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## Recent Work on Archival Color Spaces

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## Recent Work in Archival Color Spaces

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- Hans van Dormolen, Koninklijke Bibliotheek
- Dietmar Wueller, Image Engineering
- David Wyble, Munsell Color Science Laboratory, RIT

## 2011 IS&T Archiving Conference

### Color in Digital Preservation

- R. Buckley, S. Puglia & M. Stelmach

### Accurate Color? A Preliminary Investigation into the Color Gamut of Selected Special Collection Library Objects

- F.B. Wheeler & M.J. Bennett

## Archival Color Imaging

- CIE Division 8 Technical Committee: CIE TC8-09
- 31 members from AU, CH, HR, JP, NL and US
  - Collaboration with US Federal Agencies Digitization Guidelines Initiative (FADGI)
  - Robert Buckley (US) is the Chair
- Terms of Reference
  - *To recommend a set of techniques for the accurate capture, encoding and long-term preservation of colour descriptions of digital images that are either born digital or the result of digitizing 2D static physical objects, including documents, maps, photographic materials and paintings.*

## Color Image Capture



## 2009 Questionnaire

- What topics in the areas of content, capture/digitization, quality and workflow would be useful
  - Method to evaluate and validate the accuracy of images
  - Parameters of “Archival” color space, e.g., primaries, gamut, white point, gamma correction, bit depth
  - Making color space conversion and rendering intent part of this discussion



## Comments & Observations

- How do we determine the best color space to use for a project or a content type?
- The scanner targets on the market have colors that are not representative of those in the content being imaged
- Most scanner targets assume a D50 illuminant but the scanners we use have a wide range of light sources
- What can or should be embedded in files to document some of the facts about the color content?
- How critical is it to be consistent about setting the illumination model across workflow processes?
- The scale of our conversion operations and the wide variety of materials and project requirements will test the functionality and reliability of any proposed solution



## Color in Digital Preservation

Method to evaluate and validate the accuracy of images

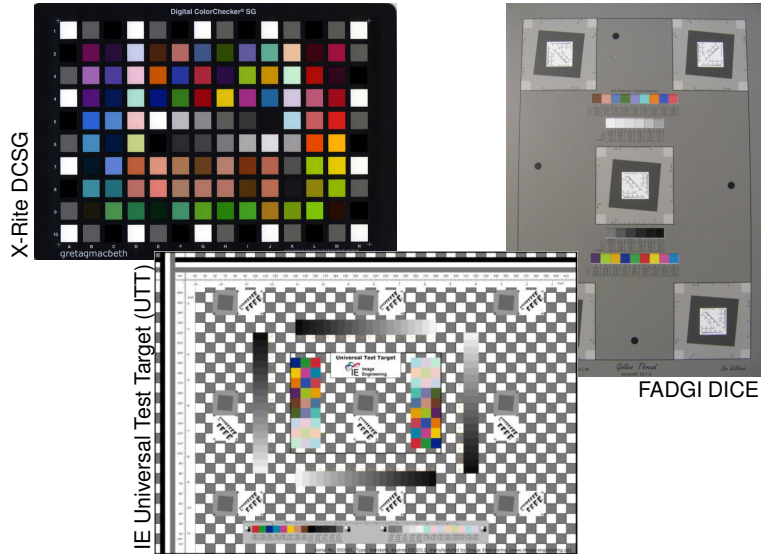
## 2011 Study

- Comparison of Capture Techniques
- Participating institutions digitize a set of test targets and sample original prints
  - 3 commercially available test targets, 4 original prints
  - Provide digital image files produced via their normal production imaging process
    - TIFF files with sRGB, Adobe RGB, ProPhoto RGB or eciRGBv2 color data
  - Provide a general description of their approach
- Analysis of the color accuracy
  - Compare digital image values to known values of targets and prints

## 2011 Study Goals

- The suitability of the commercial targets:
  - For calibrating imaging systems
  - As reference targets for image processing
  - As reference targets for documenting indirectly the characteristics of the types of originals used in this study
- The accuracy and efficacy of different approaches to device calibration and color encoding
- The suitability of different overall color imaging and encoding approaches for meeting the goals of organizations

