

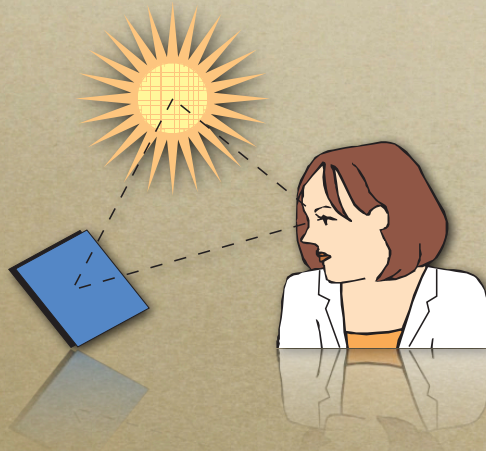
# The Color Curiosity Shop



*Mark D. Fairchild*  
*RIT Munsell Color Science Laboratory*

**ISCC Education Committee Session**  
**May 14, 2006 — Ottawa**

# Why is Color?



How do you get the sun & lightning in a single photograph?



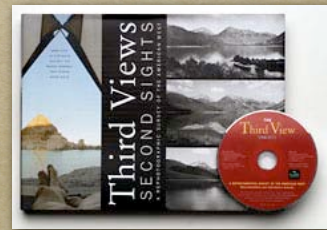
## Project Overview

- *The Color Curiosity Shop*
- *The HDR Photographic Survey*



# HDR Photographic Survey

- *Research images need not be of uninteresting subject matter and/or poorly executed.*
- *But... they often do have extra technical requirements.*



[www.thirdview.org](http://www.thirdview.org)

# HDR Objectives

- *Approximately 40 HDR Scenes*
- *Interesting Places & Things (e.g. National Parks)*
- *~20 Fully Specified*
  - *Colorimetry of Scene*
  - *Appearance Scaling (lightness, brightness, chroma, hue)*
  - *GPS/Meteorological*
  - *Mirror Ball*
- *Website/Book/etc.*
- *Images for Color Curiosity Shop*

# Why HDR?

## *HDR = High Dynamic Range*

- *Nearly Full Capture of Scene Data*
- *No Pre-Processing (other than composition)*
- *Of Interest for Research and Education*
- *“Future of Digital Imaging”*



# HDR Demo



Whites:  $382:0.72 \text{ cd/m}^2 = 530:1$   
Bright Black/Dim White:  $12.3:0.72 \text{ cd/m}^2 = 17:1$   
Overall:  $24000:0.016 \text{ cd/m}^2 = 1.5M:1$



