

# **Benchmarking Art Image Interchange Cycles: Image Quality Experimentation**

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## **Abstract**

A project, supported by the Andrew W. Mellon Foundation, is currently underway to evaluate current practices in fine art image reproduction, determine the image quality generally achievable, and establish a suggested framework for art image interchange. Toward this end, experimentation is being conducted in which a set of objective targets and pieces of artwork in various media are being imaged by participating museums. Print files and guide prints will be delivered to the Rochester Institute of Technology where prints will be made and used as stimuli in psychometric testing to generate scales of image quality. The experimental results will be among the inputs used to construct a conceptual framework of the various types of imaging taking place in cultural institutions at present. Based on this framework, an image processing tool that incorporates appearance models that are adequate for the various working environments in cultural heritage institutions will be developed.

**Keywords:** image quality, image reproduction, workflow

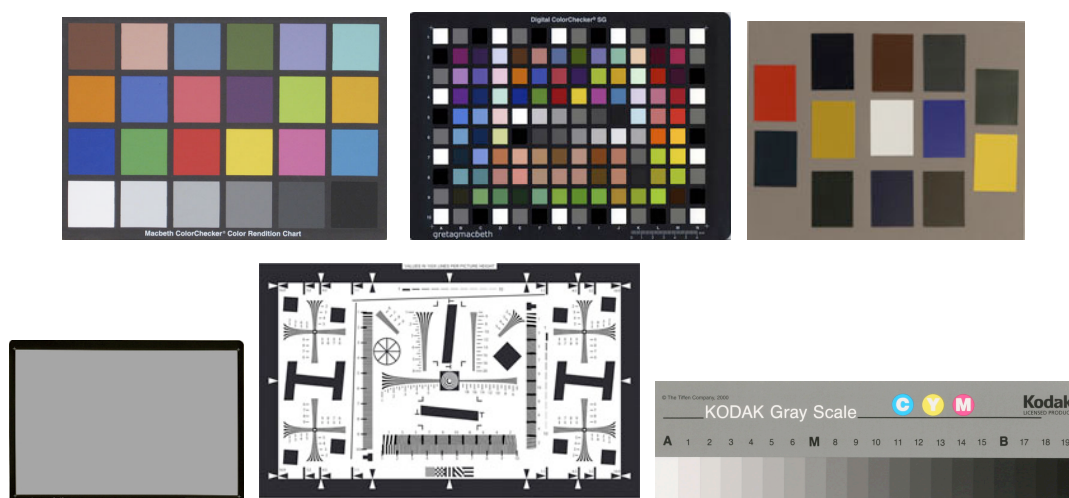
## **Introduction**

There are a variety of reasons why cultural heritage institutions may wish to create reproductions of their artwork. Production of items such as exhibit catalogues, posters, prints, and postcards for sale in museum shops may be among the most obvious. Creating digital versions of the artwork for display on promotional websites as well as those offering on-line shopping, is also of interest. Along with these commercial ventures, it is also certainly of interest to make fine art reproductions to generate images to supply image databases for research and teaching purposes, images to serve as official records in the art conservation process, images for sharing and enjoyment of our cultural heritage. The image quality requirements for each of these applications may be decidedly different. The art conservator needs an accurate reproduction of the painting receiving attention, right down to the cracks existing in the paint when the artwork is first received. Other museum personnel, in contrast, may be looking for the most pleasing reproduction possible so as to offer museum-goers items that invoke fond memories of their cultural heritage experience. One thing that all parties requiring fine art to be reproduced would agree on is the need to keep the best interests of the artwork itself in mind. To limit the exposure of delicate art items to the possibility of damage, it is of interest to minimize the handling of these items and, therefore, the number of times the items are moved for reproduction purposes. It is of interest, then, to make one image that will adequately meet the needs of all potential users. To achieve this, multi-spectral reproduction may be required. Research in this area is progressing rapidly. [Berns et al, 2005; Berns, 2000, Smoyer et al, 2005; Day et al, 2004] Some institutions are experimenting with such practices. However, the recommended spectral imaging processes and equipment are, at present, not practical or cost effective for many museums and other cultural heritage institutions.

To best meet the needs of the broad spectrum of users reproducing fine art, it is desirable to understand the optimal reproduction processes presently available. A framework to follow when reproducing fine art could prove quite helpful to many institutions, especially those with limited resources. Toward this objective, a project supported by the Andrew W. Mellon Foundation entitled “Benchmarking Art Image Interchange Cycles” has been undertaken. The goals of this project are to (1) understand the workflow processes and determine the image quality inherent in the art image interchange cycles in use today, (2) understand the image quality expectations of the users involved in this interchange cycle, and (3) develop the capability to tie the two together. To assist in achieving these goals, experimentation is underway to evaluate the image quality achievable using methodologies currently employed by cultural heritage institutions.

