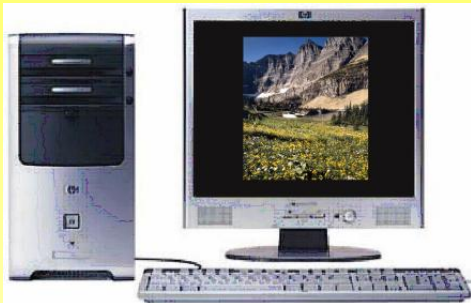


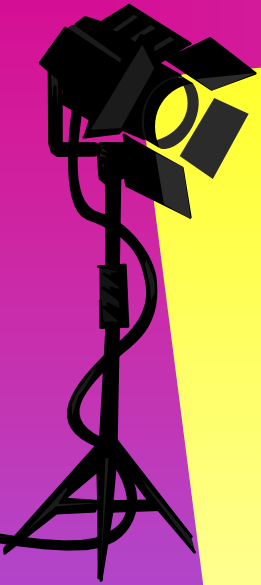
# Color Management Fundamentals - Part I



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**-OR-**

**Understanding the  
concepts of how to get  
printed images to look  
like the images on the  
monitor**



# Session Goals

To provide an understanding on a conceptual level of:

- Digital color reproduction
- Color space
- ICC profiles
- Color-managed workflow
- What one must do to implement a color-managed workflow

# Color & Visual Perception

- Many factors impact individual color perception
- Color perception varies from person to person
- Different viewing technology produces different results
- Color perception always has a large **SUBJECTIVE** component

# Film Photography

- Color Film reproduces color in a manner that is defined, consistent, and reproducible
- Each film type has unique color reproduction characteristics
- Slide Film results are “fixed”; results cannot be changed
- Prints are “flexible”; changes can be made in the darkroom

# Digital Imagery

- Digital Images are captured and displayed on a variety of devices; each digital device captures or displays images in a unique manner
- Each pixel in a digital image encodes light in a combination of discrete RGB values; without context, the RGB values are meaningless

# Color Space

- The numeric RGB values of an image file have no clear, unambiguous meaning unless they are associated with a color space.
- The Color Space defines the context of the RGB values in an image file
- All digital images refer to a color space-- either explicitly via an embedded user-specified profile, or implicitly.

# RGB Color

- What *exactly* is meant by "pure" R, G and B? ***For a given color space, "pure" R, G and B are the primary colors, located at the apexes of the gamut triangle: R on the right, G on the top, and B on the left.***
- To accommodate the wide range of gamuts in different devices-- digital cameras, film, scanners, monitors, and printers, a variety of color spaces has been developed.
- The de facto standard for the Internet, sRGB, has a limited gamut corresponding to a typical CRT monitor. Other color spaces have larger gamuts-- corresponding roughly to high quality printers or to film. For example, Adobe RGB has a much richer color space than sRGB.

