The Image Quality Translator – A Way to Support Specification of Imaging Requirements

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Abstract

Archives, libraries, and museums run numerous imaging projects to digitize physical works and collections of cultural heritage. This study presents a tool called the 'Image Quality Translator' that is being designed at the Royal Library to support the planning of digitization projects and to make the process of specifying and controlling imaging requirements more efficient. The tool seeks to translate between the language used by collection managers and curators to express needs for image quality, and the more technical terms and metrics used by imaging experts and photographers to express the requirements for the performance of imaging systems.

Motivation

Memory institutions and other organizations responsible for archiving physical works, such as text documents, graphic arts, maps, and photographic materials, invest considerable resources in imaging such collections and making the digital reproductions available on the web. From a preservation perspective, giving access to digital reproductions instead of the originals is also a means of protecting valuable, fragile, and/or often requested works from use. Furthermore, imaging can serve to safeguard information content on materials susceptible to deterioration, such as books and archives on disintegrating brittle paper or images on dissolving cellulose nitrate film base.

The nature of the works being digitized can be described by a range of different characteristics, including characteristics relating to the type of material, and to visual characteristics such as tone and color, and the level of fine details in the original. All these characteristics influence requirements for the imaging system and for imaging quality. In addition to the nature of the works the requirements depend on the value that the works represent to stakeholders, and on the purpose of the digitization. For example, accurate color reproduction is likely to be highly important when imaging unique medieval illuminated books, whereas it may not be critical when digitizing some types of documents where text legibility is the main concern. Therefore, collection managers also need to define the significant (essential) characteristics of the work, which as far as possible need to be carried forward in the digital reproduction, as part of conveying trustworthiness to users.

However, collection managers often have a background as archivists, librarians or historians, and in many cases they find it difficult to transform the descriptive needs for the reproduction into the corresponding technical requirements for the imaging system and the imaging quality. Likewise, those responsible for selecting, setting up and operating imaging systems, such as photographers and production managers, often find it difficult to understand the collection managers' needs, because these two groups of staff do not share a common language for image quality.

Problem

Collection managers lack a way of translating needs for reproducing original works into imaging quality requirements, such as requirements for tone and color reproduction, dynamic range, and resolution.

As a result, the project planning phase, where the requirements for image quality are defined typically proceeds in an unstructured and inefficient way. Likewise, the lack of a shared language impedes the part of the image quality assurance where collection managers need to control the delivered digital reproductions.

Approach

To help collection managers define requirements for image quality a so-called 'Image Quality Translator' is being developed at The Royal Library. This tool is intended to help collection managers translate descriptive needs for image quality into technical requirements for imaging that can be applied by the operator (see Figure 1).

Figure 1. *Flow chart illustrating the process of specifying imaging*
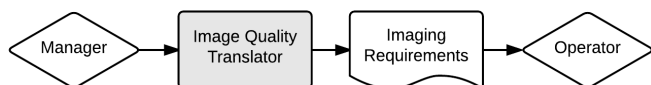
requirements from the collection manager to the imaging operator.

The intension is to express the imaging requirements formulated through the Image Quality Translator according to best practices, such as formulated in the FADGI and Metamorfoze guidelines, and other guidelines on imaging quality [1-3].

The Image Quality Translator seeks to identify and describe all the characteristics that influence the specification of imaging requirements. Figure 2 shows the four main entities used for grouping the characteristics: Value of the work, Type of material, Condition of the material, and Use case. Each of these entities is described in more detail in the next section.

The Image Quality Translator forms part of a detailed project description that must be provided for all larger imaging projects undertaken at the library. The aim of the project description is to ensure that all the many aspects of imaging projects are considered, including organization and planning, logistics and workflows, *imaging quality specification* (provided by the Image Quality Translator), digitization, rights clearing, metadata generation, ingest and archival storage, access and dissemination, and quality assurance of all processes within the workflow. Further, the aim is to provide a solid basis for estimating the costs

of running the project and of managing the digital outputs over time, as well as for assessing the benefits that spring from the project.
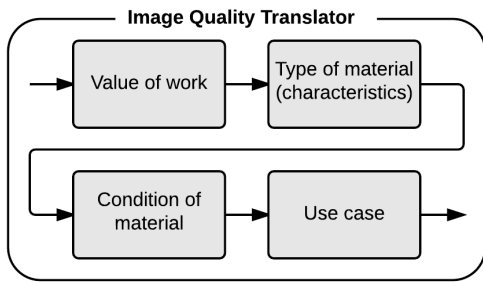

Figure 2. *Flow chart illustrating the detailed process of specifying imaging requirements within the Image Quality Translator.*

The description of imaging projects is quite labor intensive and it typically involves consulting different staff groups. Therefore all projects go through a formalized maturity process (see Figure 3).

