ARCHIVING CONFERENCE IS&T imaging.org

https://www.ingentaconnect.com/contentone/ist/ac/2011/00002011/00000001/art00024

Implementing a Quality Assurance Plan for Monitoring Scanner Performance

Michael Horsley and John Berezich; US National Archives and Records Administration; College Park MD, US

Abstract

This paper is a case study of the U.S. National Archives' Special Media and Preservation Division's implementation of an objective and quantifiable quality assurance program for monitoring scanner performance using the DICE/Golden Thread target and software for compliance with the Federal Agency Digitization Guideline Initiative (FADGI) guidelines. We present our experiences conceiving an approach for using the DICE/Golden Thread target and software; describe the steps we took to comprehend the data in a practical day-to-day process, and to relate it to the theory behind the guidelines and related standards. The combination of tools and guidelines has made the process of implementing an objective program possible.

The digitizing labs at the U.S. National Archives and Records Administration use many different types of digital capture equipment and image processing workflows. Also, we have a wide array of digital projects with external partners, as well as a variety of internal digitization operations. By implementing a target based evaluation process, we plan to ensure a high degree of consistency to the production of raster images from all sources, and to reduce the number of customized workflows that rely upon visual inspection and subjective human evaluation of image quality.

Researchers depend on the archive community to create usable and sustainable products of digital imaging efforts. We believe creating quality digital products that conform to technical guidelines will meet NARA's goals for both preservation and access. By collecting good data, and by providing feedback to vendors and manufacturers about how their products perform, the archival imaging community and the public will benefit from improved equipment design.

Introduction

> ***"By concentrating on precision, one arrives at technique, but by concentrating on technique one does not arrive at precision."***
>
> **Bruno Walter**

The Special Media Preservation Laboratories of the US National Archives and Records Administration have been working to implement a Quality Assurance and Quality Control program for digital workflows. As the majority of our analog reformatting and duplication capture processes have been replaced by digital technology, a similar effort needs to be taken to apply new tools to measure and monitor image quality. This paper will be useful for those in the cultural heritage community who lack the tools and expertise to: evaluate scanning equipment performance, make informed choices about equipment selection, and use a common language when communicating image quality.

The emergence of US [1] and European [2] initiatives to establish technical benchmarks along with the availability of accurate test targets and analytical software provide objective means to determine image quality and scanner performance. These guidelines and tools allow independent means to verify device performance and image quality separate from subjective visual analysis or reliance upon claims by vendors and manufacturers. By relying upon technical benchmarks and utilizing analytical tools to verify performance, imaging stakeholders are able to use a common language when discussing image quality.

Our experience confirms the difficulty of relying upon complex technical terminology to communicate image quality to a wide audience. By adopting consistent idioms [3] to describe image performance and avoiding vernacular expressions such as "dpi" or "high resolution", the imaging specialist avoids perpetuating ambiguity. Analytical tools synthesize complex device performance data into a "quality grade" that serves as an executive summary to describe if a device is meeting technical benchmarks. Summarizing data creates an easy to communicate performance score that patrons, vendors, manufacturers, imaging specialists, and administrators can use to make evaluations. By setting the groundwork to instill a quality management culture we hope to demystify the value and use of Quality Assurance and related process control to meet the preservation and access goals of our institution.

Quality Assurance and Quality Control

Discussions attempting to define the difference between Quality Assurance (QA) versus Quality Control (QC) often lead to confusion and misinterpretation. Generally stated QA is the set of parameters established to prevent defects prior to creating the product, whereas QC are the steps to monitor and evaluate what was created. An effective QA program depends upon defining what is to be measured and effective QC depends upon the accurate collection of data and analysis.

We quote from "Moving Theory into Practice: Digital Imaging for Libraries and Archives":

"Quality control (QC) is an integral component of a digital imaging initiative to ensure that quality expectations have been met. It encompasses procedures and techniques to verify the quality, accuracy, and consistency of digital products. Quality control strategies can be implemented at different levels…" [4]

There are a set of steps presented in "Moving Theory into Practice…" that outline the components of a QC program:

- Identify the product,
- Develop a consistent approach,

- Determine a reference point,
- Define the scope and methods,
- Control the QC environment,
- Evaluate system performance,
- Codify the inspection procedures.

Furthermore, the FADGI Guidelines point to several primary image quality metrics that a QA and QC regimen need to address: tone response, color encoding error, white balance error, illuminance non-uniformity, spatial frequency response, noise, color channel mis-registration, and sampling frequency.

For our case study we are analyzing the performance of a class of scanners commonly used to perform high throughput digitization of textual archival records and meet NARA's minimum specifications [5] to create production master digital images. The following section discusses our process to develop an approach and description of scope and methods, as well as a brief overview of our codification of QC procedures.

