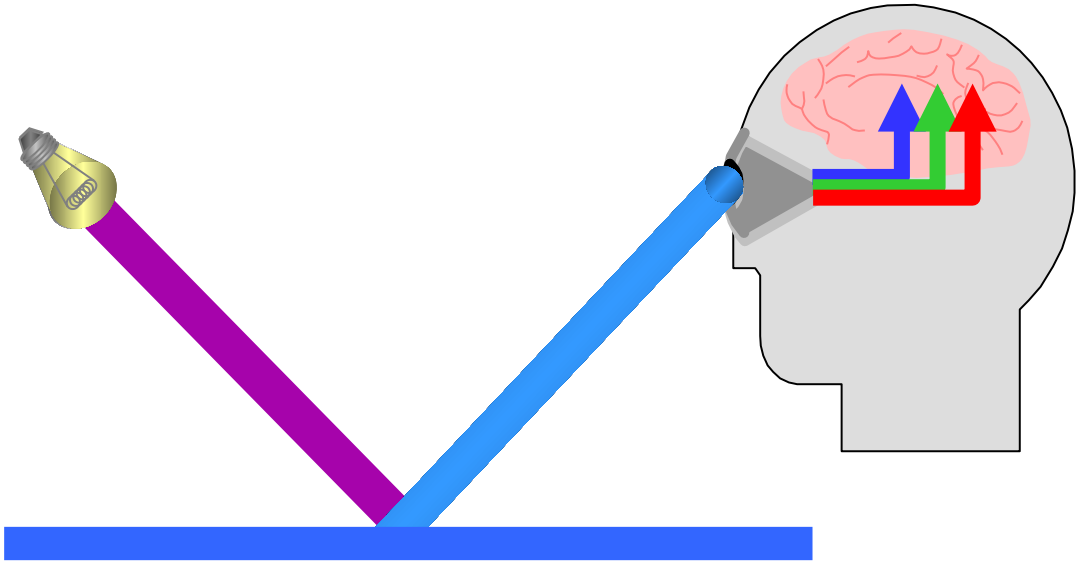
Colormanagement

Theory of Colormanagement

- Based on ICC-Technology
  (ICC = International Color Consortium)
  - worldwide Standard
  - future-proof

What is color?

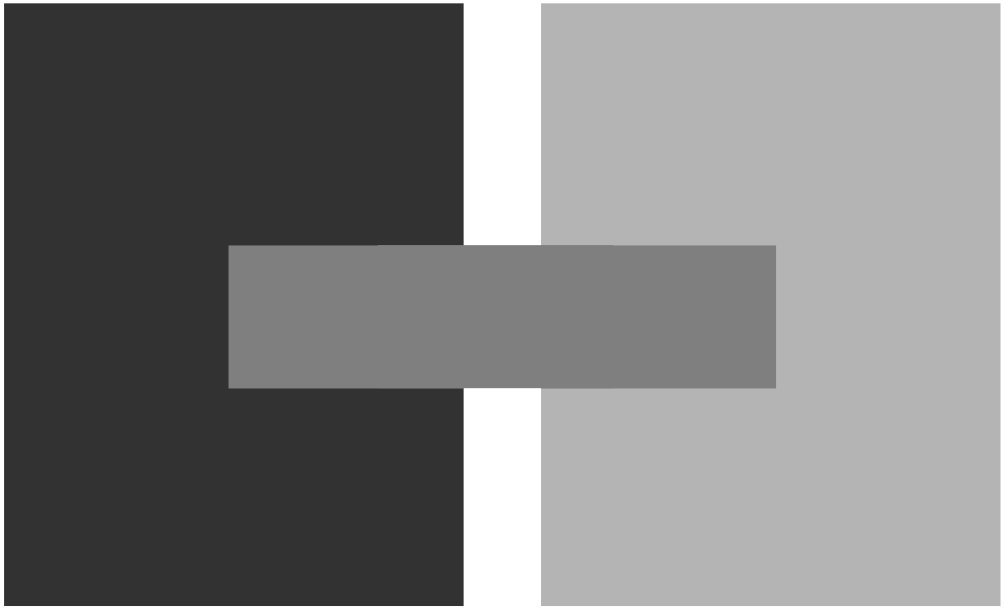
- Color is a visual information submitted by your eyes, interpreted by your brain