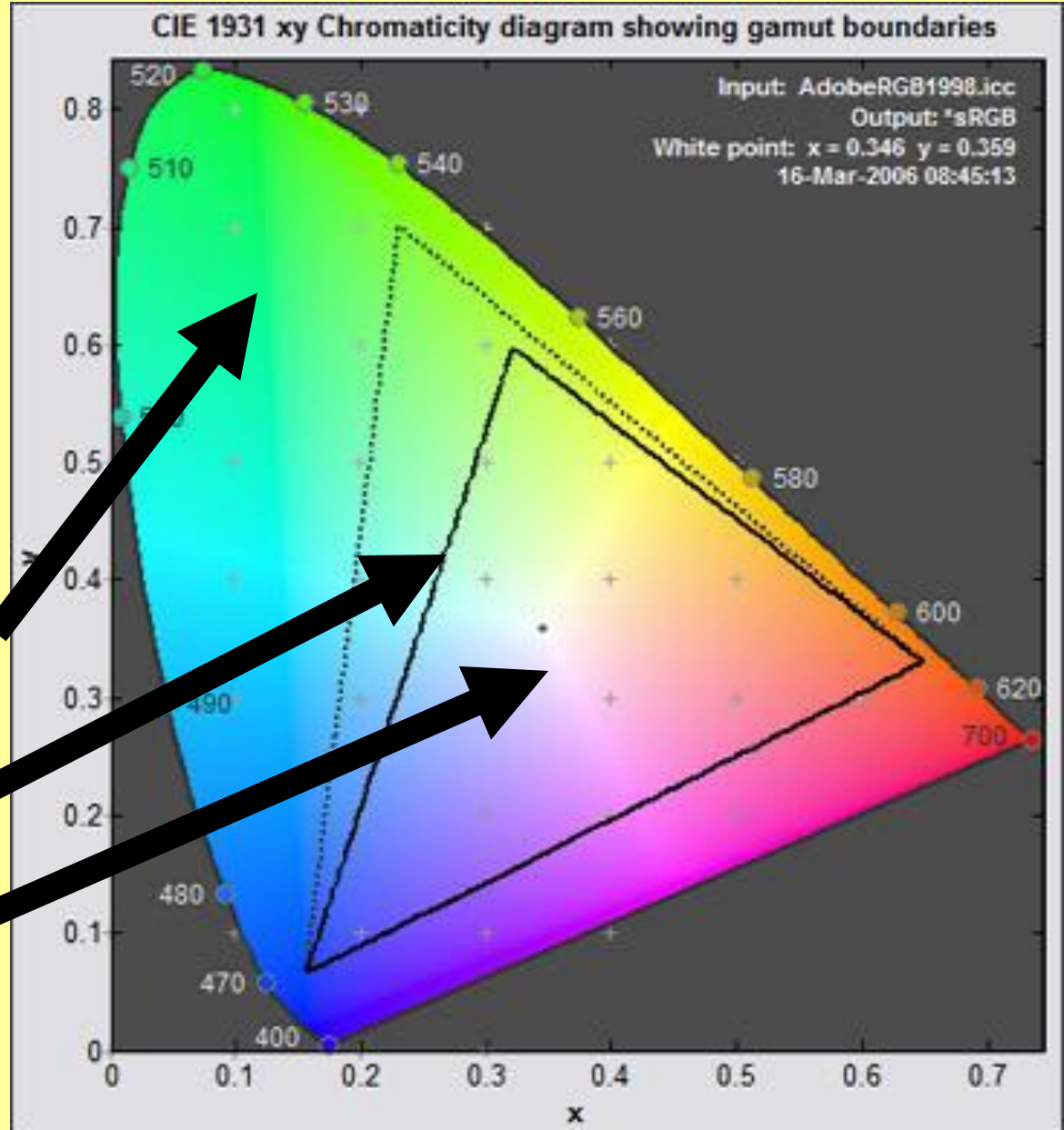


# Color Space Example

Theoretical Color Space

Adobe RGB

sRGB



# Displaying Digital Images

- Digital Images can be displayed multiple ways
- Each display technology displays color differently
- NONE can map to the same “color”
- The “trick” is to somehow let all the other devices know how to interpret the image