All project ideas are first described loosely and presented. If the project idea is accepted a more formal business plan is written that describes the overall scope, cost and benefits of the imaging project. All proposed business plans are then evaluated, typically on a yearly basis, and it is decided which projects to run. For each of the accepted projects a detailed project description is then written, including the specification of imaging requirements derived through the Image Quality Translator.
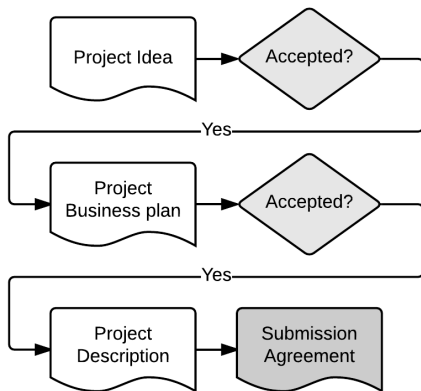

Figure 3. *Flow chart showing the project maturity process from project idea, to business plan, to project description, and the resulting submission agreement, which includes the specification of imaging requirements obtained through the Image Quality Translator.*

All three types of project documents: the idea note, the business plan and the project description, are based on the same template. This template, implemented in a spreadsheet, includes fields for inserting all the different kinds of information needed for describing the imaging project. However, for the project idea,

only a few fields are mandatory. Some more fields are mandatory in the business plan, but only for the complete project description all fields are required. Also the required degree of details for each field increases gradually from idea to the full project description. In addition, the project description is used to extract information required to write the submission agreement. This is an agreement between the production manager and the collection manager about the imaging project, including the imaging requirements.

The Image Quality Translator

The Image Quality Translator was originally developed as part of the project description template described above and implemented in a spreadsheet. However, to make the tool more user-friendly and allow for illustrations we have been looking at other ways to implement the tool. Currently we are using a form set up in Google Analyse, which is a tool for creating surveys. The form takes the user stepwise through the specification process using the four entities of the Image Quality Translator as shown in Figure 2.

At each step the user is asked a series of questions about the imaging project to clarify the needs. Whenever possible, answers are provided as a list of pre-defined options so that users just have to select an option. In cases where there might be a need for an alternative option, we have inserted text boxes that allow the users to provide answers as free-text. For example, to input a document size not included in the pre-defined size list, or write the number of items to be digitized in the project. Also, and depending on previous answers, it is possible to skip sections with questions that are not relevant. To guide users we seek to accompany the survey questions with illustration and examples. All questions and answers are tailored to meet the requirements of the library.

Figure 4 shows the opening page of the Image Quality Translator that introduces the user to the tool and the procedure. The following sections outline the four main steps in the survey.

Figure 4. *Screenshot of the introductory page of the Image Quality Translator.*

Value of the Work

In the first step of the Image Quality Translator the user is asked to determine the value of the work or collection to be digitized. This is done according to The Royal Library's appraisal policy, where collections are labeled according to their importance in unique, significant, or moderate national importance. The value of the work has a direct impact on the required imaging quality.

Type of Material

In the next step the user needs to define the type of material. Here we distinguish between three main categories: textual documents (books, journals, newspapers, manuscripts, archival materials, etc.), graphics (graphic art, maps, plans etc.), and photographic materials (unica, prints, slides, negatives, etc). Also the number of items to digitize must be estimated here (Figure 5 illustrates this section of the Image Quality Translator). Depending on the selection users are directed to the relevant material section.

The material section is divided in characteristics relating to the physical structure of the material, the information content, and to contextual aspects.

In the following we mainly describe the current form for textual materials. Where applicable we have used the Metamorfoze

Guideline to define options [2].

Figure 5. Screenshot of the Image Quality Translator showing the selection of material type and input for the number of items to digitize.

Physical Characteristics

First the user is asked to select the format of the material. Format has different meanings depending on the selected type of material. For textual materials it refers to whether or not the work is bound, and if it is bound how much it opens up. For photographic materials format refers to whether the work is a roll film, film strip or sheet film. In all cases the format influences the required type of imaging system.

Then the size of the item to be digitized is selected. Again the available options reflect the selected type of material.

For photographic materials there are more physical characteristics, which need to be considered, such as whether the photographic material is reflection or transmission material; and if transmission whether it has a glass or film support.

Content Characteristics

Then the user is asked to assess characteristics that relate to the information content.

This includes defining the size of the smallest significant detail that must be produced. For text based materials, if applicable, the size of the smallest character 'e' is used. For photographic materials it is often necessary to perform special test to determine the required sampling rate. Especially when digitizing photographic negatives, which were originally intended to be enlarged and printed in the dark room a higher sampling rate is usually required. Together with the size of the material the level of detail influences the required sampling rate.