# HDR System

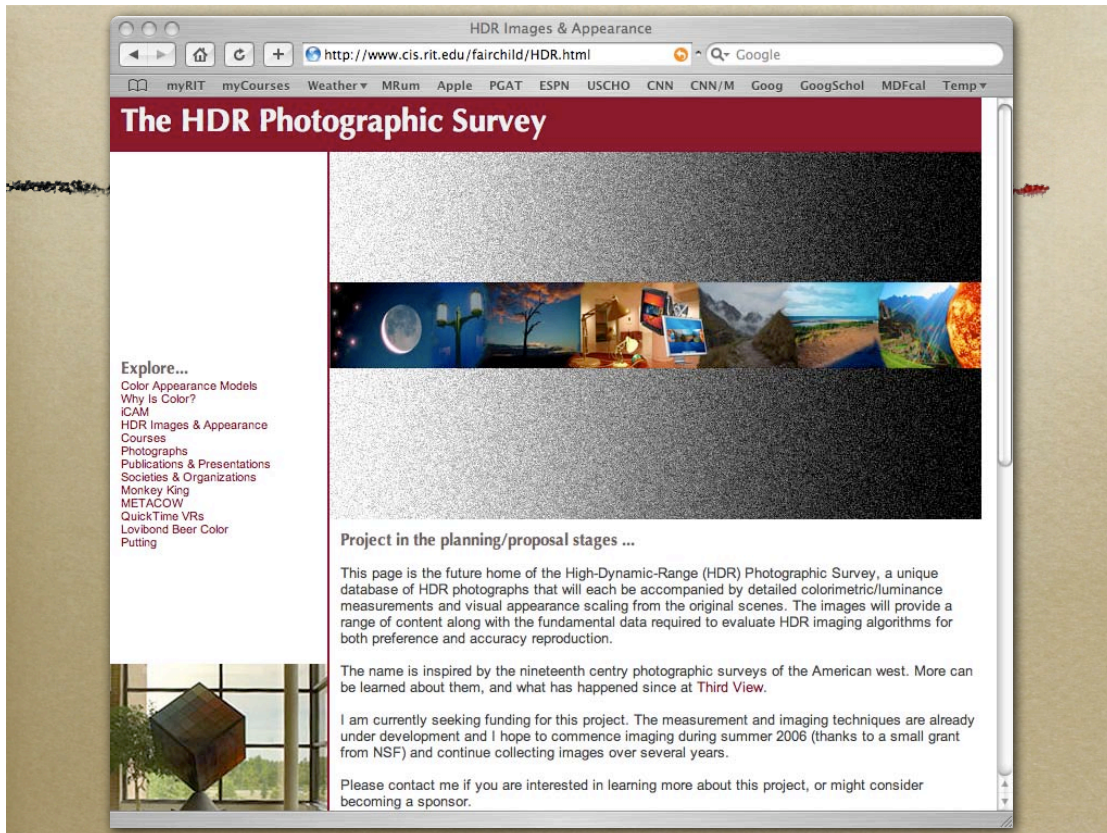
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- *12 Mpixel Nikon D2x*
- *9-Stop Auto Bracket*
  - *18 Stops with one adjustment!*
- *KonicaMinolta CS-100 (CS-200?)*
- *Mirror Ball*
- *GPS*
- *OpenEXR / Photosphere / Aperture / Shake*