# Test Targets



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# Original Prints





## Print ROIs



## Participating Institutions

- Library of Congress
- National Archives and Records Administration
- Metropolitan Museum of Art
- Harvard College Library
- Stanford University Libraries
- Art Institute of Chicago
- Preliminary Results based on captures from first three: LC, NARA and Met Museum
  - Digital camera, planetary scanner, flatbed scanner

## Capture Approach - Example

- Institution 2 – Scanners A and B
  - Manufacturers' calibration
  - 24-bit or 48-bit capture, and exposure adjusted to place white patch on Macbeth ColorChecker to RGB level of 238
  - Scanner A uses fluorescent lamps and scanner B used with NorthLight HID lights (4200° K)
  - No post-capture image processing
  - No ICC color profile for scanner A and AdobeRGB for scanner B
  - FADGI Guidelines and images intended for archiving

## Color Space Practice

### Institution 1

- Assign sRGB or AdobeRGB after correction depending on gamut

### Institution 2

- No ICC color profile for scanner A and AdobeRGB for scanner B

### Institution 3

- Conversion in capture software to ProPhotoRGB

## Analysis

- CIELAB values of ROIs on the digital images measured using software
- All color profiles were preserved and no profile assigned to untagged files
- $\Delta E$  calculated comparing digital images to values measured on targets and prints
  - ISA ColorGauge SG Analyzer
  - Bruce Lindbloom's Color Difference Calculator
  - Mauro Boscarol's Color Difference Calculator

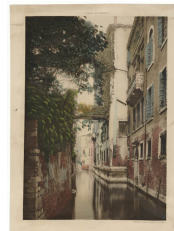
## Preliminary Results - I



### Digital ColorChecker SG

Institution	Scanner	$\Delta E$ 2000		Rank Ave
		mean	max	
1	A	5.3	17.1	3
	B	7.2	22.2	4
2	A	8.3	21.0	5
	B	4.2	9.8	2
3	A	1.1	4.7	1
Average		5.2	15.0	

## Preliminary Results - 2

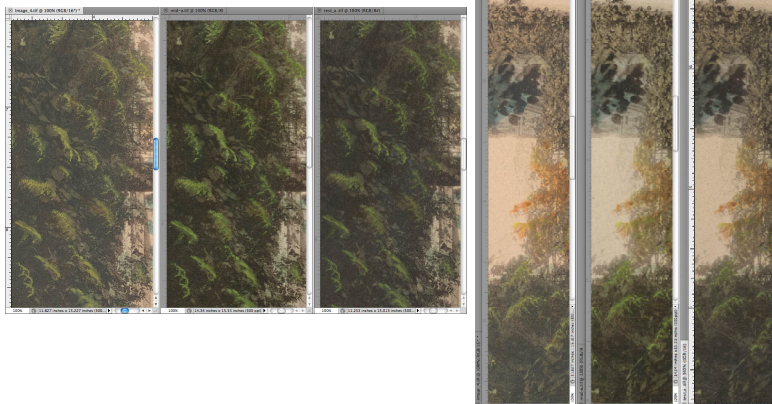


Print A

Average, highest max		$\Delta E$ 2000		Rank Ave
Institution	Scanner	mean	max	
1	A	6.3	12.6	4
	B	5.0	12.7	3
2	A	8.3	17.8	5
	B	3.8	9.3	2
3	A	2.6	8.6	1
Average		5.2	12.2	

## Preliminary Results - 3

Print A – most accurate to least accurate from left to right



## Preliminary Observations

- A well calibrated and color-managed approach has benefit – more accurate color and less variability
- Capture devices not necessarily equal
  - Digital cameras intended for photography appear to do better
  - Default calibration for document/book scanners less accurate
- In general, overall averages for  $\Delta E$  and max  $\Delta E$  for the prints slightly lower than for wide-gamut target
  - Exception - opposite for Institution 3, may be due to positioning errors during measurement

## Accurate Color? A Preliminary Investigation into the Color Gamut of Selected Special Collection Library Objects

## Background

- Current best practice workflows now are guided by physical color targets so that captured image files can be evaluated against known color standards.
- One way of improving and maintaining the quality of digital images is to plan the digital capture processes based on the *actual colors present in the original documents*.

