DEVELOPMENT OF THE MUNSELL COLOR ORDER SYSTEM

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The Diaries of Albert H. Munsell

A unique insight into his life's work

We are pleased to make these diaries available online. The links at left are individual PDFs, each in the range of 0.5 to 1MB. They represent all of volumes A and B in approximately twenty page increments. The Index pages list the names of people mentioned in the diaries. Sorry, but there is no subject index. If you would like to create one, we will gladly publish it here!

Note that some PDFs are actually more than 20 pages. We grouped the texts by the page number in the typed copies. Many pages were inserted with letter notation (4a, 4b, 4c, etc). Also, some of the handwritten pages are unnumbered. You may want to download the document before or after to make sure you get the desired pages.

Original cover sheet

Below is the text from the cover sheet in the diary binders as received. It was slightly edited for typographical errors. Links to PDFs of individual chapters are at right.

The diary hereby made available is one kept by A. H. Munsell during the years in which he was developing both the Munsell color system and apparatus and charts by which to explain it.

A typewritten copy was made at the Munsell Color Company in the years 1920-23 from 6 volumes of a handwritten diary kept by Professor Munsell. Drawings and sketches were all hand-tinted, and handwriting was inserted where corrections or additions were made.
“IT MAY SOUND STRANGE TO SAY THAT COLOR HAS THREE DIMENSIONS, BUT IT IS EASILY PROVED BY THE FACT THAT EACH OF THEM CAN BE MEASURED.”

Albert H. Munsell
A Color Notation
p. 10
“IT MAY SOUND STRANGE TO SAY THAT COLOR HAS THREE DIMENSIONS, BUT IT IS EASILY PROVED BY THE FACT THAT EACH OF THEM CAN BE MEASURED.”

Albert H. Munsell
A Color Notation
p. 10
Organizing Color in Three Dimensions

White

Black
Munsell’s Preferred 3-D Organization: The Sphere
Possible Uses of a Revolving Spherical Color Chart

- Educational – to present the relations of colors.
- Record – to preserve and reproduce any color group or effect.
- Apparatus – for mergence and predominance of hues in any sequence.
- Key-board – or instrument for color arrangements.

Munsell’s Diary June 2, 1899
Influences: Lovibond Tintometer, 1885
Influences: Base-10 Arithmetic

http://theleanleap.com/2015/06/10-lean-six-sigma-sayings/
Influences: Professor Ogden Rood, Chair of Physics, Columbia University
First Entry in Munsell’s Diary

1879

Studied Rood’s Modern Chromatics.

Made twirling model of two triangular pyramids - fastened base to base - while studying descriptive geometry in class C (N. A. S.) and placed red, green and violet at angles.

(vermilion - emerald green - ult. blue)

1887

Reviewed Chevreul - at Beaux-Arts Library - and visited Sobelins - to see scale of yarns -
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Influences: Weber, Fechner, Plateau

- W-F: logarithm
- Plateau: square root

Amount of Red: 0, 10%, 20%, ..., 100%

Munsell’s Diary
Organizing Color in Three Dimensions
Middle Gray in the Center of Sphere
HUE DIMENSION
Because of two-word intermediates, no orange
Specific Hues Spun to Make a Gray
What About Hering and Four Elemental Colors: Red, Yellow, Green, and Blue?
Spinning Disk: Red, Yellow, Green, Blue
Spinning Disk: Red, Yellow, Green, Blue, Purple
Invented Portable Photometer, the Lumenometer

US Patent 686827A 1901
Value: Measurement Based

- Photometer used to measure %R (weighted by an observer’s luminous efficiency function)
- Used Plateau’s psychometric function

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Replacing Photometer with Spinning Disk
Fechner’s Law
CHROMATIC INTENSITY DIMENSION
Terminology for Chromatic Intensity

- Energy
- Intensity
- Saturation
- Chroma
- Purity
- Freedom from white light
Chroma: Departure from Gray at Constant Value

If you are using photometry to measure reflectance, you would bin by Value, and thus, Chroma is perpendicular.
Extending the Sphere
Mixing Paint Does Not Fit Concept of Chroma

PIGMENT CURVE describes combined C & V or any Hue

Set of templates grading any color to W & B by 10 equal steps

Given, the strongest sensation of Red
1. to grade it to white
2. " " " black) by equal
3. " " " gray ) sensations

Experiments show that
1. Equal loss of chroma requires unequal steps of value.
2. Unequal steps of chroma will permit equal steps of value.
Defining Chroma Spacing with Psychometric Function

See Vol. 2 (p.40) and Vol. 1 (p.49) p.32 in this book.