# HDR Plans

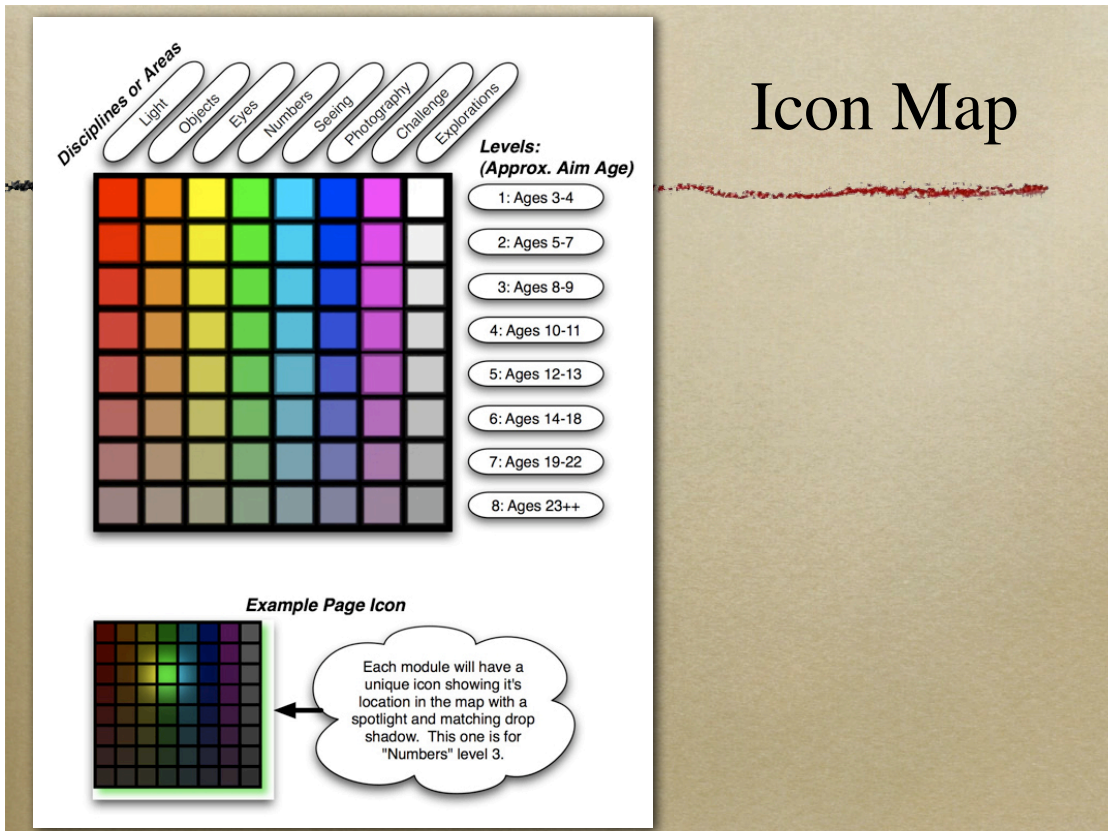
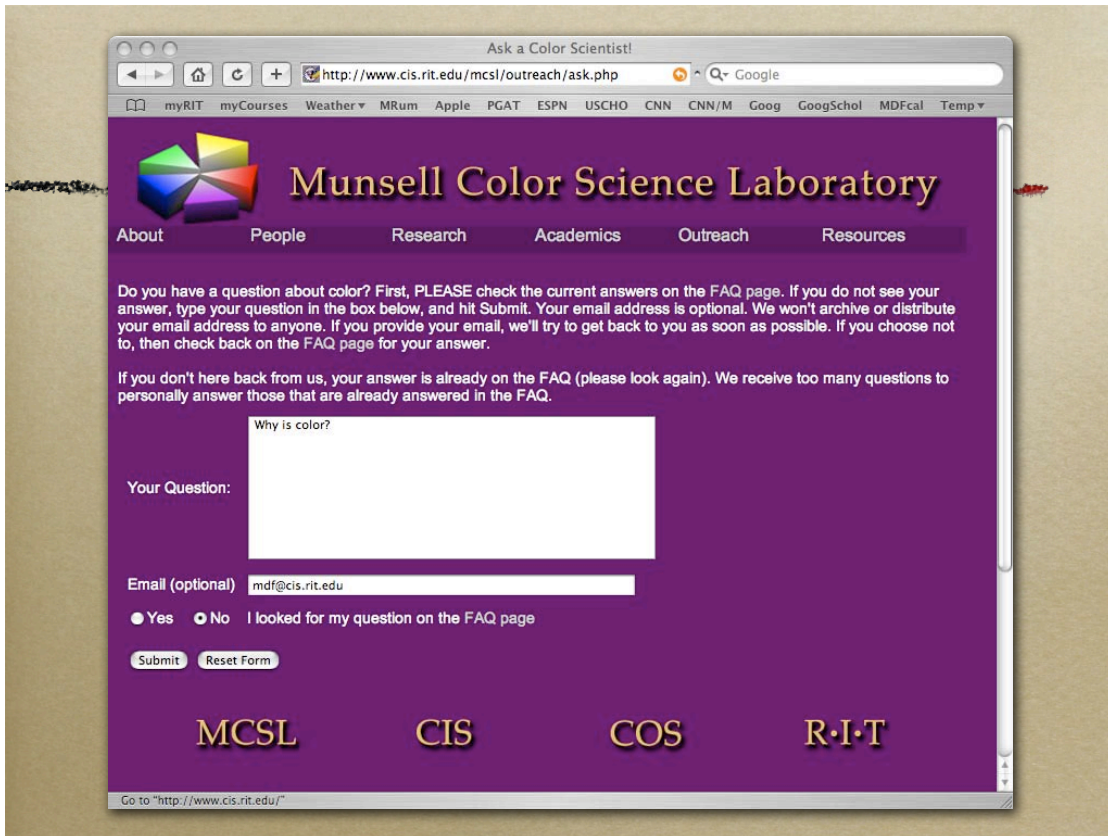
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- *In-Lab Calibration Scene*
- *Algonquin P.P. / Niagara Falls (This Week)*
- *Acadia N.P.*
- *New England Autumn*
- *Arizona Winter*
- *West Coast Trip Next Spring*