## Purpose

- Perform survey of the colors present in a diverse set of documents held in the Library of Congress' collections and to analyze how closely the document colors relate to the sets of sample target colors that are used to create the Library's device profiles.

## Why Might This Be Important?

1. Color Space Choice
2. Thinking More Deeply About the Reference Colors Used for Calibration and Profiling

## Possible Problems...

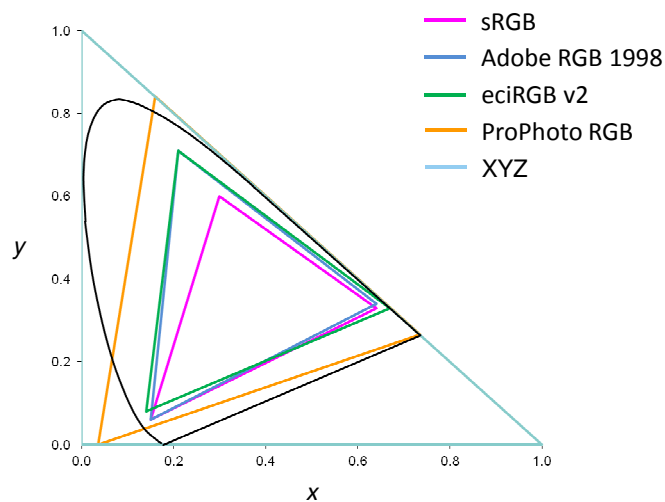
- In many instances AdobeRGB(1998) and ProPhotoRGB are selected under the assumption that the digitized master images may safely be converted to a narrower gamut for any derivative images produced with minimal color fidelity loss... however...

## Possible Problems... (cont.)

- A difficulty of using one of the larger color spaces is the need for increased bit depth in order to avoid posterization or banding.
- Adopting a wide gamut may also, “actually serve to diminish color fidelity by increasing the encoded quantization interval between neighboring colors. Larger quantization intervals can reduce color and tone discrimination, which makes it difficult to render subtle near neutral tones in slowly varying image areas.”\*

\* Don Williams and Peter D. Burns, “Capturing the Color of Black and White,” *Society for Imaging Science and Technology, Archiving 2010, Final Proceedings, 2010.*

## RGB Color Spaces





## Methodology

- Each document was laid on (or backed by) a neutral white support and covered by the Mylar sheet.
- An X-Rite 530 Spectrodensitometer connected to a computer was used to take measurements at each point of interest, and resulting data was placed in an Excel spreadsheet.
- Such colorimetric data was recorded in the device-independent CIELAB format
- This data was then studied to determine the gamut and range of colors within the gamut.

