U.S. Census 2010 Quality Assurance Strategy

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Introduction

The Census Bureau has long been committed to providing an accurate, timely, and cost-effective population count in each decennial census. Census 2000 continued the Bureau's tradition of a high quality count, but the experience also revealed areas of potential risk that could hamper efforts in Census 2010, particularly regarding quality assurance and quality control.

For that reason Census management assigned a team to develop a comprehensive strategy for quality assurance in Census 2010.

The strategy provides for a clearly defined and communicated approach to integrating QC and QA into all decennial census activities. This approach will help the Census Bureau successfully manage the tradeoffs between quality and production. A successful QA program will enable production and QA to jointly identify quality issues and agree how to resolve them in a timely way.

What is Quality?

Here are some of the many definitions of "Quality."

- Conformance to requirements.
- Conformance to mutually agreed-to expectations.
- Fitness for use.

The Project Management Body of Knowledge defines quality as "the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs" (PMBOK Guide, 2000). The American Society for Quality (Daniels, 2002) gives two definitions:

- The characteristics of a product or service that bear on its ability to satisfy stated or implied needs.
- A product or service free of deficiencies.

At the Census Bureau, we use an implicit definition of quality – getting the job done, on time, within budget, so that it meets the specified requirements.

When an organization develops and maintains processes that consistently deliver quality products (or services), it will deliver products that meet requirements. When products do not meet requirements, the organization will have to rework, repair, or sometimes even discard them. If the organization relies exclusively on inspection and rework to make products meet requirements before delivering them, it is unlikely to save time or money. As Deming said, "Inspection to improve quality is too late, ineffective, costly" (Deming, 1982).

People frequently confuse quality with grade and equate "higher grade" with "higher quality." But the two characteristics are not the same. For example, a computer program with a limited number of features has low grade. Another program with many features has higher grade. Either of these programs can have high or low quality. If the product has few bugs, is designed so the user can easily access the available features, and has readable user documentation, it has high quality. If the program has many bugs, cumbersome user interfaces, and a poorly organized user interface, the program has low quality (PMBOK Guide, 2000). Some of the Census Bureau's products may reinforce this confusion of quality with grade. For example, estimates from a survey can be made more precise and reliable by interviewing a larger sample. Precision is one aspect of quality, because inadequate precision means the estimates will not meet the specified requirements. A higher level of this aspect of quality than specified can be considered a higher grade.

This confusion of quality with grade can lead to problems when planning for quality in projects. Project managers may think of quality as a feature, part of the scope of the project, that can be balanced with the constraints of cost and schedule.

Planning for quality means planning to assure that the product meets the requirements. This requires determining what the requirements are, including the appropriate grade of the product. And then planning t develop the standards, processes, and procedures that will deliver a product that meets the requirements.

When people talk about delivering "the appropriate level of quality," most often they are confusing grade with quality. They really should ask one or more of these questions:

- What are the real requirements for the product?
- What is the appropriate grade?

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- How much effort should be spent to assure that the product meets the requirements?

By "the appropriate level of quality," usually people are thinking of the third of these issues, "What is the appropriate level of effort to put into planning, quality assurance, and quality control?"

Planning for quality and implementing quality assurance costs time and resources, especially in the early stages of a project. But by thoughtful planning, building the appropriate standards, processes, and procedures, and investing in quality assurance, the project ultimately will save both time and resources. But neither time nor resources will be saved if a product is flawed and must be reworked, or even discarded. Costs in time and resources are even higher if a defective product is delivered and must be recalled. These situations also hurt staff morale and motivation. And delivering and recalling a defective product can seriously damage an organization's credibility.

The incorrect perception of quality as a feature can be reinforced if the QA staff insists on a level of quality assurance higher than required by the goals of the project.

Unfortunately, defining that "appropriate level of quality" usually is not simple, especially in the context of the decennial census. To determine where to draw the line of "how much 'quality' is appropriate?" the QA staff and the project managers must identify and quantify risks and balance them against the available budget and schedule.

What are Quality Control and Quality Assurance?

The short answer is, quality control (QC) makes sure that the product is good and quality assurance (QA) makes sure that the processes are capable of delivering good product.

The PMBOK Guide defines quality control as, "monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory results." The PMBOK Guide defines quality assurance as, "all the planned and systematic activities implemented within the quality system to provide confidence that the project will satisfy the relevant quality standards." Further, quality assurance consists of "evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards" (PMBOK Guide, 2000). The Software Engineering Institute makes a similar statement, "The purpose of Software Quality Assurance is to provide management with appropriate visibility into the process being used by the software project and of the products being built" (Paulk, 1993). The American Society for Quality (ASQ) points out that the terms "quality control" and "quality assurance" often are used interchangeably (Daniels, 2002). Juran compares QC and QA, "Under quality control, the prime purpose is to serve those who are directly responsible for conducting operations – to help them regulate current operations. Under quality assurance, the prime purpose is to serve those who are not directly responsible for conducting operations but who have a need to know – to be informed as to the state of affairs, and hopefully, to be assured that all is well (Juran, 1999).