Next the user must describe the tone/color of the work, whether it is black and white, grayscale or color. Following this selection the user is asked to indicate how significant a characteristic the given tone/color is. The options here are highly, relatively or not significant. This information guides the requirements for color space and overall imaging accuracy. Figure 6 shows a screenshot of this part of the tool and the illustration provided to help the user understand the difference between capturing a work in grayscale and color.
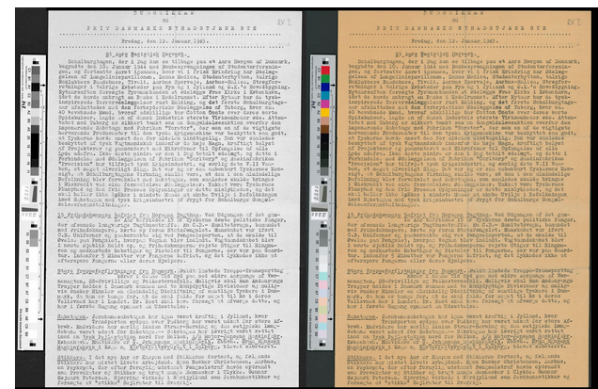

Figure 6. Screenshot of the Image Quality Translator showing the section related to describing the tone and color information. The left image is produced in grayscale and the right in color.

The user is then asked to assess the contrast of the work, which influences the requirements for the dynamic range of the imaging system, and also guides the imaging requirements for bit depth. Usually the maximum density of textual and graphic works is below 1.50, which excludes the need for storing the information in more than 8 bits per channel. Most photographic materials have a maximum density above 1.50.

Context Characteristics

Then any requirements relating to what we term context is defined.

This includes definition of whether for example bindings, blank pages, the backside of prints should be digitized.

Also it describes requirements for cropping.

Then it also addresses if the work or any housing materials contains information that needs to be captured, either by imaging or added as metadata.

Finally, it describes requirements for embedded metadata, both technical metadata and descriptive, and for metadata standards.

Condition of the Material

In the next step of the Image Quality Translator the user is asked to describe if the condition of the material is stable or unstable (fragile). The condition has a direct influence on the selection of suitable types of imaging systems and on how the material must be handled through the imaging processes.

Also the condition influences the overall requirements for imaging quality. If the material is deteriorating rapidly imaging can be used to secure the information content of the original material by preserving it in digital form. In this case it is particularly important to capture all the significant characteristics of the original, since it may not be possible to re-digitize the material at a later stage. Likewise, if the material is very fragile or difficult to handle re-digitization should be avoided. Therefore, the user is also asked to indicate if the imaging is for access or for preservation and access.

Use Case

All reproductions are made in a baseline quality that will allow for a 1:1 representation of the original work on screen or print. The use case section of the Image Quality Translator describes any additional use case driven requirements. For example, higher sampling rates to allow for enlargements (prints/zoom).

Also it describes any requirements for post-processing, such as optical character recognition (OCR).

Figure 7 shows a screenshot of this section of the tool, where we have added an illustration that shows the difference of a 2, 4, and 6 times magnification.

Transforming Needs into Imaging Requirements

Once the Image Quality Translator survey has been completed it should be possible for the imaging manager to transform the recorded needs and descriptions of the value, material type, material condition, and use case into imaging requirements.

Figure 7. *Screenshot of the Image Quality Translator showing a digital reproduction of a fragile document and the effect of a 1:2, 1:4 and 1:6 times magnification.*

The specification of imaging requirements should include:
- requirements for the overall imaging quality (including tone reproduction, noise, color, resolution, shading, distortion, and lines)
- requirements for the parameters: dynamic range, bit depth, color space, sampling rate, and file format
- requirements for the type of imaging system to use for the imaging project

The transformation from the imaging needs to requirements is based on a series of assumptions and rules.

The first assumption is that the overall goal of imaging is to reproduce the original works in a visually accurate and trustworthy way with respect to the contrast, tones, colors and level of details. The tool is not suitable for imaging projects where the goal is to digitize for character recognition only.

The specification of imaging accuracy and the analysis of the obtained degree of accuracy is done with a set of tools: The specification of imaging aims and tolerances follows the Metamorfoze Guidelines [2] using the Universal Test Target (UTT) as reference chart for reflection imaging and the iQAnalyzer software from Image Engineering for analysis of image quality. The purpose of using a multi-pattern target is to make imaging quality analysis more efficient. However, for transmission imaging there is no equivalent to the UTT multi-target, so for checking the image quality we use a series of different targets including the Preservation Microfilm Scanner Target and the Mscan software from Image Science Associates.

A joint working group (JWG 26) under ISO/TC42 Photography is currently developing a standard for image quality analysis. The standard will define which imaging characteristics should be measured in order to assess imaging quality and how

these characteristics should be measured using a multi-pattern reference target. If possible the standard will include guidelines on selecting quality aims and tolerances for each of the imaging characteristics.