1a. Same disc in color reverses gradation
Gray disc -to graduate chroma built by geometric areas.

- no lighter ) only (gray) less chroma

CHROMA
relative greyness (distance out from neutral axis)

Methods of determination
1. Union with compl. to form grey, inversely as areas of discs
2. Least perceptible addition or subtraction (c)
3. Radius as a scale of C.
Chroma Template Based on Psychometric Function
Munsell Tree
Atlas of the Munsell Color System
MUNSELL COLOR SYSTEM
ATLAS
COLOR CHARTS.

YELLOW AND PURPLE-BLUE CHART.

This chart presents the color plane grouped through the use of the color circle and having the complementary hues, yellow and purple-blue. This pair of opposite hues is chosen in order to emphasize scale values in color, and these groups of the spectrum.

VALUE (Hue) multiplied by the hue angle is a hue (H) in color (Y)

CHROMA (or strength of color) = hue angle / hue angle in color (Y)

Each step in the color plane is shown as a percentage equal in height and width. Thus, Y in the yellow, the strongest permanent yellow, which shows 60% of the strength of 80% of the saturated yellow. In purple, P5R, where the same percentage of light is 20%, of the saturated light. This means that the pure hue must be reduced in the chroma, i.e., more.

Avoid dust, handling and exposure to strong light.
### CHART H

#### SCALE OF HUES

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### CHART H

**Ink Pigment Coloration**

This chart represents a color chart that was developed for the coloration of inks. It includes various shades and hues to help in the differentiation of colors for printing and other applications. The chart is used in the printing industry to ensure consistency and accuracy in color reproduction. It is explained in a previous introduction and is covered in detail in the Munsell Color Book.
“YOU HAVE PUT AN ARTISTIC IDEA INTO SCIENTIFIC FORM”

Professor Ogden Rood, April 1900
Products

- Sphere
- Atlas
- Books
- Crayons
- Watercolors
A. E. O. Munsell

“From his earliest days with the Company, Alex Munsell was greatly influenced by Irwin G. Priest, chief of the Colorimetry Section of the Bureau of Standards and an active leader in the Optical Society of America’s outstanding Committee on Colorimetry.

Mr. Munsell was neither a business man nor an artist. His interest lay, rather, in scientific fields, and from the beginning he left much of the handling of the business of the Company to others, while he concentrated on the scientific aspects of the Munsell work. The writer’s first memory of A.E.O. Munsell is that of his enthusiasm upon his return from the 1921 October meeting, of the Optical Society of America where he had met and talked with I. G. Priest. It was at that meeting that he first heard of Carl W. Keuffel’s direct-reading spectrophotometer, later described before the O.S.A. One was ordered on the spot and was delivered in New York to the Munsell Research Laboratory during the next year.”

Ms. Dorothy Nickerson, 1940
Modifying the Atlas: The 1929 Munsell Book of Color

- Errors in the photometer
- Errors in manufacturing
- Is a square root the correct psychometric function?
- More rigorous specification for defining system and its manufacture
New Experiments to Scale Hue, Value, and Chroma

In collaboration with the National Bureau of Standards (NIST)
Revised Value Scale

Plateau-Munsell: $1.57(Y)^{1/2.49}$

Fairchild (RLAB): $10\left(\frac{Y}{Y_n}\right)^{1/2.3}$

Plateau: square root $10(Y)^{1/2}$

Fig. 12. Comparison of average value scales obtained by the just-noticeable-difference and value-step methods. Gray background, light adaptation.
Details

- All colors defined using disk mixtures under controlled daylight.
- Painted papers: primed near color, varnished, final coat matching disk specification.
- Each sample measured with spectrophotometer
- One or two chromatic pigments, black, and white
Further Improvements by the Optical Society of America

7 constant value charts, 20 constant hue charts, 3 backgrounds, ~100 samples / chart, 41 observers, >300,000 observations (not 3,000,000)
Charts on White, Gray, and Black Backgrounds
Example Score Sheet
Visual Data Averaged, Plotted on x,y chromaticity diagram on oversized paper, smoothed, and “digitized” manually
“IT MAY SOUND STRANGE TO SAY THAT COLOR HAS THREE DIMENSIONS, BUT IT IS EASILY PROVED BY THE FACT THAT EACH OF THEM CAN BE MEASURED.”