# ICC Profiles

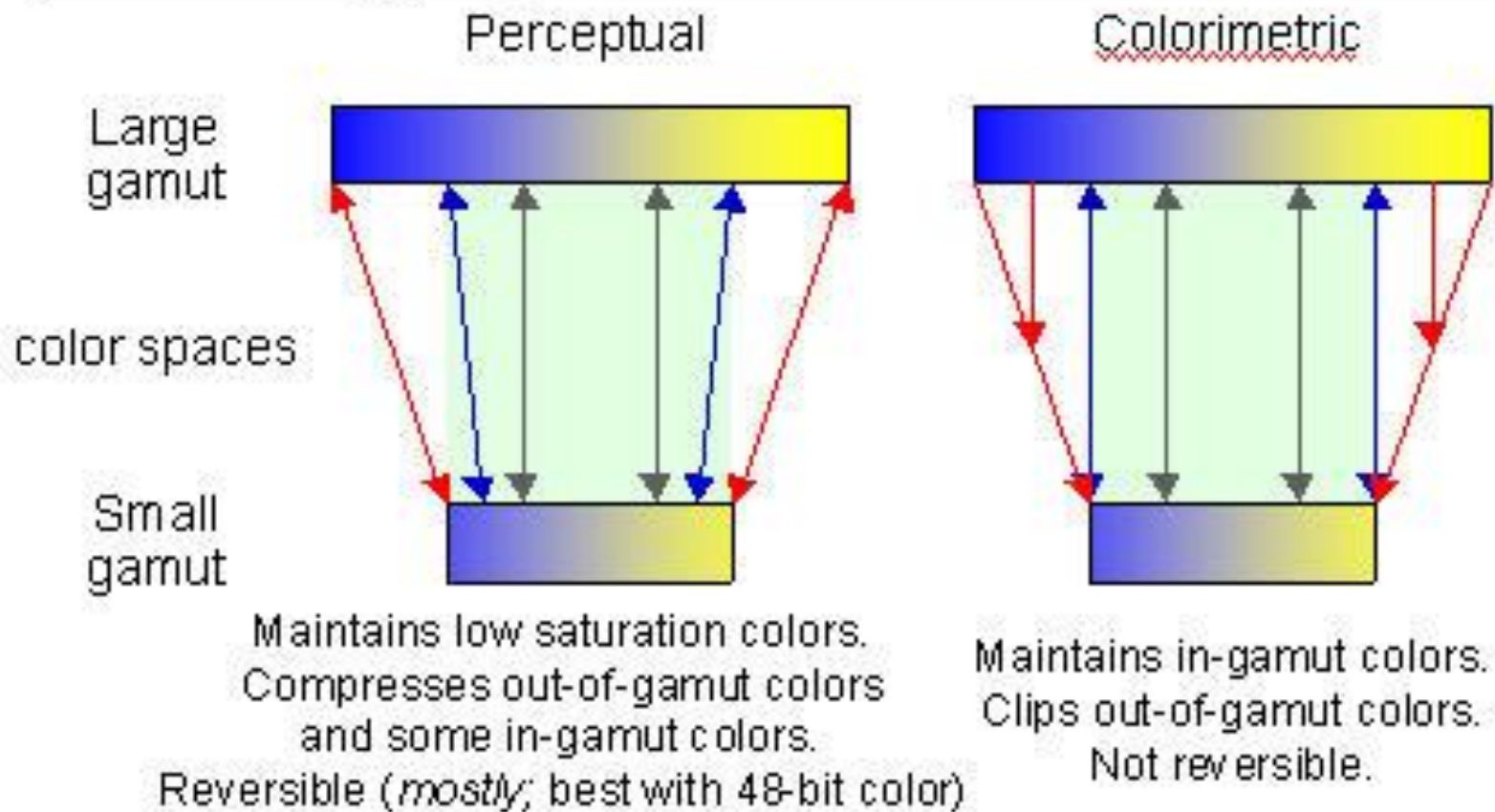
- Profiles are the standard for how digital devices (scanners, digital cameras, printers, etc.) communicate color information to each other
- Printer profiles let the image processing program know how to translate what is on the monitor to the printed page
- Editing profiles, such as Adobe RGB or sRGB, allow you to edit images and get consistent results
- Monitor profiles tell your operating system or image editor how to display the picture accurately
- Camera & scanner profiles communicate to all the other steps in the workflow how to interpret the original image