## Experimental Methodology

Research has been conducted previously on the capture stage of the art image reproduction process. [Berns et al, 2005] In this work it was discovered that current capture processes are variable and that these varied processes can result in significant perceptual differences in color appearance and image quality. The present study will evaluate the entire reproduction process with an emphasis on the perceptual image quality at the print end of the art image interchange cycle. The basic approach to accomplish this starts with understanding and documenting the workflow processes in use today. A review of the key steps included in the workflow processes as documented by ten participating cultural heritages institutions was conducted. Next, these workflows are being exercised by sending a variety of pictorial “targets” along with objective targets to each of three participating institutions for image capture and print file preparation. The objective targets are included with the goal of finding measurable image characteristics that correlate with the subjective results. It is hypothesized that color and tone reproduction, sharpness, and uniformity may be among the key image characteristics. As such, the objective targets include patch targets for color and tone measurement including two Color Checker targets, a gray scale, and a paint target; a slanted edge target for assessing sharpness, and a uniform gray card for evaluating uniformity, Figure 1. The paint target was constructed by doing draw-downs using the same paints used to make the four oil paint pictorial targets. Patches were clipped from the most uniform areas of the draw-downs for the target.



**Fig. 1:** Objective targets – Macbeth ColorChecker, Digital ColorChecker SG, GretagMacbeth ColorChecker, Gray Card, Kodak Gray Scale, ISO 12233 Slanted Edge target, and Paint Checker



**Fig. 2:** The artwork included in the study from top left: Photograph, Orchid, Daisies, Night over Wheatfield, Impression of Monet’s Waterloo Bridge, Nude, Abstract, and Still Life.

The experiment will follow an anchored scaling procedure in which the artwork will represent one end of the scale if the prints generated following the museum workflows are perceptually diverse. If, however, the prints are perceptually close, the triplet comparison protocol outlined in ISO 20462-2 may be substituted for the direct scaling approach. The objective data, including uniformity information from the gray card, sharpness information from the slanted edge target, following the experimental protocol outlined in ISO 12233, and color and tone information measured from the color patch and gray scale targets, will also be obtained. Analysis will then be conducted to determine if the objective data relates in a predictive way to the image preference scales. Information on the image quality attributes that the participants use to make their quality ratings will also be collected. The scaling and attribute information will be used to determine attributes important in image quality decisions.

Ten different pictorial targets are included in the experiment to provide a variety of images for exploring the impact of scene content and various image media while keeping the number of test stimuli manageable. These include a line drawing, two aquatints, a photograph, a high-quality lithographic print, a high-quality ink jet print, and four oils including scenes that are relatively light or high-key, relatively dark and having a high dynamic range, and having a fair amount of blue, purple, and orange, Figure 2. Blues and purples are included because research has shown some blues are difficult to reproduce due to the differences in the way the camera and the human eye “see” certain blue pigments, especially cobalt blue. [Berns, 2000] At least in part for this reason, Monet’s “Waterloo Bridge” has been cited as a painting that has been difficult to acceptably reproduce. Orange is a color that has proved critical in color difference perception experimentation conducted using electrophotographic prints. [Farnand, 1997] Each institution will deliver the digital files that they create, information regarding its workflow, and any guide prints, which are often generated as part of the art image reproduction process to give the print shop direction on how the color and contrast of the printed image should appear under specified lighting conditions. Prints from the digital files

will be generated using equipment at the Rochester Institute of Technology's Print Applications Laboratory.

When the prints have been made, a psychophysical experiment will be conducted to generate visual ratings to help develop an understanding of the image quality being achieved in the art image interchange cycle today. The experimentation will be conducted under multiple viewing environments to evaluate the impact of these conditions on the experimental results. Art reproductions are viewed under various lighting conditions, even for image evaluation, from light booth to office to museum shop to living room to gallery. It is important, consequently, to understand and quantify the significance of this effect.

**Table I:** General steps in documented fine art reproduction workflows

Workflow Process General Function	Specific Workflow Process Steps and Considerations	Additional Steps and Considerations
1. Image capture	Objective targets used	Lighting set up used to illuminate the artwork including polarization
		Camera calibration
		Flat-fielding
2. Proofing and image file preparation	Monitor Calibration	
	Working color space	Screen background used for file viewing
	Viewing environment Sharpening	Physical image size on the screen Image orientation
	Resolution and file size	
3. Image delivery	File format	Image layers for documentation of image processing conducted
	ICC color management Delivery media	
	Guide prints and proofs	
4. Image archiving	Archiving protocol	Proper handling and storage of guide prints
	Metadata	
	Image naming	

### Current Progress

To date, the review of the general workflow processes as documented by ten participating institutions has been conducted. The reported steps, listed in column two of Table I, generally address what happens to the image file following image capture. Also, the pictorial and objective targets, shown in Figures 1 and 2, have been imaged at the first participating cultural heritage institution and guide prints have been produced for the artwork. In executing these tasks, there were steps taken that are not currently included in the general descriptions of art image workflows. These additional steps are listed in column three of Table I. Points of interest include the importance of lighting, flat-fielding, and camera calibration in the image capture and the screen background when viewing the artwork image. It was also interesting that the orientation in which the artwork was viewed mattered. It may also be noted that information regarding the steps taken for each guide print including color corrections, sharpening, and contrast and saturation adjustments is preserved in the layers of each print file that will be delivered to RIT.

The artwork and targets are now being shipped to the next participating institution. We expect to have the files from the participating institutions by the end of May and the psychophysical experimentation conducted by early summer.

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