The Census Bureau has a very strong commitment to quality and a strong history of quality control. However, as in many other organizations, Census Bureau staff often confuse the roles of QC and QA and use the terms QC and QA interchangeably. For example an internal Census Bureau memorandum posted to the Census Bureau's Quality Management Repository on October 12, 1999, "Quality Assurance Programs in the Decennial Area," lists 32 activities as "quality assurance programs." Of these 32 activities, the plans for five activities had not been completed. Of the 27 activities with completed plans, only eight plans described actual quality assurance activities. The other 19 plans described activities that involved checking results (product) and correcting them – quality control (Singh, 1999).

One consequence of this confusion between QC and QA is that neither the Decennial Census program nor the Census Bureau as an organization, has a comprehensive QA program that coordinates quality assurance across all activities. However, the Bureau performs strongly in some aspects of QA, notably the pretest and evaluation programs conducted throughout the decade to prepare for the upcoming decennial census. These pretest programs identify and evaluate the methodologies that will be used in the upcoming census and eventually fine-tune those methodologies and procedures. The Census Bureau's Methodology and Standards area has taken steps to strengthen its QA programs further by developing standards for critical processes to help ensure that quality products result. These standards reside on the Census Bureau's Intranet in the Quality Management Repository (QMR). The Bureau relies on the individual program areas, such as the Decennial Census program area, to see that the standards are followed, but no formal audit process is in place to ensure compliance.

The 2010 QA strategy team borrowed heavily from the model and terminology for quality assurance in the software development industry. Many of the tasks and products of a decennial census are remarkably similar to those of software development. In fact, Census 2010 will place more reliance on automation and software than any previous census. Because many managers at the Census Bureau have been trained in project management under the Project Management Institute's model, the team also borrowed from the concepts of the Project Management Institute.

This section of the paper incorporates the ideas and concepts of Watts Humphrey's discussion of Software Quality Assurance (SQA) in Managing the Software Process (Humphrey, 1989). What Humphrey says about SQA applies to Quality Assurance in general.

Humphrey cites an old management precept, "What is not tracked is not done." A decennial census involves many projects and thousands of tasks that must be performed correctly. The role of the QA function is to do that tracking.

Humphrey indicates that in small organizations managers can monitor the work so closely that no formal QA activity is needed. But as staff size increases, managers have other duties and they lose touch with the day-to-day technical work. Three possible solutions are available to managers.

- Find a way to handle their other workload so they can monitor their people's work more closely.
- Hire someone to do the audit work.
- Motivate the people to monitor each other.

Humphrey indicates that while the third option is the most desirable from several aspects, these "buddy systems" have historically broken down and failed to work.

In a large endeavor like the decennial census the work is so complex and the staff is so large that management has difficulty keeping track of the day-to-day technical work. According to Humphrey, QA has three main goals.

- To improve product quality by monitoring both the product and the process that produces it.
- To ensure full compliance with established standards and procedures, for both the product and the processes.
- To bring to management's attention any deficiencies in the product, the process, or the standards and procedures, so management can take steps to have them fixed.

The QA function not only must ensure compliance with the standards, they also must assure that effective and appropriate standards and procedures are established and documented.

The QA function will be most effective when it reports through an independent management chain, when it is staffed by competent professionals, and when the QA staff see their role as collaborative, supporting the project teams in providing a quality product.

For QA to be an effective management tool, it must be used properly. The main benefit of a QA program is the assurance it gives management that the specified process actually is being implemented. What QA is supposed to do, and **all** that QA can do, is alert management to deviations from the established standards and procedures. Management's job is to take steps to fix the quality problems. Without management's continuous interest and active support, QA will become an expensive bureaucratic exercise.

However, special situations may warrant management **not** taking corrective action. Generally the problems that QA uncovers indicate the potential for bad product to occur. QA alerts management to these risks and provides the basis for making informed decisions. Management must weigh the risk and potential consequences against the costs and time required to eliminate the problem. Management may decide to accept this risk. For example, if the problem is failure to adhere to procedural standards, management may grant a waiver. Or the corrective action may be to change the standard.