# Gamut Mapping

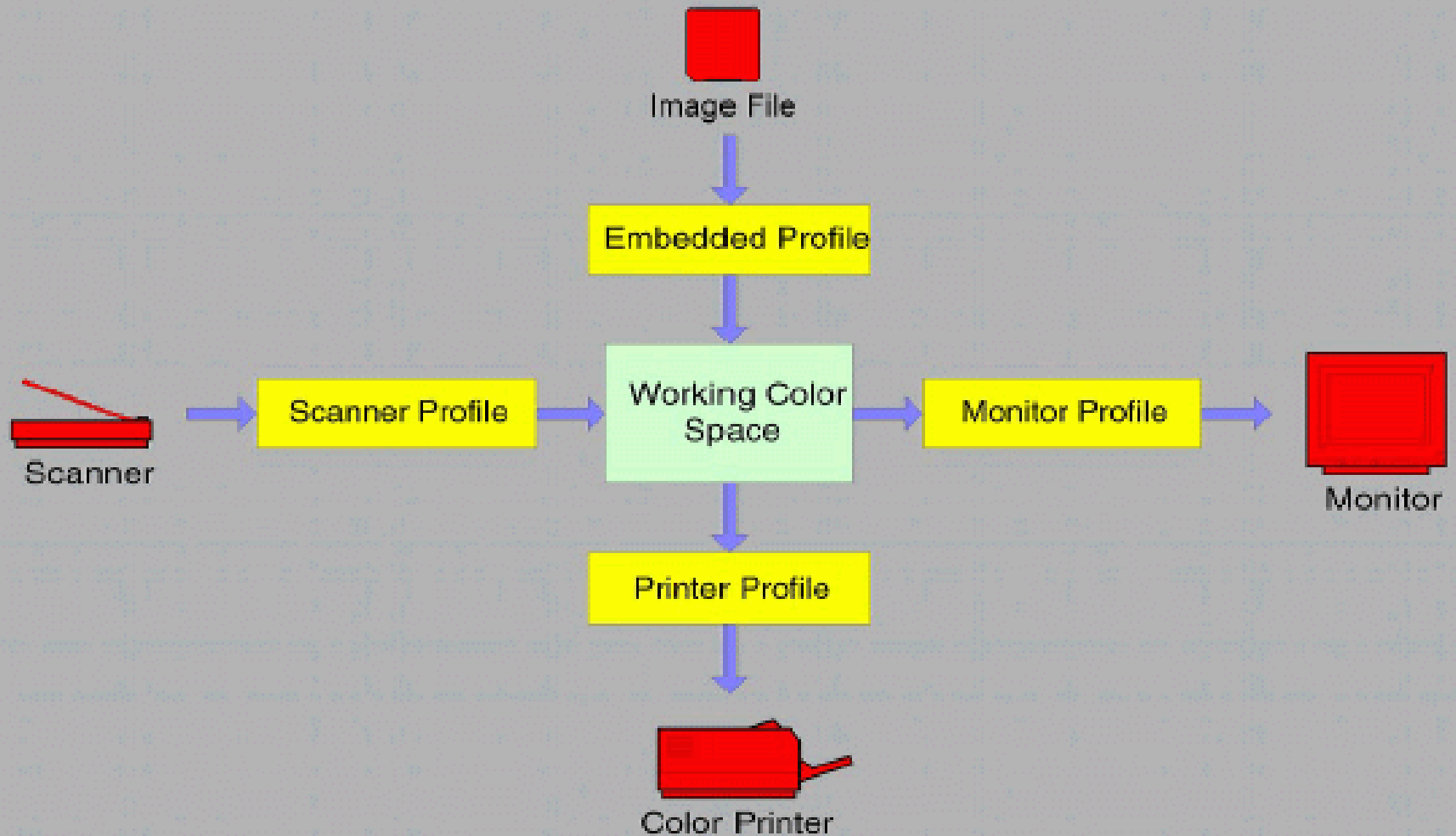
- ***Gamut mapping:*** The transformation that takes place when an image is transferred between formats or devices, for example,
  - from one color space to another.
  - from an image in memory to a monitor.
  - from an image in memory to a printer.
  - from an image capture device to memory