Keeping it Simple

Realizing that establishing an effective QA and Process Control program at an institutional level is a complex undertaking, we chose to limit our efforts to analyze one specific type of equipment: the Zeutschel 14000 scanner was selected as a digital replacement for our analog microfilming program. By narrowing our analytical efforts to one class of imaging device used to create a specific type of digital image product, we were able to develop a methodology to make practical measurements of scanning equipment.

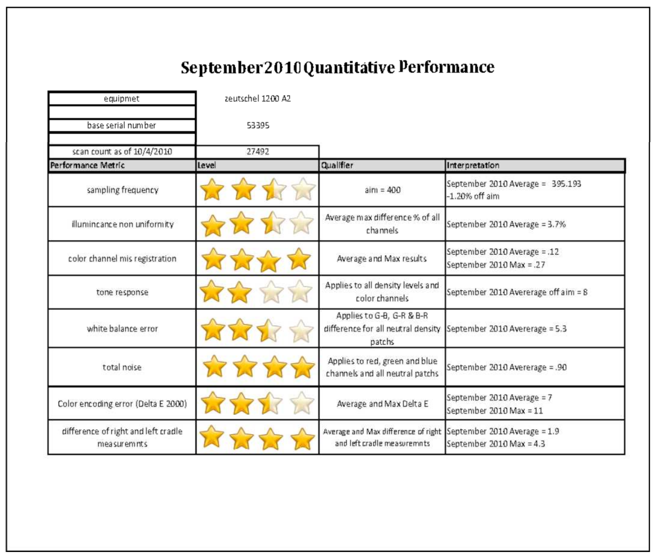
In 2009, we observed inconsistencies in images created by these devices and we were experiencing an unacceptable number of service calls to calibrate, maintain, and troubleshoot the scanners. As a starting point, we used NARA's 2004 Guidelines and later the FADGI guidelines. We implemented the Imaging Science Associates' Golden Thread image analysis software and targets to monitor fifteen Zeutschel 14000 overhead scanning devices (twelve A2-size table-top scanners and three A1-size floor model scanners).

Our main goal was to utilize standards and sophisticated image quality analysis software into a practical day-to-day process on various types of equipment and relate it to the theory behind guidelines and standards. By meeting technical guidelines we ensure the delivery of quality products to our customers along with meeting NARA's preservation and access goals. One of the first hurdles we encountered when putting the theory into practice was determining the essential data of a mass digitization workflow.

We had to organize the data points for 15 imaging devices without suffering information overload. The analysis phase turned into a daunting and time-consuming task because of the amount of data collected. Early on, we recognized the need to develop an efficient method to organize, analyze and utilize the data. Frustrated by the plethora of data we followed the sage advice of a project mentor to "keep it simple". In a moment of inspiration we organized the raw information by pasting printouts of the wide range of data on an office wall. We were able to step back and observe common data points and then group them into a logical order.

Executive Summary

We used the FADGI guidelines to set benchmarks, and by measuring different performance parameters we were able to rate and classify how a specific device met the standards through the use of an executive summary. The summary synthesizes objective data from the various image quality metrics into an easy to understand quantitative performance chart that allows all image stakeholders to make informed decisions regardless of technical expertise. For example, instead of displaying the raw complex Spatial Frequency Response (SFR) or Opto-Electronic Conversion Function (OECF) data the executive summary organizes the metrics into categories and a "star" system is used to rate how well a device performs. Note fields, which list issues and concerns, are attached to the summary and are used by both internal QA technicians and external maintenance and support staff to identify specific problems and track mitigation efforts. Fig. 1 shows an example of an executive summary sheet, which provides an overall snapshot of the performance of an imaging device.


September2010 Quantitative Performance

equipmet	zeutschel 1200 A2
base serial number	53395
scan count as of 10/4/2010	27492

Performance Metric	Level	Qualifier	Interpretation
sampling frequency		aim = 400	September 2010 Average = 395.193 -1.20% off aim
illumincance non uniformity		Average max difference % of all channels	September 2010 Average = 3.7%
color channel mis registration		Average and Max results	September 2010 Average = .12 September 2010 Max = .27
tone response		Applies to all density levels and color channels	September 2010 Avererage off aim = 8
white balance error		Applies to G-B, G-R & B-R difference for all neutral density patchs	September 2010 Avererage = 5.3
total noise		Applies to red, green and blue channels and all neutral patchs	September 2010 Avererage = .90
Color encoding error (Delta E 2000)		Average and Max Delta E	September 2010 Average = 7 September 2010 Max = 11
difference of right and left cradle measuremnts		Average and Max difference of right and left cradle measuremnts	September 2010 Average = 1.9 September 2010 Max = 4.3