## Methodology



*X-Rite 530 Spectrodensitometer in use (note numbered Mylar sheet)*

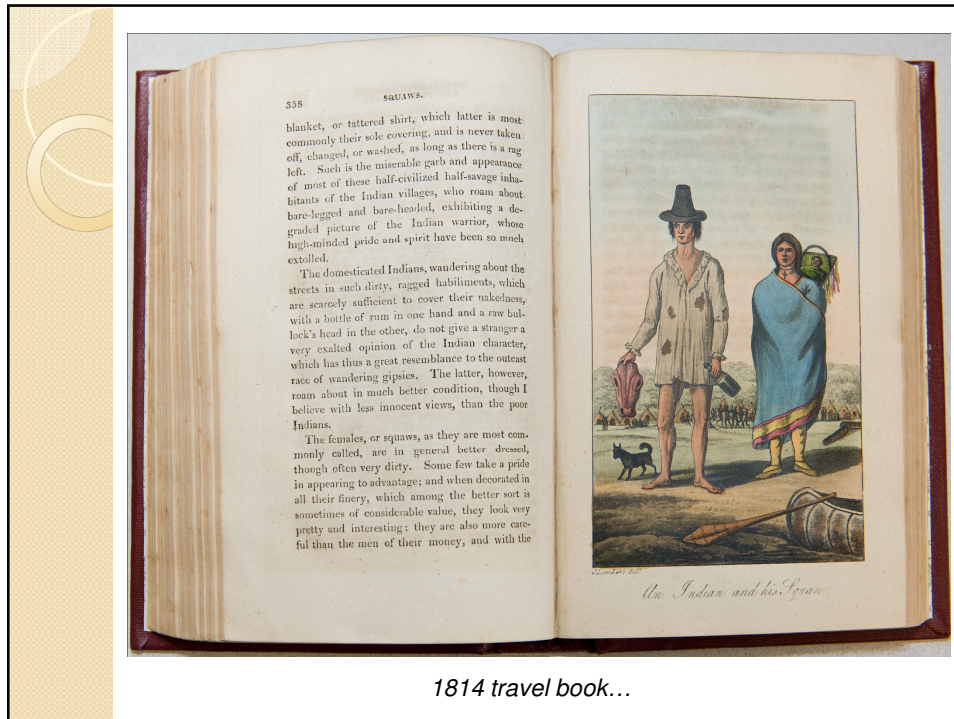
## Methodology

- The CHROMiX ColorThink Pro software application was used to plot all data showing the relationship of each color to the sRGB and AdobeRGB(1998) color spaces.
- The colors were also compared to the colors of the Macbeth color charts used to calibrate the Library of Congress' imaging devices.

