 Requirements process - establish agency-wide guidance.

People involved in the formulation of requirements should have been trained on how to perform this function. There was no standard, systematized requirements definition process to provide guidance on how to perform the requirements analysis. Moreover, the requirements were not "frozen" in that they were subject to constant change. One unique aspect of the requirements for OCS 2000 was that the system would be used by temporary personnel who lacked detailed knowledge of census operations. Requirements should always be mindful of the "user base" to ensure usability of the application and to minimize the training effort.

Recommendation: Implement standardized guidelines to assist agency personnel with performing requirements analysis according to a structured approach. Recognizing that a well-defined set of requirements is an essential foundation for any system development effort, many agencies have such guidelines in place, usually through promulgated directives. It is recommended that the Census Bureau develop such guidelines. Additionally, once developed, requirements should be frozen to the extent possible, with any proposed changes being subject to a CCB.

With respect to the matter of temporary personnel, there should have been greater emphasis on making the system easy to learn and use. Typically, when guidelines are employed during the system development process, such considerations as the user base are less likely to be overlooked.

5.2 Development contractors - conduct contractor orientation.

Contractor's played a major role in OCS 2000. In the planning and development phase, there were concerns expressed that contractors lacked an understanding of the nature of census business processes. There are indications that this may have resulted in unnecessary communication problems, and could also have had an impact on development activities. This issue was resolved prior to the implementation of the system for Census 2000.

Recommendation: It is recommended that Census Bureau consider indoctrinating contractors about the nature and history of the census through an orientation program. This should be

accomplished within one week of the contractor's assignment to a census task, whether that contractor is on-site or not.

5.3 Contract management team - assign contracting officer to team.

The assignment of a dedicated contracting officer to the OCS 2000 team proved to be an effective arrangement that facilitated timely handling of contractual issues. In the technology environment, quick response to problems and needs can often preclude unnecessary costs and project delays.

Recommendation: The assignment of a dedicated contracting officer is a best practice that Census Bureau should consider implementing whenever it undertakes a large and/or critical system development project. This practice can minimize development delays (e.g., contractor downtime, late implementations of needed changes) that often result from slowness in handling time consuming contractual documentation which may be necessary to process contractual actions such as modifications.

5.4 Change control board - extended use of change control process beneficial.

The CCB was used not only to assess the impact of proposed system changes, but also to prioritize and schedule software releases. This "extended" function of the CCB was used to good effect by TMO.

Recommendation: CCBs are an essential and effective mechanism for controlling changes and should be implemented for all system development projects. They should utilize standardized change request forms, have established meeting schedules, and recordation/distribution of minutes to all interested parties. Also, when there are system interrelationships (i.e., interfaces with other Census Bureau systems), relevant CCB proceedings should be shared with other CCBs to ensure that all effected parties have knowledge of issues that may impact their systems. With OCS 2000, for example, there was "cross pollination" with PAMS/ADAMS development personnel to facilitate information exchanges on issues of mutual interest.

5.5 Beta site testing - communicate testing process.

TMO set up another layer of testing outside of the Beta Site because they perceived it was largely a "certification" function (as well as a means to assure security compliance). The Beta Site was perceived as a professional, but bureaucratic, layer which was unnecessarily time consuming.

Recommendation: Acceptance of the Beta Site role would be greater if testing procedures were consistent and well-defined. It appears that some Beta Site testers may have employed extraordinary efforts to "break" the application by using unusual combinations of keystrokes. While applying rigorous testing techniques is an acceptable methodology, it can, in some cases, lead to a negative perception about the process. This can give rise to communication problems, which can slow down the deployment of software.

5.6 JAD methodology - JAD facilitator recommended.

Although the JAD method is a widely used and often successful technique, the particular approach applied by the contractor was highly complex and produced output that was not easily understood by non-technical personnel. There was a general perception that this process was "not steeped in reality." This severely limited the effectiveness of the JAD for OCS 2000.

Recommendation: JADs are a widely used, and often successful, technique--when properly conducted. Typically, an experienced "facilitator" is used to lead JAD sessions. To ensure objectivity, this person should ideally be an outside expert with no pre-conceived notions about the requirements or personal associations with the participants. Moreover, since the JAD participants are from diverse areas within the agency, the JAD process and the resulting set of requirements needs to be easily understandable to a wide variety of people. It is recommended that future JADs employ the services of a qualified facilitator, and that they be tailored to the participants, which should include all stakeholders and subject matter experts (up to a reasonable size group).

5.7 System lead-time - perform development/testing activities early in decade.

Notwithstanding the impact of the Supreme Court decision on OCS 2000, the nature of the decennial census is such that decisions regarding technical solutions need to be made very early in the development cycle.

Recommendation: The Dress Rehearsal takes place two years before the commencement of the census, so requirements, development, and testing activities need to be initiated as early as possible. Delays in starting the system development process will likely result in compressed development schedules which can place the project at risk by not allowing sufficient time for system planning and development. Dress Rehearsals should be used to "test drive" a nearly completed system and for fine tuning system features, not for incorporating numerous new requirements and modifications.

5.8 Test data for system interfaces - provide for simulated data feeds early in process.

Given its linkages to other systems, OCS 2000 had unique interfacing requirements. Testing was necessary to ensure that the data exchanges between those systems were reliable. The test data were not always available.

