

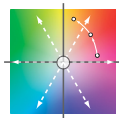
## AARDENBURG IMAGING & ARCHIVES

### ON THE PERMANENCE OF PHOTOGRAPHS, LABORATORY TESTING, AND REAL WORLD BEHAVIOR

The history of photography is rich with materials and processes that have varying degrees of resistance to environmentally induced deterioration. Few people think about the huge range of environmental conditions that exist in homes and offices or how that range can cause over a thousand-fold impact on the image deterioration of photographs. Within the historical context of photography, modern digital printing materials run the gamut from inherently unstable to best-in-class image permanence. Even under steady-state laboratory test conditions some images change in appearance quickly and then slow down over time while others change at a fairly consistent rate, and still others show little change initially but then decline much more rapidly at a later point in time. The visual appearance of image deterioration also varies greatly. Some photographs simply age more gracefully than others!

Modern laboratory tests for image permanence generally provide the consumer with a single predicted value for “display life.” The value is an extrapolation of the accelerated test to a more benign and steady-state environment which is supposed to be representative of the real world. The predicted value is also based upon a specific endpoint criterion for how much change is allowed. This test methodology can often yield valid apples-to-apples comparisons of different products, but conclusions can go awry. First, the combined real world effects of light, heat, humidity, and air pollution are not easy to quantify. Results of tests that were primarily designed to examine one variable (e.g., light fading) are often mistaken by the public to be a comprehensive answer to overall product performance. Second, the magnitude of real world environmental fluctuations is not realistically modeled by the single steady-state environment upon which extrapolated test

Rev: 2007-09-26

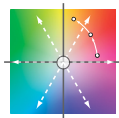


results are usually based. Third, personal expectations for noticeable or objectionable aging can vary significantly among users and even for the same user depending on circumstances. In other words, you may or may not agree with the chosen endpoint of the test. Fourth, the visual impact of aging is not just dependent on the materials and their display environment. It is also image dependent. For example, the image area of a bride's white wedding dress will quickly reveal any paper staining and yellowing while the groom's dark tuxedo may conceal it entirely. Thus, the results derived from a standardized image test target may or may not relate well to your unique image. Finally, uneven rates of change in some products can lead to misranking of their overall product performance because a single endpoint analysis cannot adequately describe non linear rates of deterioration.

Consider this reproduction of an albumen print from my personal collection. The original print is from the Mathew Brady Studios, circa 1860. It is well past its "end of display life" according to typical endpoint criteria used to rate today's print products. Yet the print is more valuable today than the day it was made, and the yellowish and faded tone acquired over time is not nearly as objection-



able as lesser color shifts I've seen in some recent color prints. An enlightened philosophy on image permanence must consider not merely *how long* a photograph lasts. Rather, we must consider *how well* a photograph lasts! Good image permanence properties are about aging gracefully under the pressure of myriad changing environments that photographs experience in the real world. We can best learn how well photographic prints last by also conducting image permanence studies in the real world not just in the laboratory.

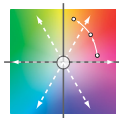


## **The Life of a Photograph**

The “life” of a photograph is a very good metaphor for image permanence. With life must also come death, and there can only be one indisputable criterion for the “death” of a photograph. It is the point in time where all information content in the photograph is gone. No image is left. It is only when no information content is extractable, either by careful inspection or by heroic restoration measures, that a photograph will have undeniably reached its “end of life.” Photographs can appear radically changed and downright ugly long before they give up all information content. Think about your own experiences and how many deteriorated photographs you are keeping or have seen still on display in other people’s homes. We often have a very high tolerance for image deterioration when a photograph continues to have recognizable image content and no better copies exist. That said, photographers and fine art printmakers usually desire their work to retain all of its original beauty. They would certainly not welcome print life predictions based on the total loss of all information content. Endpoint criteria in common use today by manufacturers and independent test laboratories assume some definition for “noticeable fade.” Although noticeable fade occurs much earlier in the natural print aging process than total information loss, it is nevertheless a subjective criterion. “Noticeable fading” may allow too much change when the image depends on subtle color and tonality to convey the artist’s original intent. Yet noticeable fading may underestimate objectionable loss for a less demanding consumer application or for historians who are seeking any useful information content they can find in a photograph.

## **Testing Print Permanence in the Real World**

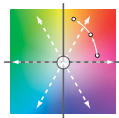
Artists sometimes evaluate light fading characteristics of their materials using a very real world approach. Often called a “window test”, these experiments tend to have visually determined endpoints and unknown environmental conditions. The side-by-side product testing principle is actually pretty sound, but without environmental data and instrumentation to document changes,



artists' tests cannot be pooled to form a broader database of tested materials. The combinations of materials and processes in use today and the range of real world environments in which prints are displayed requires a more dedicated and systematic research plan. The logical test methodology is to approach the problem the same way pharmaceutical companies test the viability and efficacy of a new drug. A large parametric study must be conducted in the real world. The representative print samples are best made by printmakers in their own studios rather than in the laboratory. The prints must then be placed randomly and in large quantities into a wide geographic variety of homes and offices. The conditions must be monitored, and changes in image quality can be evaluated both objectively with instrumentation and subjectively by participants in the study. By examining extreme environments and subsequent deterioration within the overall population, early detection of product changes under harsh conditions can be a good predictor of future changes to prints located in more benign environments. The comprehensive database of experimental results becomes a powerful tool to explain which product combinations are doing better in the real world and why.