Effect of light

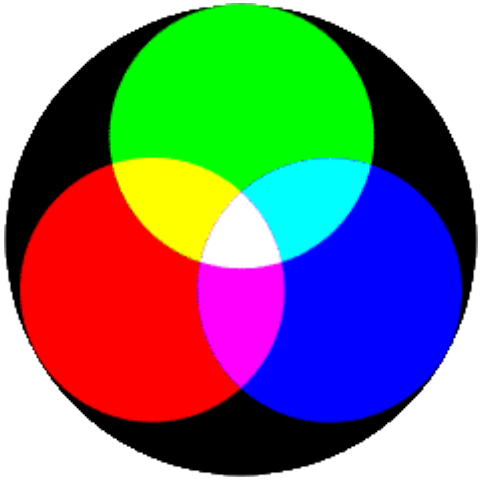
- Different luminous sources → different effects
- Standard: D50 → Daylight 5000°Kelvin

Impression influenced by environment

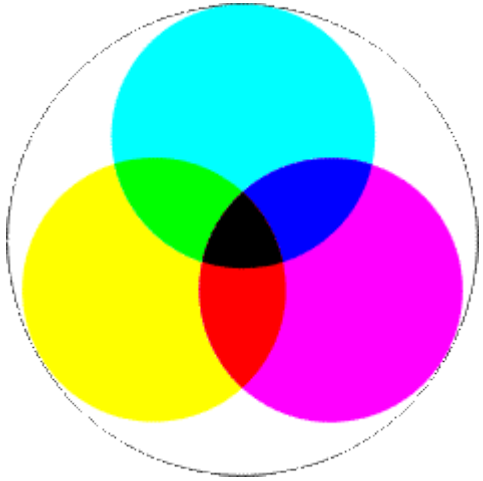


Systems of color mixture

- RGB → additive mixture of color
  - scanner
  - camera
  - display

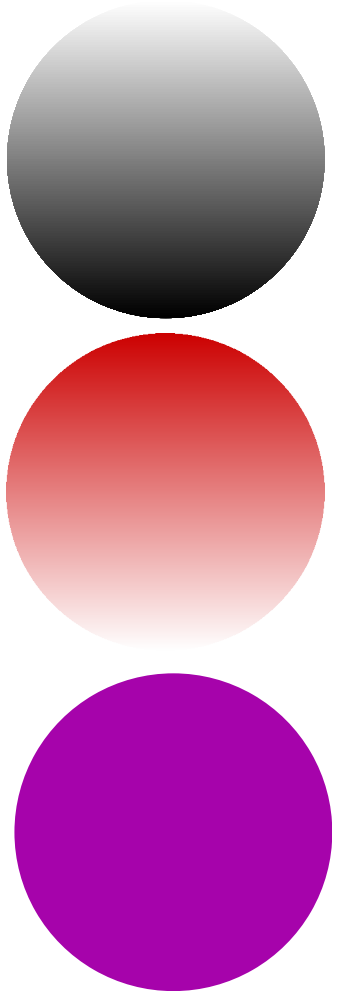


- CMY → subtractive mixture of color
  - printer
  - platesetter
  - printing pres



What defines a color (What is HSL)?