Recommendation: Interface testing is highly complex and requires a thorough understanding of data format (record layouts) and electronic linkages. In the best of cases, such testing can be very time consuming. Difficulties encountered in acquiring test data was noted above. It is recommended that future system interfacing needs be fully

explored as soon as possible and that provisions be made early on to simulate data feeds that may be otherwise unavailable. Another potential solution, albeit more involved, would be a data warehouse. This type of repository contains historical census data from other systems and could be downloaded for testing purposes.

5.9 Access to OCS 2000 - fully define user community prior to system deployment.

OCS 2000 met access and information requirements for field users; however, many other users at headquarters expected access to the system even though the Management Information System (MIS) 2000 was intended to provide the necessary management information. There was contention surrounding this issue. For those favoring expanded access, it was a matter of viewing current status data. This was believed to be technically feasible over a network, and was largely an issue of data sharing within the Census Bureau. Another perspective held that OCS 2000 was designed to be a control system for field operations and therefore was not intended to be used either as a status monitoring system or a management information system.

Since the Census Bureau does not have a standard architecture or desktop for users, every non-field user (including FLD-HQ) would have required a custom set-up and upgrade with every release of OCS-2000. This was not practical given the available resources nor was the system sized to accommodate a large number of headquarters users. OCS 2000 personnel involved in the design and development of the system were concerned about the potential for misinterpretation of the data. For example, the measure of "cases completed" is defined differently by different organizations involved in the census. This could lead to erroneous conclusions regarding the status of the operation. There was also a concern that an expanded user base could lead to degradation of system performance.

Recommendation: In a networked environment, anyone who is "connected" should be able to have access to OCS 2000. For those who need only view data and reports, "read only" access can be granted, and would not permit that person to enter or change any data. However, staff desiring system access who are not thoroughly familiar with the nature, limitations, and interpretation of OCS 2000 data, should receive some form of training or orientation to avoid the potential for misinterpreting the information provided by the system. Prior to deployment, the purpose of the system and the appropriate user community (i.e., those who should have access) should be well defined, documented, and shared with other system development efforts to control expectations, avoid overlaps in functionality, and enhance data sharing.

It is recommended that, given sufficient justification (e.g., need to respond to Congressional inquiries) and assuming that appropriate training and documentation has been afforded users, the Census Bureau should consider expanding the user base. Alternatively, the Census Bureau could enhance the OCS 2000/MIS 2000 interface to ensure that appropriate high level status information is made available through Census

Bureau's management information system. Whatever solutions are adopted to address this issue, the requirements definition phase for the next Operations Control System should address the need for project status data that will inevitably arise from inquiries generated by oversight bodies. As it was, a Quality Indicators Report was created to satisfy such inquiries, but the requirement for this report was not identified until the census was well underway.

5.10 FedEx interface - fully assess requirement for external system interface.

The FedEx interface with OCS 2000 worked moderately well; however, package tracking was not accomplished directly through OCS 2000. Given the anticipated volume of material, the need for automated tracking data should have been specified in the requirements definition phase. Additionally, receipts from Data Capture Centers were handled on a manual basis which required the transmission of numerous faxes, before they could be posted in OCS 2000 by TMO. What may seem as minor shortcomings have to be put in the context of the huge volume of material that was sent via FedEx--490,000 boxes. Given this large number of shipments, greater emphasis should have been placed on defining the requirements in order to reduce the considerable time and effort required to manage shipping activities. Moreover, much of the effort was undertaken by personnel who were not familiar with shipping documents or processes.

Recommendation: The FedEx shipping interface did not fully realize its potential to improve productivity. It is recommended that, when requirements exist for interfacing with external systems, the Census Bureau engage an independent contractor to fully assess the technical challenge, costs, and benefits of such interfaces. Ideally, a contract of this type should be managed within the decennial area. When this is not possible, the contracts should at least be flexible enough to accommodate modification needed to support decennial activities. It may also be advisable to have a separate development contract for implementing an external interface. This way, the prime contractor can avoid distractions and technical complications that may dilute their effort on the main project and/or contribute to delayed deployment of the primary system.

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Participants

Howard Prouse	Technologies Management Office 3-1425, +1.301.457.2839 Howard.R.Prouse@census.gov
Judy Dawson	Technologies Management Office 3-1769, +1.301.457.3002 Judith.A.Dawson@census.gov
Leah Arnold	Technologies Management Office 3-1757, +1.301.457.1936 Leah.Marie.Arnold@census.gov
Gail Leithauser	Field Division 2-1111, +1.301.457.2030 Gail.A.Leithauser@census.gov
Karen Field	Field Division WP1-204, +1.301.457.8253 Karen.C.Field@census.gov
Peter Sefton	Field Division 3-1313, +1.301.457.2051 Douglas.P.Sefton@census.gov
Ed Gore	Decennial Management Division 2-1422, +1.301.457.8436 Raymond.N.Loftin@census.gov
Ray Loftin	Decennial Management Division 2-2012, +1.301.457.3998 Edison.Gore@census.gov
Agnes S. Kee (DMD Program Support)	Decennial Management Division 2-1422, +1.301.457.4223 Agnes.S.Kee@census.gov

Participants – Continued

Peter Conn	Total Service Solutions

	301.306.7206
Vivek Gore	Client Network Services, Inc. 301.990.6700