Figure 1. *Executive Summary*

Control Charts

The software analyzes digital images of targets scanned on an imaging device and the data is saved into a spreadsheet, which serves to collate the raw information and facilitate the export of information. Initial tests showed some data points for certain performance parameters to be more consistent than others. For some of the parameters with more consistent data points, we were able to do an average of all readings and draw up a control chart of the averaged number. We were then able to analyze the control charts for the consistency, performance patterns and trends in an imaging device. We are currently working on an automated system to analyze random samples of targets created with every scan throughout a working day. We will have a control chart, which will offer real time monitoring of an imaging device without creating any extra work for QA technical staff. This practice will be a helpful process to monitor equipment performance for mass digitization projects.

An automated process, proper organization, and clear and concise presentation of data give us the ability to manage the performance of large amounts of devices with little effort. Over time, trends will be detected for specific imaging devices and preventative measures will be developed to mitigate problems and reduce the amount of rework. Data concerning problematic device performance patterns and trends in the form of performance ratings will allow the deployment of devices to meet specific image quality projects and prepare to take equipment offline for preventative maintenance before performance trends outside desired performance limits or it fails. Control charts are a tool for a pro-active management approach to maintenance, support and QA of a digitization workflow. Fig. 2 is a simple example of a control chart for white balance performance tested periodically over a four-month period.

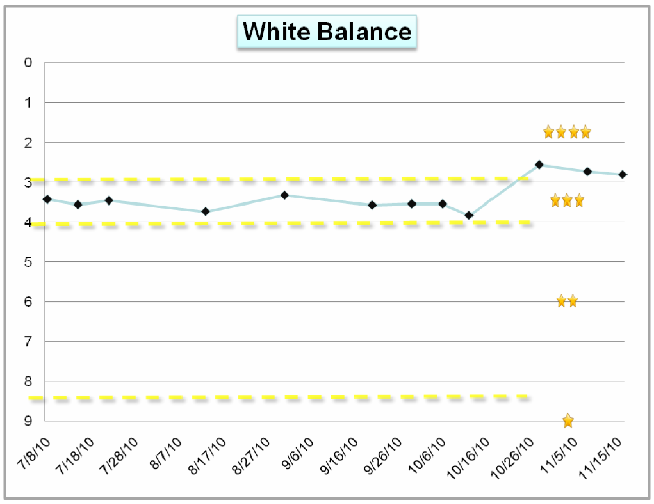


Figure 2. *Control chart*

Maintenance and Support

The implementation of a standardized method to measure, maintain, and monitor performance of digital capture equipment has many benefits. By measuring and monitoring, we will develop a clearer and improved understanding of the performance capability, calibration, and maintenance requirements of equipment. We are able to identify specific devices that meet certain image performance benchmarks and deploy them to meet critical needs. Additionally, we will be able to identify and track devices that require a more frequent level of maintenance.

Prior to establishing a QA/QC monitoring program, our maintenance efforts were reactive resulting in costly service calls. Through active monitoring, poor performing devices become outliers and a QA specialists are able to efficiently categorize problems and triage corrective actions needed to improve quality. Trough the use of mutually agreed upon objective terminology the monitoring program is a valuable tool for to vendor, manufacturer and technical staff to communicate performance issues of an imaging device.

With more accurate data, the vendor and customer can properly negotiate to develop a routine calibration schedule and a preventive maintenance program. Gathering and sharing data and providing feedback to vendors and manufacturers about how their products perform reduces confusion and facilitates positive responses from all parties. The customer is able to compare and evaluate products, and track consistency. For NARA, the main beneficiary of improved imaging performance is the American public who trust that the products we use to create digital images that meet agreed upon standards.

Bridging the Gap

> ***"Good tactics can save the worst strategy. Bad tactics will destroy the best strategy."***
>
> **George Patton**

Implementing process improvements requires skill to transition from older established workflows. Without a well thought out implementation plan that addresses both technical issues and conforms to the institutional culture, the work of the QA staff will be for naught. The reactive approach of the past resulted in a loss of productivity, due to unplanned equipment downtime and poor internal and external communication. We analyzed our existing communication bottlenecks and have established a shared information network and decision-making tree to streamline roles and responsibilities from equipment operator to specialist.

To help improve communication between QA technical and digitization staff, it is essential to draft Standard Operating Procedures (SOP's) tailored to specific audiences. For each device we provide two manuals. One with the basic procedures and troubleshooting that would occur on a day-to-day basis. The second contains more complex methods, procedures and resolutions. The second manual helps technical specialists classify the severity of an issue and determine corrective action once it passes from the non-specialist stage. Additionally, we created a web-based error-reporting database for production staff to log system and equipment problems. The log is a user-friendly tool to document workflow issues and helps the QA team identify issues that are addressed through a FAQ or a troubleshooting chart. Fig. 3 diagrams the flow of QA/QC communication among the imaging stakeholders.