## Color Curiosity Shop Objectives

- *An Educational Resource*
- *Students of All Ages*
- *Science without Fear*
- *Color as the Theme*
- *Satisfaction of Natural Curiosity*



# Topics

- *Light (Physics)*
- *Objects (Chemistry)*
- *Eyes (Biology)*
- *Numbers (Mathematics)*
- *Seeing (Psychology)*
- *Photography (Technology)*
- *Challenge (Interactive Quiz)*
- *Explorations (Links & References)*

# Levels

- *Eight Levels*
- *Denoted by Number Only*
- *Pre-School to Post-Graduate*
- *No Barriers or Stigma*

# Resources

- *Interactive Website* (links to others)
- *Free Electronic Book*
- *Inexpensive Printed Book* (@Cost, lulu.com)
- *Science Museum Exhibits?*

**Disciplines or Areas**

- Light
- Objects
- Eyes
- Numbers
- Seeing
- Photography
- Challenge
- Explorations

**Levels: (Approx. Aim Age)**

- 1: Ages 3-4
- 2: Ages 5-7
- 3: Ages 8-9
- 4: Ages 10-11
- 5: Ages 12-13
- 6: Ages 14-18
- 7: Ages 19-22
- 8: Ages 23++

**Example Page Icon**

Each module will have a unique icon showing its location in the map with a spotlight and matching drop shadow. This one is for "Numbers" level 3.

# Icon Map Redux

### How many colors are there in the world?



Sun dogs on each side of the rising sun are caused by ice crystals in the sky on a very cold morning. Dispersion of light in the ice crystals also produces the rainbows. Since there are ice crystals in the air between the barn and the camera, the rainbow is also visible in front of the barn. There are many colors in this scene, produced in many different ways — lights, objects, and scattering volumes.

The best answer is infinity!

Careful measurements of our visual system's best performance have been made by psychophysicists (people who study human responses, like seeing color, to things in the world, like light). They have shown that we can see about 1000 levels of light-dark, 100 levels of red-green, and 100 levels of yellow-blue for a single viewing condition in a laboratory. This means that the total number of colors we can see is about  $1000 \times 100 \times 100 = 10,000,000$  (10 million). A computer displays about 16.8 million colors to create full-color pictures, really more than necessary for most situations.

However, the answer is not quite so simple. What color looks like is greatly affected by the viewing conditions. These conditions include the color of the lighting, the amount of lighting, and other colors in the scene. Colors also appear in different modes when they appear on different objects such as surfaces, light sources, or within volumes. Different people also have slight differences in the way they see color.

Since we can see at least 10-million colors in a single viewing condition and the variety of viewing conditions and observers is endless, then the only truly correct answer is infinity. If we have 10-million colors, times 10-million lighting types, times 10-million lighting levels, times 10-million surrounding colors, times 6-billion people in the world, times 3 modes of viewing we get a really huge number. The result of that multiplication is 18 followed by 33 zeros (18,000,000,000,000,000,000,000,000,000,000), or 18 decillion. That might not quite be infinity, but is close enough since all those estimated numbers are probably on the low side. And there is no way to exactly measure each of them. To learn more about the names of really big numbers, visit [www.jimloy.com/math/billion.htm](http://www.jimloy.com/math/billion.htm).

Photos: M. Fairchild

3 - 4  
(Level:3 - Topic:4,Numbers)



There are just 24 crayons in this box, but imagine all the colors you can make with them, some creativity, and different objects to color on.