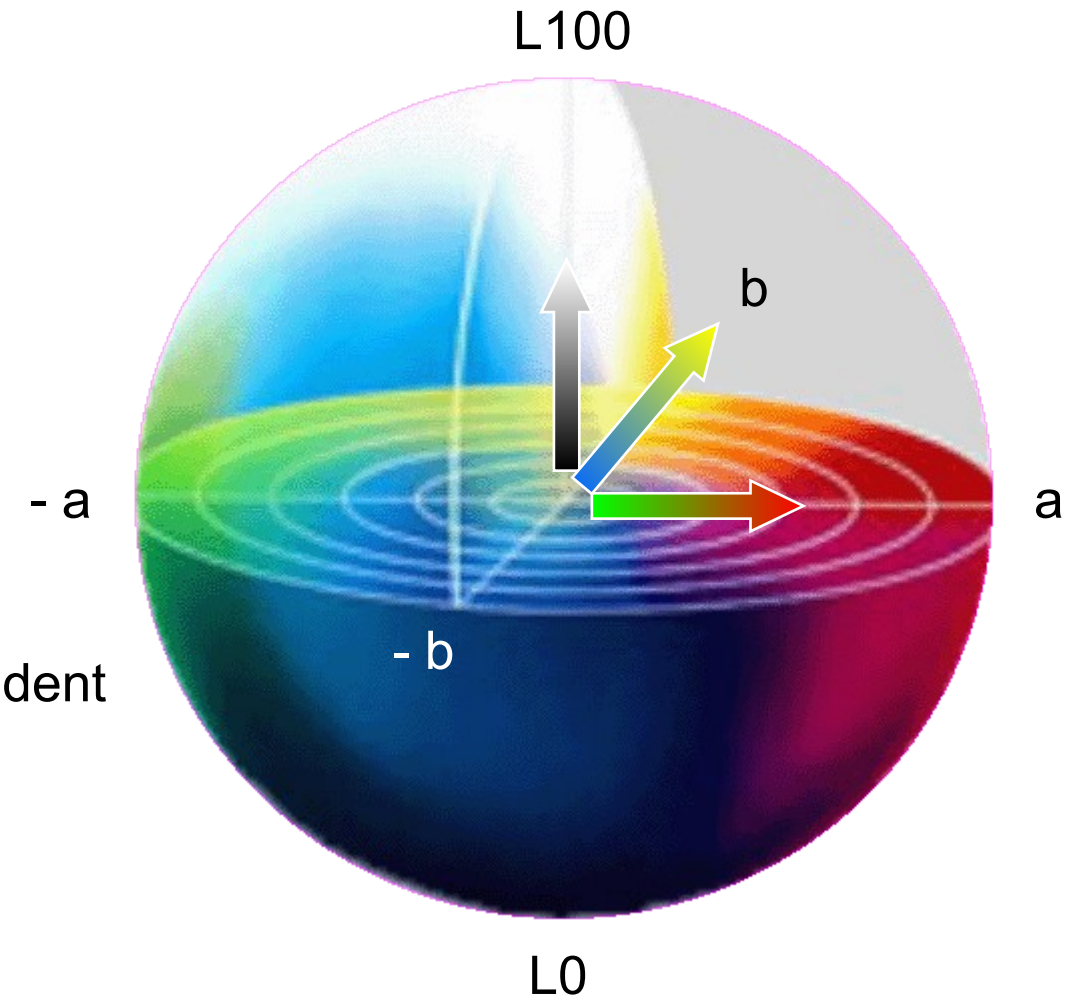
- Lightness/Luminance
- Saturation
- Hue



Lab-color-space

- L → Lightness/Luminance
  - 0 to 100
- a → red-green-axis
  - -127 to 127
- b → yellow-blue-axis
  - -127 to 127

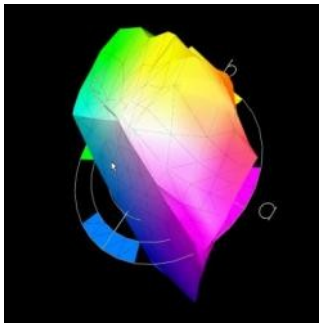
→ device-independent



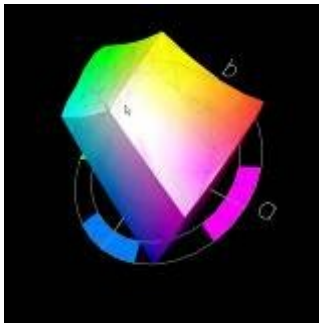
Why Colormanagement?