But without an effective QA function, management probably will be unaware of the problems, and will accept the associated risks by default. The QA function gives management the ability to decide which risks to accept. It also gives management the opportunity to make contingency plans if they determine that taking immediate corrective action is too costly or time consuming.

With an effective QA function, the quality decisions will be made consciously and will be documented.

Paraphrasing Humphrey, effective QA ensures that:

- Appropriate methodologies are in place for all projects.
- Projects adhere to established standards and procedures.
- Independent reviews and audits are conducted.
- Documentation is produced to support the project, the product, and subsequent activities.
- The documentation is produced during project development and implementation, not after.
- Change control mechanisms are established and used.
- QC focuses on high-risk areas.
- Each task in a project is completed satisfactorily before its successor task is begun.
- Deviations from standards and procedures are identified quickly.
- The QC work itself is performed according to established standards and procedures.
- The project plan and the QA plan are compatible and integrated.

Why QA Is Important for Census 2010

The Census Bureau has been in existence for 100 years and the U.S. has conducted censuses successfully for over 200 years, all without a comprehensive approach to QA. Managers may wonder why it is so necessary now. Creating and maintaining the QA function will require time and resources, which are always in short supply. And funding for census activities is even tighter

now, with increased competition for a finite federal budget.

But a comprehensive and coordinated QA program is more important now than ever. Not only will the processes and systems needed to carry out Census 2010 be more numerous, more complex, and more interdependent than ever before, but much of the work will be contracted out and not under direct Census Bureau control. A comprehensive and coordinated QA program can decrease the risks associated with these factors.

An effective QA function can reduce the chances of expensive missteps that require rework or last minute work-around solutions. Deming has noted that rework increases costs (Deming, 1982). Rework also sets back the schedule. Work-around solutions represent work beyond what was planned for, add costs, and can set back the schedule. And because work-around solutions are implemented hastily, they may generate still more errors.

The Census Bureau realizes the importance of QA. For example, the Bureau contracted to have some of Census 2000's QA activities evaluated (the evaluation report is not yet available). And Decennial management formed a team to develop a comprehensive strategy for QA for Census 2010.

The 2010 QA strategy proposes a comprehensive and coordinated approach to quality assurance across all decennial activities.

Tension and Contention

Considering the preceding list of what the QA function aims to accomplish, it is easy to see how some tension can exist between the QA function and production. Effective QA requires time and resources. In effect the QA function competes with production for resources, not just for the QA staff, but for the production units to comply with QA requirements. For example, QA will require information and data, which will require time and resources for production to provide. Further, if QA determines that the specified procedures are not being followed or are not adequate to provide the specified quality of product, the production staff must expend more time and resources to come into compliance.

This tension often leads to contention between QA and production. The production staff can easily develop the perception that the QA staff is creating a drag on the process by focusing exclusively on quality issues without regard for the effects on cost and schedule. The QA staff can develop the perception that production cares only about delivering the product with little concern about whether it meets the quality requirements.

Some contention is to be expected. But in the fast-paced environment of the decennial census, a slow decision process can yield a default decision not to take corrective action. To facilitate timely decisions on quality issues, the 2010 QA strategy recommends implementing a specific process to resolve contention, with timely escalation of issues to appropriate management levels. The strategy also recommends designating a high-level manager as a Quality Assurance advocate. Not only would the QA advocate provide high-level management involvement, but would be the final link to Decennial top management in the contention process.

A Key Requirement for QA Success

To be effective, the QA function needs an independent reporting channel to top management. It should not report exclusively to the project manager. When resources and schedules are tight, the project manager may be less sympathetic to reports of incomplete development or QC plans, documentation errors, shortcuts in procedures, circumventing change control, etc. Humphrey states that to be most effective the QA function should report to a high level manager who is directly affected by poor quality. And, senior management must tend to support QA in disputes with production management. If management consistently decides against QA, the QA staff will become discouraged and revert to defect counting. The result is that the organization will receive little benefit from the resources expended on QA (Humphrey, 1989). For QA to be effective, top management must visibly support quality concerns on a par with cost and schedule.

A QA Example from Census 2000

The confusion between QC and QA mentioned earlier not only means that the purpose of quality assurance is misunderstood, it results in a very heavy reliance on quality control. One risk in this approach is that the quality control function can become overwhelmed and result in bottlenecks in the census process. Such bottlenecks could jeopardize the timely completion of the affected tasks and subsequent tasks, or result in curtailing the quality control, possibly lowering the quality of the product. Although a major role of QC is to determine and correct the root causes of errors, in the decennial census we usually have only a brief time period to perform an operation. By the time we determined the root cause of a quality problem, the operation could be over.