# Gamut Mapping Examples

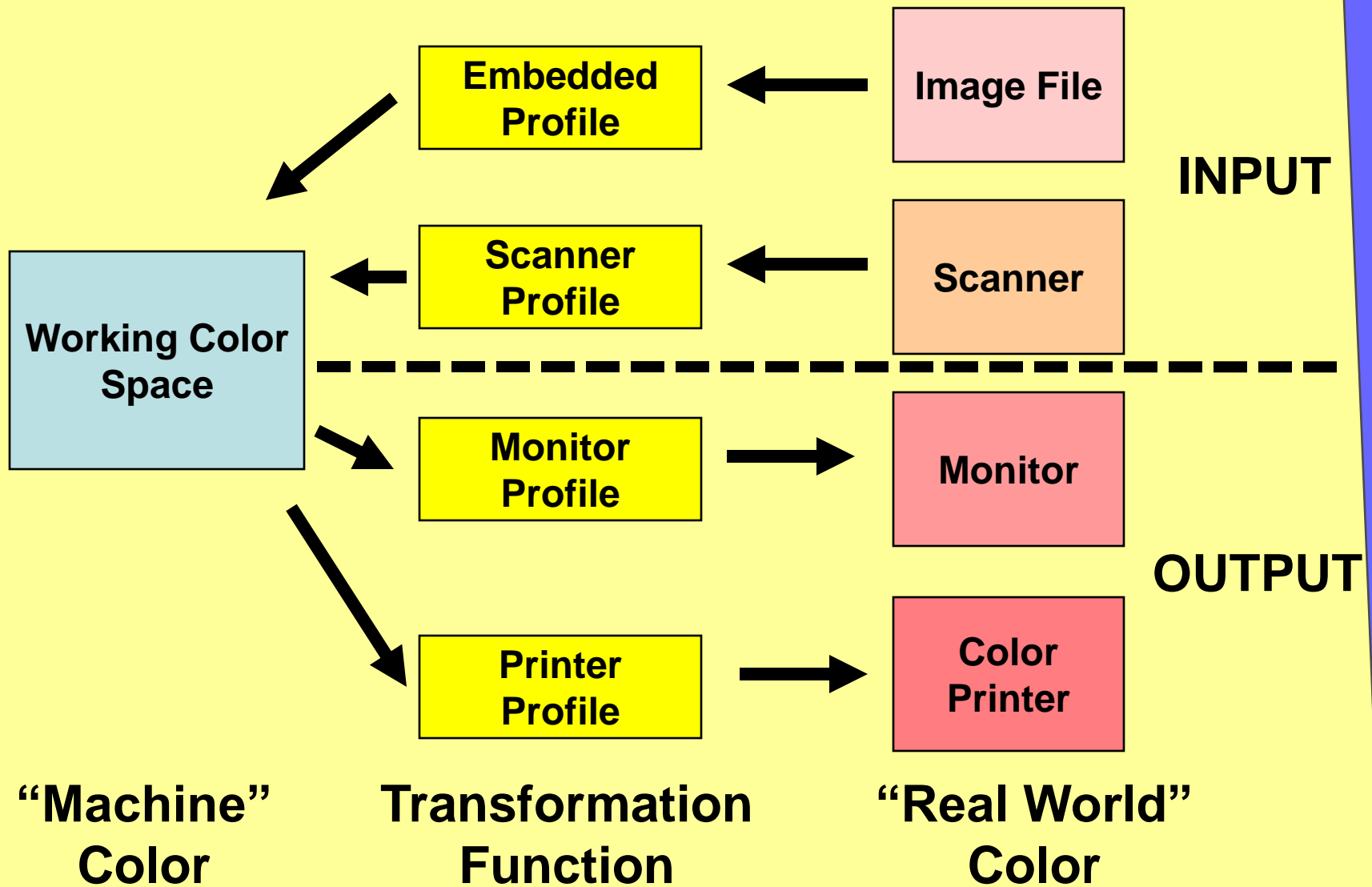
## Gamut mapping



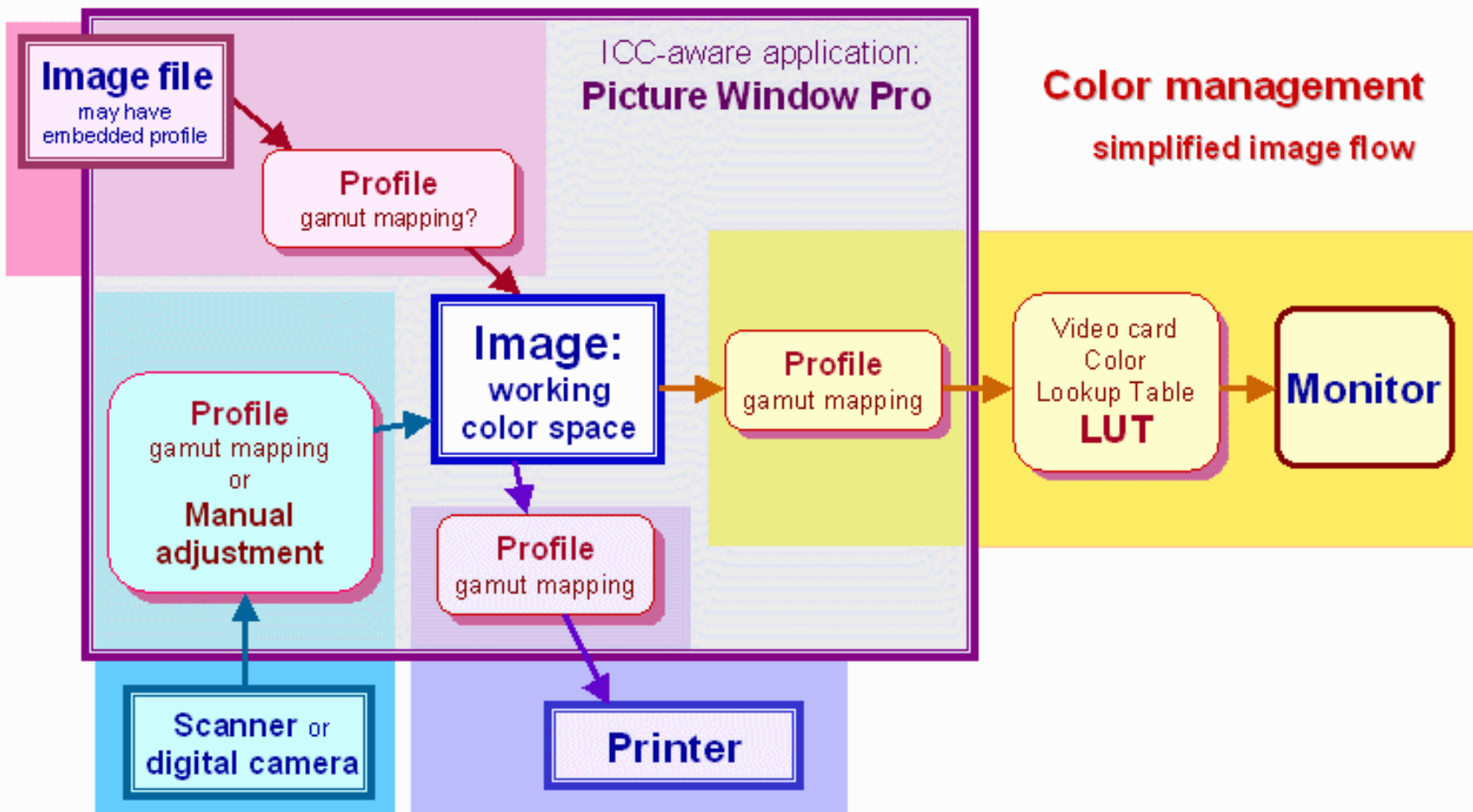
# Basic Color Management



# Digital Color is NOT Consistent



# Basic Color Managed Application Block Diagram





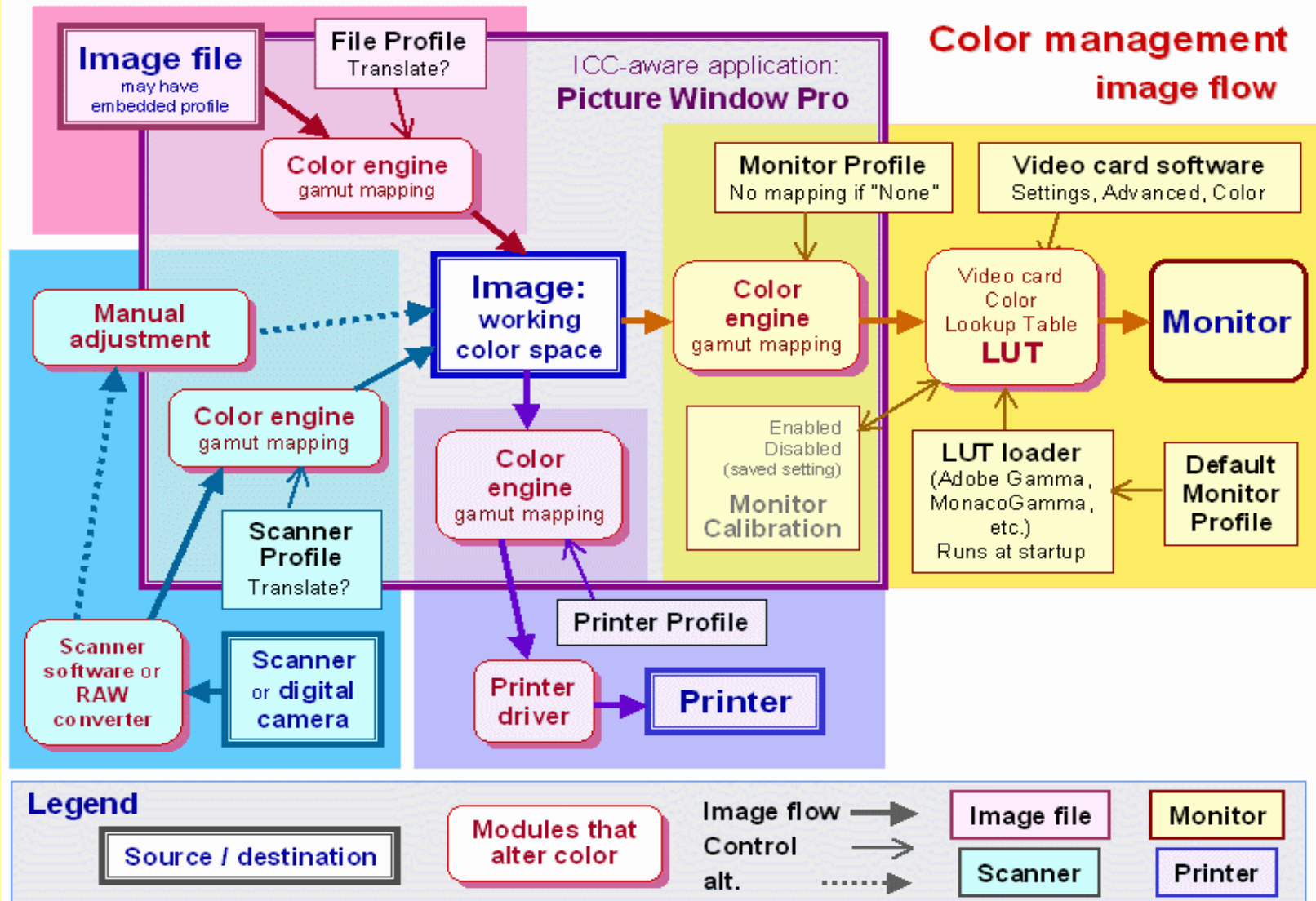
# Color-Managed Workflow

- ICC-aware programs to do two things:
  - recognize color spaces and device profiles, and
  - apply the appropriate gamut mapping when transferring images.
- Sounds Simple but "the devil is in the details"

# Color Management Workflow

- Establishes a working color space for editing and storing images
- Establishes procedures for handling images from input devices, such as scanners or digital cameras
- Establishes policies for handling image files that are untagged or have different color spaces
- Creates or selects the monitor profile and selects the monitor rendering intent
- Selects the printer profile and rendering intent.