# Example Page

## COLOR CURIOSITY SHOP



### Explore...

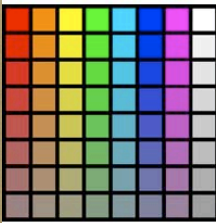
- [Why Is Color?](#)
- [Feedback/Questions](#)
- [Project Icon/Map](#)
- [Project Summary \(PDF\)](#)
- [Example Book-Form Content \(PDF\)](#)
- [Sponsors/Collaborators](#)
- [HDR Images & Appearance](#)
- [Mark's Homepage](#)

### Explore Mysteries of Color --- Discover Why is Color

This site is the future home of the Color Curiosity Shop, an educational resource currently in the planning and early development stages. If you are interested in learning more about it, or funding its development through a grant or gift to RIT, please contact Mark Fairchild. This page will be updated as the project progresses. The curiosity shop will be a living resource that is continuously updated, but it is hoped that the first full version will be in place within a couple of years.

Download PDFs of the project proposal summary and a draft example page from the proposed electronic book. Other details can be found by exploring the links to the left.

Submit questions, comments, or suggestions using this [feedback form](#).



## Submitted Questions

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- *Well Over 150 Already*
- *Answers Provided when Possible*
- *Short Answer Page to be Added*
- *Let's Look at the Feedback Page...*

## Next Steps

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- *Select Questions*
- *Create Web & Book Layouts*
- *Begin Writing Answers*
- *Begin Gathering Images/Videos*
- *Find Review References & Sites*
- *Continuous Feedback*
- *Get More Sponsors...*

# Sponsors/Collaborators



# Museums?

- *Links*
- *Look for Best Practices*
- *Exhibits that Work (Teach)?*
- *Future Collaborations...*

# Other Interesting Questions...

- Do you attribute the amazing complexity of the HVS to evolution or creation?*
- If people are affected emotionally by color, then are people with color blindness less emotional?*
- What mixture of colors will make Deep Sea Blue?*
- My psychology professor asked my class who invented color? Who did color originally come from?*
- Have you seen Star Wars 3?*
- Are you a blue dude or a cool peach colored human?*
- Are angus bulls color blind?*
- Why does a blue M&M last longer than any other?*
- Why is it that fish poop looks green when it can look yellow?*
- How many colors do M&Ms come in?*

The screenshot shows a web browser window with the address bar displaying <http://www.cis.rit.edu/fairchild/WhylsColor/feedback.f>. The page title is "Color Curiosity Shop: FEEDBACK FORM".

**Color Curiosity Shop: FEEDBACK FORM**

Please help make this project a success...

Are you curious about something related to color? If so, submit your question using this form. If you include your email address I will reply directly. Regardless, your question might end up being part of the final *Color Curiosity Shop*. Questions from students of all ages on any color-related topics are welcomed and encouraged.

Also, feel free to use this form to send me comments and suggestions regarding the proposed *Color Curiosity Shop*.

If you are looking for specific answers to color science questions, you might also want to check out our FAQ and Ask-a-Color-Scientist page.

Thank you,  
-Mark Fairchild

Your Question about Color or Comment on the Project:

Your Email Address (optional)

**Explore Mark's Other Pages...**

- [Why is Color?](#)
- [Feedback/Questions](#)
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**Questions I'm Considering...**

Here are some of the questions I have received so far. Feel free to check them out and let me know if you there are any you would particularly like to see (or not see) in the final resource. And please do help me out by submitting new questions of your own.

- How many colors are there in the world?
- Why do leaves change color in the autumn?
- How does color-changing silly-putty work?

## How Can You Help?

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- *Submit Questions*
- *Submit Links, Suggestions, Etc.*
- *Review Materials as they Appear*
- *Become a Sponsor???*

[<whyiscolor.org>](http://whyiscolor.org)

## Now Let's Chat

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- *Suggestions*
- *Questions to Address*
- *Resources*
- *General Comments*
- *Potential Sponsors*



**Thank You!**