- Treatment, handling and transmission of colordata
  - stable
  - predictable
  - Inside color-space of different devices (Gamut)

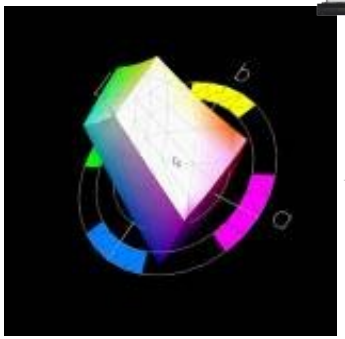
Displaying without Colormanagement



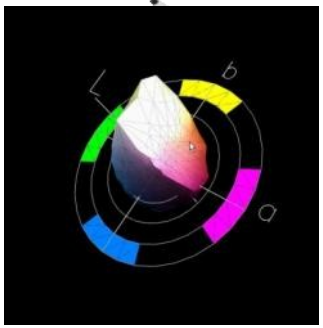
Scanner
RGB



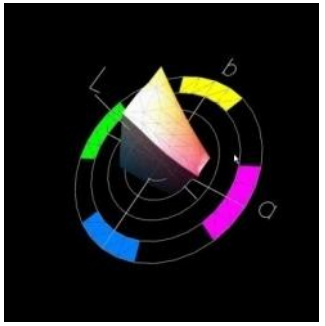
Monitor
RGB



Projektor
RGB

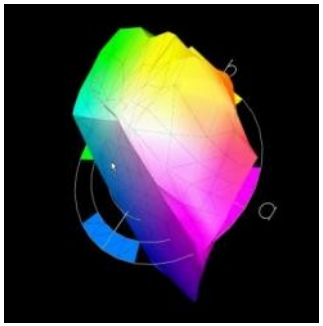


Inkjet

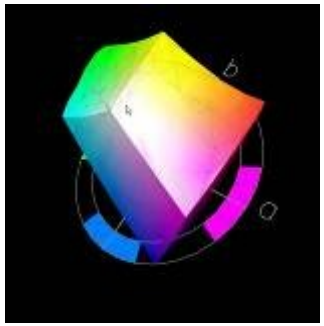