# Detailed Workflow



# Implementing a Color-Managed Workflow

- Implementing a color managed workflow is highly dependant upon the imaging software used
- Implementation details may vary even between different releases of the same software
- Key to color management is selecting the profiles of each of the digital technology components

# Monitor Calibration

- Monitor Calibration is THE most important component – without a “viewing standard” all other results are suspect
- “Eye Ball Calibration” using gamma adjustment
  - “Free”
  - Highly subjective and Time consuming
  - Not consistently reproducible
- Hardware calibration device
  - Expensive
  - Objective
  - Reproducible

# Printer Calibration

- “Off the Shelf” solution: select a generic profile that most closely matches the printer, ink, and paper combination used
- Custom Solution: obtain a “custom” printer profile for the specific printer, ink, and paper used
- Print test images and adjust accordingly
- Highly dependant upon how much work one is willing to do
- The digital equivalent of color printing using film technology

# Image Acquisition Device

- The “set-up” of the digital image acquisition device (camera, scanner, ...) determines how the image is gamut mapped into the color space
- Image appearance is determined by all of the factors of digital exposure: resolution, exposure, brightness, contrast, color balance and saturation
- Other factors are the bit-depth of the image (24 or 48 bit color), color space, and image format

# Color Management Reality

- Maintaining consistent color appearance in the translation between different devices and color spaces is no easy task
- Color management provides a reasonably sane and practical solution. But it's is no panacea. It is always an approximation
- Even the most sophisticated system can't make two devices with different gamuts display *exactly* the same colors; for example, it can't make a monitor or printer display high-saturated colors from a slide.



# Color Management References

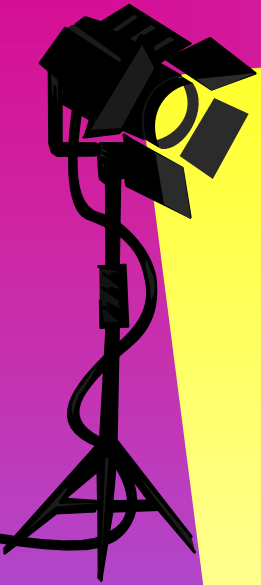
- Specific Workflow implementation details are unique to the imaging software used
- For more data and specific details on understanding and implementing color management workflow go to:
- [http://www.drycreekphoto.com/Learn/color\\_management.htm](http://www.drycreekphoto.com/Learn/color_management.htm)
- [http://www.normankoren.com/color\\_management.html](http://www.normankoren.com/color_management.html)

# Summary

- Color Spaces define the context of a digital image
- ICC profile determine how the various digital technologies interpret and display a digital image
- Color management is an attempt to bring order out of chaos; it is essential in order to get reproducible color image results
- How successful one is in color management is directly proportional to how much money one spends and how hard one is willing to work

# Final Thoughts

- Film Photography enables image manipulation either before the image is taken or in the darkroom
- Digital Photography enables image manipulation either before the image is taken, after the image is taken but before it is printed, or when it is printed
- Printing high quality digital images is similar to color film printing; it's a lot of work, highly subjective, and for most people it may not be worth the effort



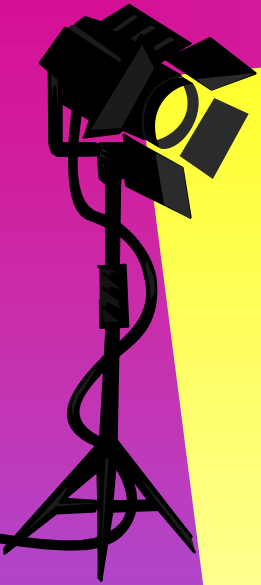
**Questions, Comments, or  
Suggestions?**

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# Schedule

## (2nd Saturday of every Month)

Date	Description
5-12-07	Color Management Fundamentals Part I Understanding the Basics of Color Management
6-09-07	Color Management Fundamentals Part II Matching Image, Display and Printer Color
7-14-07	Color Management Part III (?)
8-11-07	Digital Camera Picture Taking (how to get a good digital image)
9-08-07	* Vendor Presentation

**Additional Classes TBD**