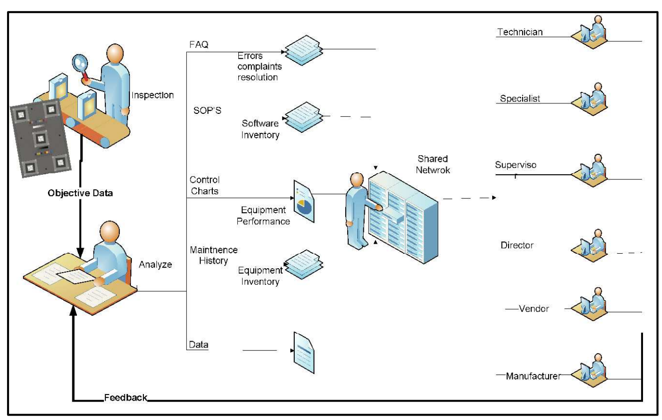


Figure 3. *Communication Network*

Along with standardizing a QA program, we found it necessary to establish a QC technical plan for each unique digitization project. The inclusion of a project level technical QC plan is a new innovation. It is the result of our QA program and compliments the preexisting Archival QC plan. To avoid confusion and define responsibilities, we have found it efficient to separate technical imaging performance QC from project or archival QC issues.

The technical plan is an agreed upon set of QC gates that include, but are not limited to: operator level QC, pre-delivery visual analysis, pre-delivery structure and naming. A standard template is used as a starting point for negotiations, but each QC gate can vary for each project. The QC gate would include standard operating procedures that include specific methods for the inspector. The sample size of each QC gate will be determined by size of the batch and an agreed upon acceptable quality level (AQL). By introducing a QC plan into the work process, we have created a quality assurance culture that continually reevaluates process and improves communications between the QA team and external stakeholders, and increase output.

Conclusion

The establishment of standard Quality Control and Quality Assurance procedures on digital capture equipment will significantly improve digital products created by our labs and satisfy the high degree of trust the public has placed in NARA. We believe that by instilling an efficient and effective Quality Assurance program, we are contributing to the future of NARA's digitization efforts for preservation and access. Process control and performance standards are an integral part of a successful digitalization infrastructure.

References

[1] Federal Agencies Digitalization Initiative Still Image Working Group, Technical Guidelines for Digitizing Cultural Heritage Materials: Creation of Raster Image Master Files, (2010)

[2] Metamorfoze Preservation Imaging Guidelines draft, Bureau Metamorfoze Koninklijke Bibliotheek, National Library of the Netherlands, The Hague, (June 2007)

[3] D. Williams, Debunking of Specsmanship: Progress on ISO/TC42 Standards for Digital Capture Imaging Performance, IS&T PICS Conf. Proceedings, (2003)

[4] Rieger, O, "Establishing a quality control program", in Kenney, A. and Rieger, O. (Eds), Moving Theory into Practice: Digital Imaging for Libraries and Archive, Research Libraries Group, Mountain View, CA, pp. 61-83. (2000).

[5] S. Puglia, J. Reed, and E. Rhodes, Technical Guidelines for Digitizing Archival Materials for Electronic Access: Creation of Production Master Files – Raster Images, U.S. National Archives and Records Administration (NARA), (2004).

[6] L. Serenson Colet, D. D'Amato, F. Frey, and D. Williams, Guides to Quality in Visual Resource Imaging, Council on Library and Information Resources, (2000)

[7] J. Riley and K. Whitsel, Practical quality control procedures for digital imaging projects, OCLC Systems & Services, Vol. 21 issue: 1, pp. 40-48 (2005)

Author Biography

Michael Horsley is a Digital Imaging Specialist in the Special Media Preservation Laboratories in the National Archives and Records Administration. He has over 15 years of experience working in cultural heritage institutions such as the Smithsonian Institution, Library of Congress, and the National Archives. He has served in a variety of roles in the preservation, conservation, and digitization efforts of these institutions. He has a BA in History from the University of Maryland and a Certificate in Digital Imaging from the Corcoran College of Art.

John Thomas Berezich is a graduate of Rochester Institute of Technology and is part of the technical staff in the Special Media Preservation Laboratories at the National Archives and Records Administration. He has helped NARAs' microfilm laboratories transition into digital imaging work flows, and developed an efficient digital imaging infrastructure. Recently, his focus has been on implementing a successful quality assurance program for NARAs' digital imaging labs.