Offset

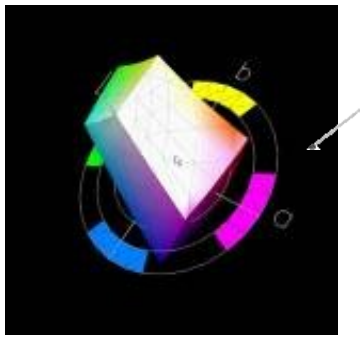
Goal of Colormanagement



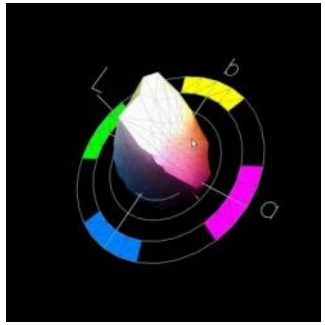
Scanner
RGB



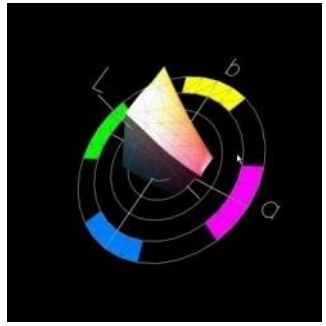
Monitor
RGB



Projektor
RGB



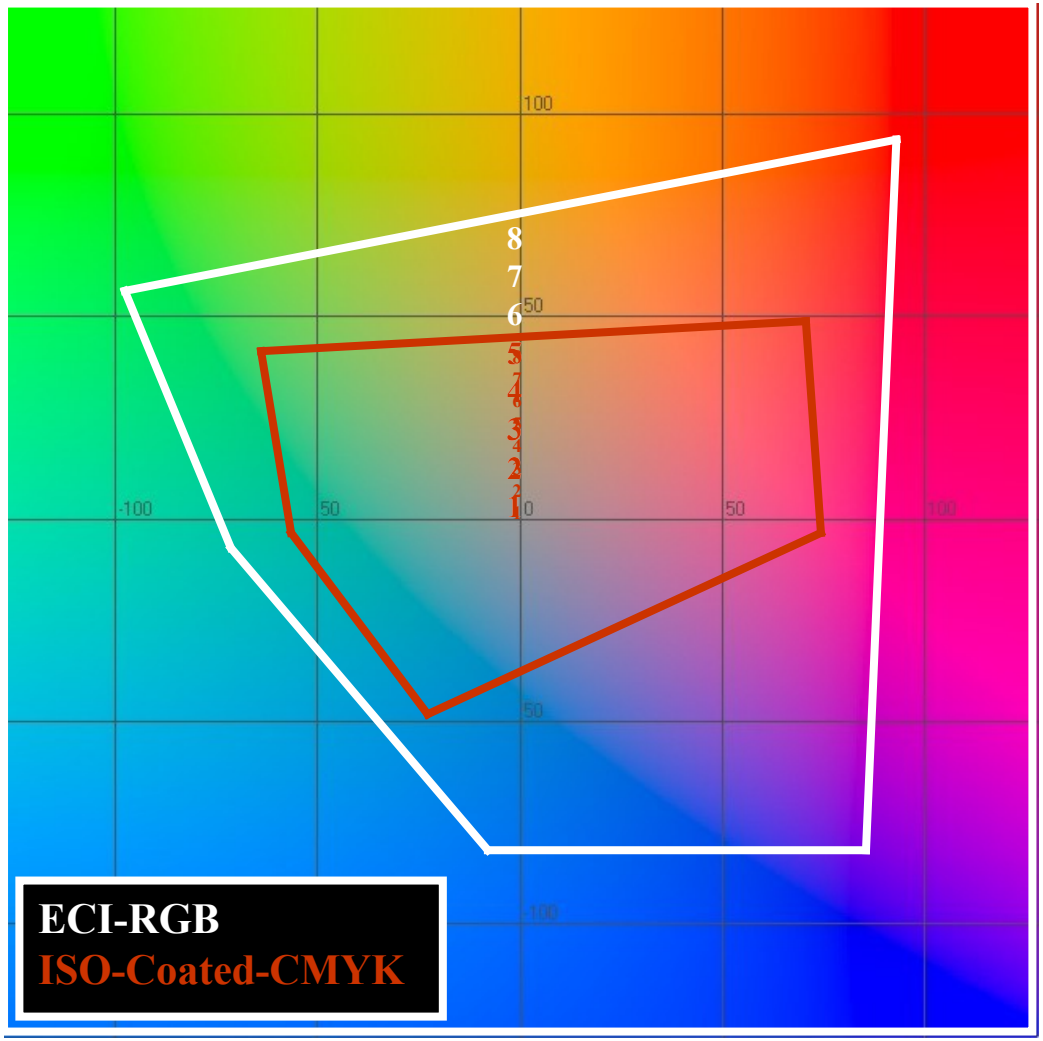
Inkjet



Offset

Gamutmapping

- Replacement of not viewable colors from source-color-space in destination-color-space → as unobstructive as possible