### **Test Patches that Correspond to Real Images**

One of the founding principles for Aardenburg Imaging and Archives is indeed the study of real-world print aging behavior because the need for relevant information has not been adequately addressed by current laboratory test methods. The Aardenburg Digital Print Research Program is the cornerstone of this work. We collaborate with photographers, artists, and printmakers and ask them to print a special array of color patches. The array contains standardized test colors. Twenty-four colors reproduce the industry standard Macbeth Colorchecker® target. The printed array also includes up to 30 additional colors selected by the artist and/or printmaker. The array also contains image-specific colors corresponding directly to the chosen image. Aardenburg samples the image contents to create a sub-sampled and ordered array of colors from within the pictorial image. The figure on page 5 shows an Aardenburg color array customized to the specific image content of a photograph.



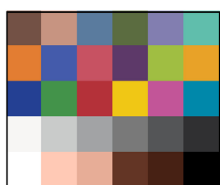
AARDENBURG IMAGING  
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## PHOTOGRAPHER'S PRINT WITH AARDENBURG COLOR ARRAY



Mark H. McCormick-Goodhart ©2006

*Monument Mountain, The Berkshires, April 20, 2006*



Standard Set

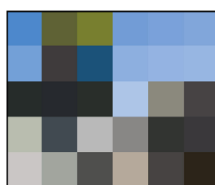
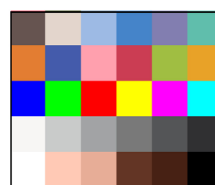


Image Selects



Artist Selects

**Aardenburg Imaging & Archives Digital Print Research**  
[www.aardenburg-imaging.com](http://www.aardenburg-imaging.com)



Standard Set

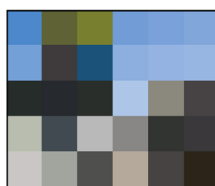
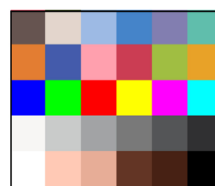


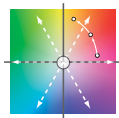
Image Selects



Artist Selects

Upper target row is exposed to light,– Lower target row is dark stored under matt frame

Image Capture: Fuji S3.RAF, Printer: Canon iPF5000 RIP/Drivers: Canon 16 bit Photoshop plugin Profile: Aal\_jpf5000\_MusSilvRag.icc Inks: Canon OEM Paper: Crane Museo Silver Rag Date Printed: 2007-08-09



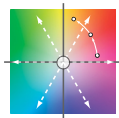
## The I\* Metric

We ask participants in the research to display and enjoy prints in their own homes and offices one year at a time. AaI&A measures the daily environmental factors of light, heat, and humidity within the microclimate of the framed artwork using special data loggers suited for the task. The prints are retrieved by AaI&A each year and evaluated for any changes in the spectral properties of the color patches using spectrophotometers. They are then returned to the field for another year of real world aging. Because spectral data is collected, any current industry protocols such as densitometry or color difference models can be applied to the Aardenburg Digital Print Research database. However, AaI&A evaluates color and tone changes using the recently developed I\* metric (pronounced “i-star”).<sup>1,2</sup> The I\* metric calculates retained color accuracy (hue and chroma) and retained tonal accuracy (lightness and contrast). It returns percentile ranked scores from 100% to 0% which are intuitively easy for the general public to understand. The great merit in the I\* approach is that we can now objectively quantify very small changes early on in the life of a print, very large changes later on, and everything in-between as a print changes progressively in color and tone over time. Aardenburg Imaging & Archives does not try to impose an arbitrary endpoint as do most current industry test methods. Rather, we objectively track how photographs age over time using the I\* percentile scale, but leave it to our participants to decide if print quality meets their expectations.

The AaI&A approach to the gathering of real world image permanence data is innovative and ambitious in its experimental methods but not in its scope. Many companies successfully deploy large numbers of products in the field and track them over time. Aardenburg Imaging & Archives can do the same with a little help from our friends. Please join the Aardenburg Digital Print Research Program!

Mark H. McCormick-Goodhart  
Director, Aardenburg Imaging & Archives





## References

- 1) Mark H. McCormick-Goodhart, "An Introduction to the I\* Metric," Aardenburg Imaging & Archives, February 7, 2007
- 2) Mark McCormick-Goodhart, Henry Wilhelm, and Dmitriy Shklyarov, "A 'Retained Image Appearance' Metric For Full Tonal Scale, Colorimetric Evaluation of Photographic Image Stability," IS&T's NIP20: International Conference on Digital Printing Technologies, Final Program and Proceedings, IS&T, Springfield, VA, October 3–November 5, 2004, pp. 680–688.

\*Both papers are available in PDF format at [Aardenburg-Imaging.com](http://Aardenburg-Imaging.com).

## About the Author

Mark McCormick-Goodhart is the founder and Director of Aardenburg Imaging & Archives. He has over thirty years of professional experience in imaging and materials science and holds eight U.S. patents in the field of imaging science and technology. He has also published over 30 papers related to imaging science and photographic conservation. Photography and printmaking has been his special interest for over forty years. From 1988 to 1998, he was the Senior Research Photographic Scientist for the Smithsonian Institution in Washington DC. Mark also cofounded one of the first fully color-managed digital fine art printing studios, Old Town Editions, in Alexandria, Virginia, with partner Chris Foley in 1996. From 1998-2005, he collaborated with Henry Wilhelm of Wilhelm Imaging Research, Inc to develop new image permanence test methods for evaluating modern digital output media.

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