A notable example from Census 2000 of the heavy reliance on QC and a QA that was less effective than desired can be seen in a report by the Commerce Department's Inspector General (Commerce, Office of Inspector General, September 2000). When the Inspector General discovered that three local census offices (LCOs) in South Florida failed to follow the QC procedures for the Non-Response Follow-Up (NRFU) enumeration, the

Census Bureau had to re-enumerate over 67,000 housing units assigned to those offices. The purpose of the QC was to detect and correct bad product – housing units enumerated without a proper interview. Because the QC procedures were not implemented correctly, bad product slipped through. By monitoring the QC reports, an effective QA program would have uncovered this problem early, so that management could have taken corrective action before such a large amount of rework was needed. Unfortunately, the data from the NRFU QC operation were not available timely. And because the QA program did not have a documented plan and agreed upon plan for capturing and transmitting the QC data to the QA staff, it could not effectively support a request for the data against other requests for process data from the census operations. The operation took place from April through July, 2000, but the Census Bureau's Decennial QA staff did not receive the QC files until August 5, 2002. (Wharton, 2002) Without timely access to the data on the QC operation, the QA staff had no chance to determine whether the QC procedures had been followed properly. Timely access to the QC data would have made it more likely for the QA staff to detect and correct the problems in the Florida LCOs before massive rework was needed.

2010 QA Strategy

Main Purpose of the 2010 QA Program

The QA program's main purpose is to provide Decennial Management with ongoing visibility into the decennial processes, through monitoring and measuring. This visibility will identify problem areas and processes needing improvement. It is up to management to take steps to ensure that the problems are addressed and the needed improvements actually take place.

Requirements for the 2010 QA Program

To be successful and justify the resources expended, the QA program must satisfy key requirements.

- QA activities are well defined, carefully planned, and thoroughly documented.
- QA plans and results are communicated timely to all stakeholders in the process.
- QA activities are conducted independently from the production activities.
- Senior management actively supports the QA program and activities, and addresses the quality issues identified by the QA function.

Key QA Activities

The key activities of the QA program are

- To develop the QA plan, or assist the project managers in developing the plan.
- To monitor processes and report results to top management, as well as project managers. This monitoring provides management with visibility into the processes, so decisions on quality issues can be better informed and more effective.
- To seek timely resolution of process deficiencies. QA can identify problems, and report them to management. But it is management's responsibility to take corrective actions. This calls for understanding the consequences of the quality problems and the cost and schedule trade-offs involved in fixing the problem.

2010 QA Implementation Plan

The QA strategy team recommended testing the strategy in a pilot project before implementing it full-scale. The general steps the team recommended to implement the strategy are:

- Develop the Decennial QA Policy
- Identify the support structure for the Decennial QA function.
- Develop a plan for the QA pilot project.
- Conduct the QA pilot project.
- Evaluate the QA pilot project and make appropriate modifications.
- Roll out the Decennial QA program, possibly phased in over a few programs at a time.

The QA pilot project would be carried out as part of a census pretest operation. This pilot would identify problem areas in the QA strategy and implementation plan with sufficient time to make adjustments before the Census 2010.

Issues and Risks

A main concern is how to staff the QA function. The Decennial Management Division assigns a project manager from its staff to oversee each project. That manager's job is to assure that the project is completed on time and within budget, and that it is done correctly.

One viewpoint is that these program managers already are responsible for the QA function and that responsibility simply needs to be reaffirmed.

But two risks seem apparent. First, it doesn't follow the proven model of QA having a reporting channel to senior management that is independent of the project manager. Lack of independence means that schedule and cost pressures might influence the QA staff's decisions. The QA staff might be reluctant to recommend that the project manager stop an activity, even though serious noncompliance problems exist. (Paulk, 1993)

Second, carrying out the activities of a true QA function will take time. For example, performing independent reviews and audits of the processes is an activity the Census Bureau has not performed to date. This task will be in addition to the work the project managers have traditionally performed. Simply monitoring the schedule and budget, and resolving issues and problems not directly related to quality consumes most of these managers' time, so the risk is substantial that the QA function will not receive adequate attention or priority.

Dedicating staff to the QA function will require adding resources or shifting resources from production work and ensuring effective communication, trust, and collaboration between the QA and production staffs. That's one reason why the implementation plan recommends piloting the QA program in a few of the 2010 Census test operations and expanding the program as we learn more and the system demonstrates its value.

Conclusion

The 2010 QA strategy proposes to institutionalize a formal QA program that coordinates QA activities across all decennial projects. It calls for a specific contention process to resolve QA issues and it recommends identifying a QA advocate to act as the final step in the contention process. The 2010 QA strategy has been presented to the Decennial Directorate's senior management and now is under consideration.

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