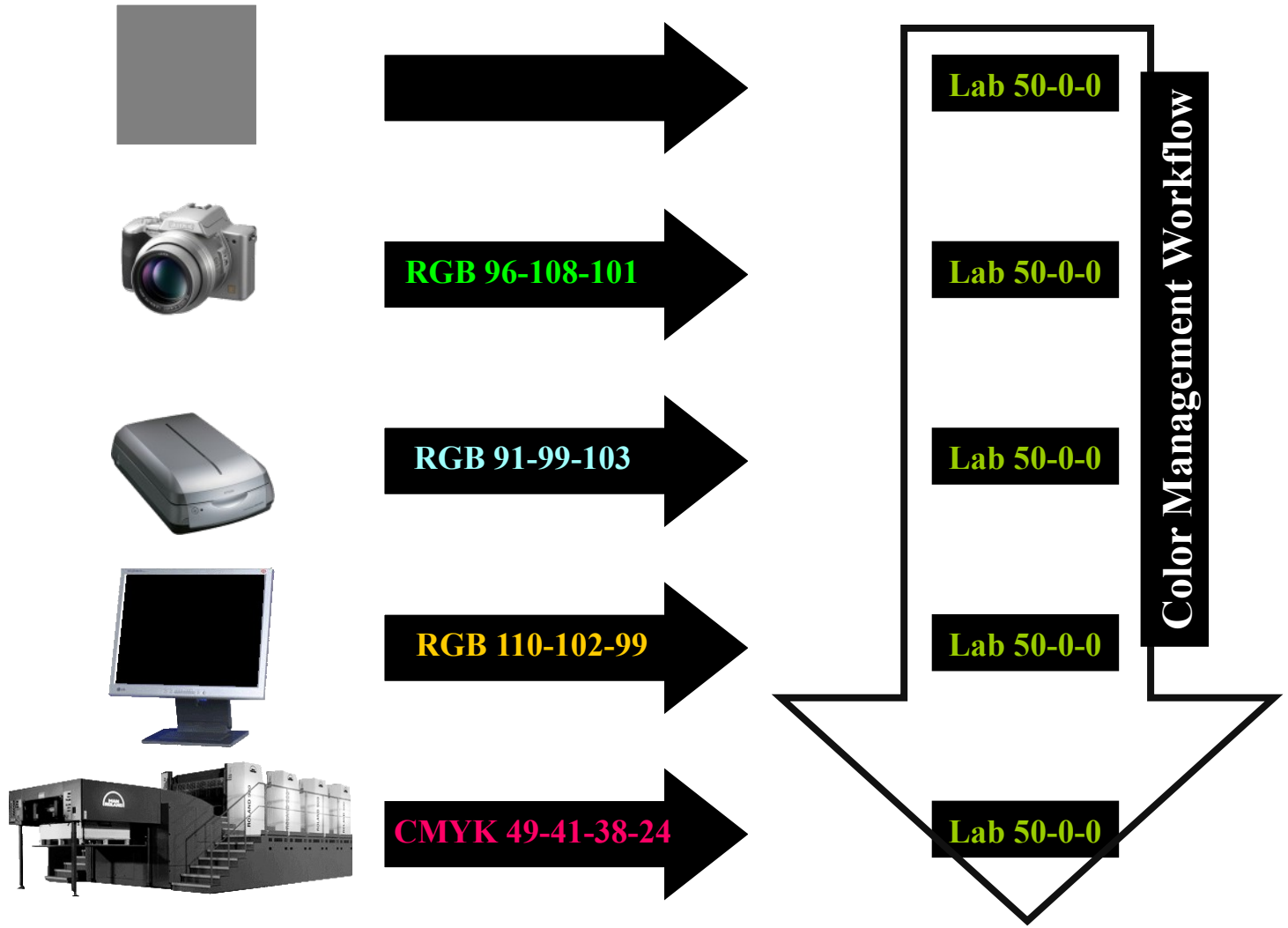


What is an ICC-Profile?

- Translation-Matrix for colors

RGB		Lab		CMYK
128 – 128 – 128		50 – 0 – 0		47 – 36 – 35 – 10
202 – 121 – 91		60 – 45 – 40		5 – 53 – 60 – 0
241 – 0 – 31		60 – 92 – 83		0 – 91 – 91 - 0

Utilization of ICC-Profiles



Functionality

Target-profile: Display

L	=	50	R	=	118
A	=	0	G	=	115
B	=	0	B	=	123

Source-profile: Scanner

R	=	130	L	=	50
G	=	110	A	=	0
B	=	115	B	=	0

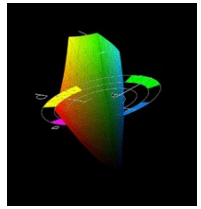
Target-profile: printer

L	=	50	C	=	49
A	=	0	M	=	41
B	=	0	Y	=	38
			K	=	24

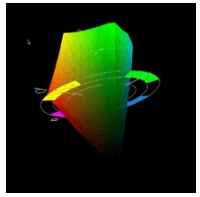
Standardprofiles

Standardprofiles are defined standard-color-spaces in Lab

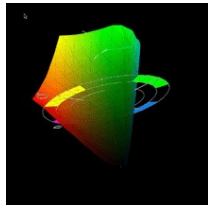
- sRGB
  - Average color-space of displays