The value of the work determines the requirement for the overall imaging quality. The higher the value of the work is the higher the required imaging quality. If based on the condition of the material the purpose of the imaging is preservation this also pushes for a higher overall imaging quality than when the purpose is access.

If the work to be digitized is categorized as a textual or graphic material, the maximum density of the work is normally below 1.50, and as a consequence a bit depth of 8 bits per channel is sufficient to make a good reproduction; whereas if the work is a photographic material 16 bits per channel are usually required because of the higher contrast of these materials. If however the value of the work is significant or moderate, and the purpose of the digitization is access then the requirement is reduced to 8 bits.

If the value of the work is unique it is captured in color. Likewise, if the value of the work is significant and the purpose of the digitization is preservation it is also captured in color. If the value is significant or moderate and the purpose is access it is only captured in color if this is considered a significant characteristic of the work. Otherwise it will be captured in grayscale.

As a baseline standard it is assumed that all reproductions are made in a quality that will allow for a 1:1 representation of the original work on screen or print. Requirements for higher sampling rates depend on the intended use.

The Royal Library still uses tiff as master format for preservation imaging. For access various formats are used including jp2000, jpg, and pdf.

The specification of imaging requirements, especially the value of the work and the condition of the original material, also influence the way the reproductions are stored. Thus, the Royal Library operates with different quality levels of archival storage that reflect different degrees of security and confidentiality. All digital collections are divided by type and assigned an archival storage level.

In this system digital reproductions made for access purposes are stored at the lowest level of security. If an unrecoverable loss in the collection of access reproductions should be encountered, it is assumed that re-digitizing and replacing the loss is less expensive than storing this type of collection at a higher level of security.

Reproductions made for preservation where the digitization has typically required more resources, are as a consequence stored at a higher security level. Reproductions made to safeguard valuable information content on deteriorating materials where re-digitization is usually not an option are considered as important as born digital materials, and therefore stored at an even higher level of security.

All the information collected in the Image Quality Translator can be exported to a spreadsheet.

Conclusions

We designed the first version of the Image Quality Translator in a spreadsheet as part of our imaging project description template. Now we are in the process of testing a version implemented in a Google Analyse survey form to provide a more user-friendly application that also allows us to include illustrations.

The first reactions from users at the library have been positive, it is easy to use the form, and it has helped users better understand the consequences of the choices they make regarding imaging quality. The tool has also it has made the specification of requirements more formalized and thus more efficient.

However, there are still things that need to be improved. First of all we need to complete the form for graphic and photographic materials. Users have also requested more guidance on selecting the overall imaging quality, especially with regards to accurate color reproduction. Also we would like to include information about the implications of users' needs on cost, for example the impact of additional requirements for sampling rates, and its influence on file sizes.

Furthermore, we are looking for a smarter way to automatically derive the imaging requirements based on the rules we have defined for transforming needs into requirements, and for transferring the imaging requirements back into the project description template and ultimately to the submission agreement.

The Image Quality Translator is currently tailored to the needs of The Royal Library. It is however possible to adjust the provided options to make it suitable for other organizations as well.

References

[1] Technical Guidelines for Digitizing Cultural Heritage Materials, Federal Agencies Digitization Guidelines Initiative (FADGI), Still Image Working Group, 2010, http://www.digitizationguidelines.gov/guidelines/digitize-technical.html

[2] Dormolen, H.v., Metamorfoze Preservation Imaging Guidelines, Image Quality, version 1.0, 2012, National Library of the Netherlands (KB), The Hague (NL), http://www.metamorfoze.nl/sites/metamorfoze/files/bestanden/richtlijnen/Metamorfoze_Preservation_Imaging_Guidelines_1.0.pdf

[3] Wüller, D., What if the image quality analysis rates my digitization system a "no go"?, Proceedings of the Imaging Science &Technology (IS&T) Archiving Conference 2011, http://www.imaging.org/IST/store/epub.cfm?abstrid=44600

Author Biography

Ulla Bøgvad Kejser holds a PhD in Conservation Science from the School of Conservation in Denmark. She is a researcher and preservation specialist at the Royal Library in Denmark working in the areas of preservation imaging, preservation planning, and curation of physical and digital collections, especially images. Her current main research focuses on the cost and benefits of preservation. She is a participating member of ISO TC42 JWG 26.

Mogens Bech is a portrait and commercial photographer, educated in the US and in Denmark in advertising photography. Since 2008 he is an imaging specialist at the Royal Library in Denmark working in the area of preservation imaging and quality assurance, providing technical expertise for a wide range of digitization projects. In his spare time he runs his own studio 'Atelier Sorte Hest'.