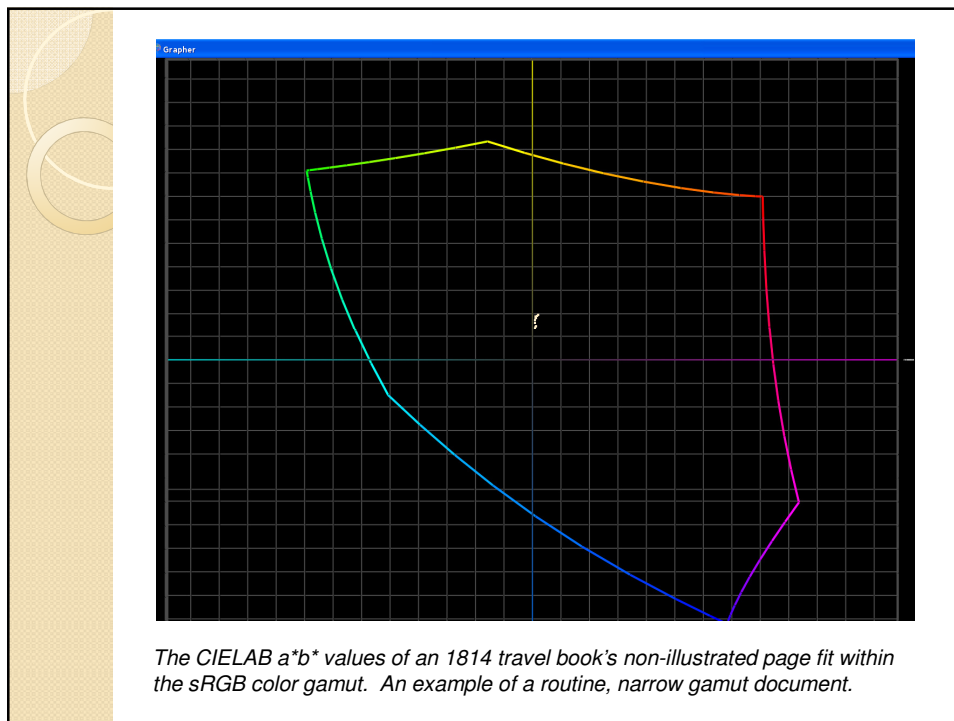
## Results

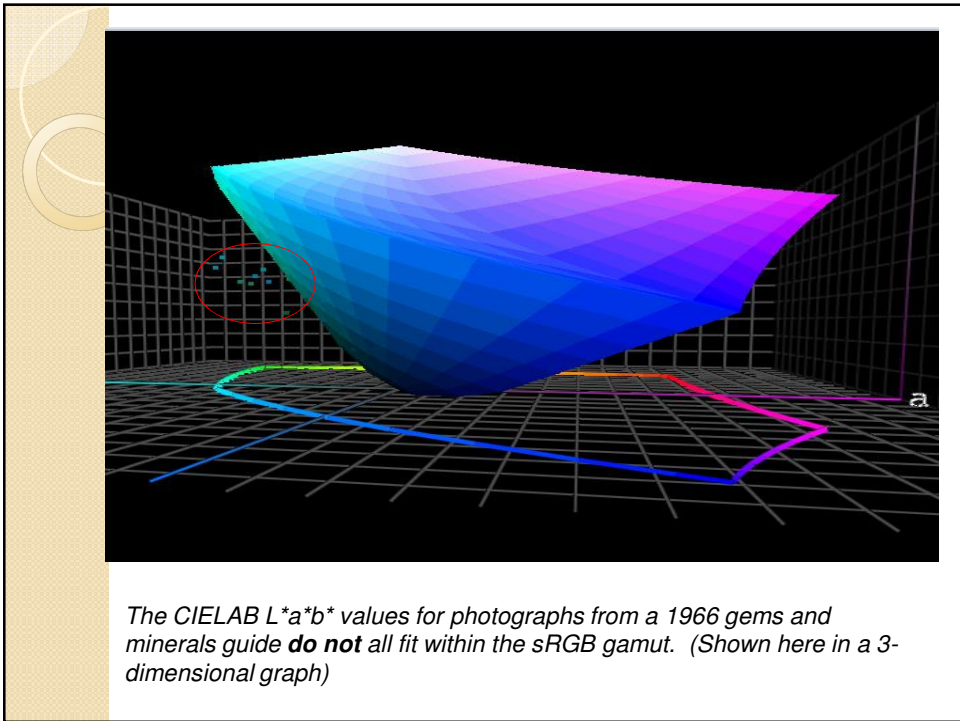
- Initially ten (10) CIELAB datasets\* were measured from the Library's general collection documents.
- Then ten (10) datasets were collected from the Prints and Photographs collections. To date, 4 datasets have also been collected from maps in the Geography and Maps collection.
- Additional datasets are being collected from six (6) more maps, and work is underway towards obtaining datasets from the manuscript, music, and rare book collections.
- Currently, a total of 700 spot readings of  $L^*a^*b^*$  values have been taken from all documents.

\* Project datasets may be downloaded from: [http://digitalcommons.uconn.edu/libr\\_pubs/35/](http://digitalcommons.uconn.edu/libr_pubs/35/)



1814 travel book...





## Discussion

- All documents except two could be imaged using the sRGB color space without color clipping or adjustment.
- For bright colors, especially on coated paper; it may be necessary to check on a 3-dimensional diagram that includes  $L^*$  values.
- The *ColorThink* diagrams show that the 24 patch *ColorChecker* does not provide reference colors for ICC profile calibration that are close to the colors contained in the study's source documents...

## Discussion (cont.)

- ...prior research suggests that more distant profile reference points result in less accurate color.
- A target with significantly more colors, such as the *ColorChecker SG*, used to prepare an ICC device profile might help improve color accuracy. In cases where this also may be insufficient, color patches similar to specific document colors might be printed and used to provide even closer reference colors.\*

\*Trumpy, Giorgio. "Digital Reproduction of Small Gamut Objects: A Profiling Procedure based on Custom Color Targets." In *CGIV 2010, Final Program and Proceedings*, 5:143-147. Joensuu, Finland: Society for Imaging Science and Technology, n.d.

## Custom Reference Target



### **Developing a custom colour target for artwork imaging**

MS Kurečić, D Agić and L Mandić

Faculty of Graphic Arts, University of Zagreb

The Imaging Science Journal, Vol. 59, No. 6, Nov. 2011, pp. 317-331

## What's Next

- Collect more data and do more analysis
- Extend CIE study to participating institutions in Europe