- Adobe98-RGB
  - Internat. Standard-color-space



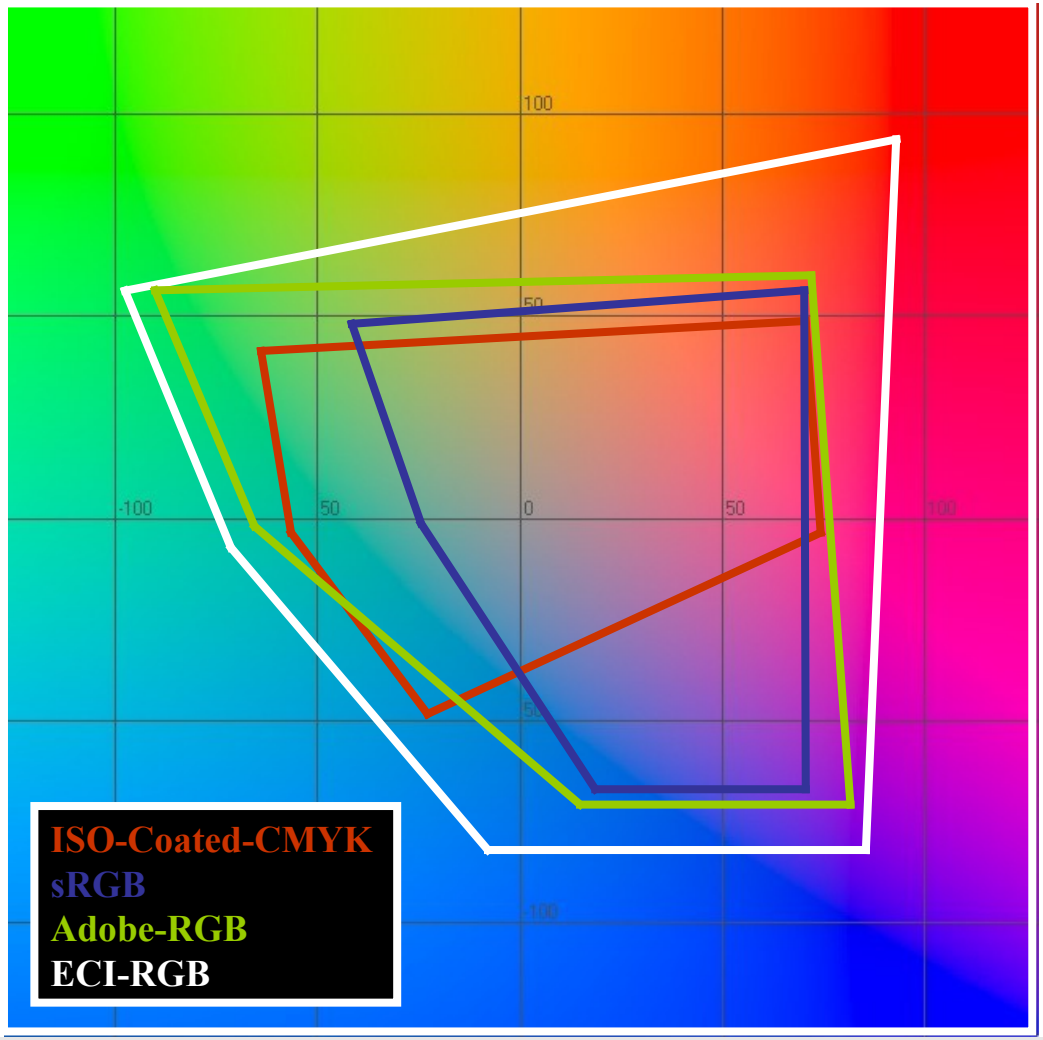
- ECI-RGB
  - Europ. Standard-color-space

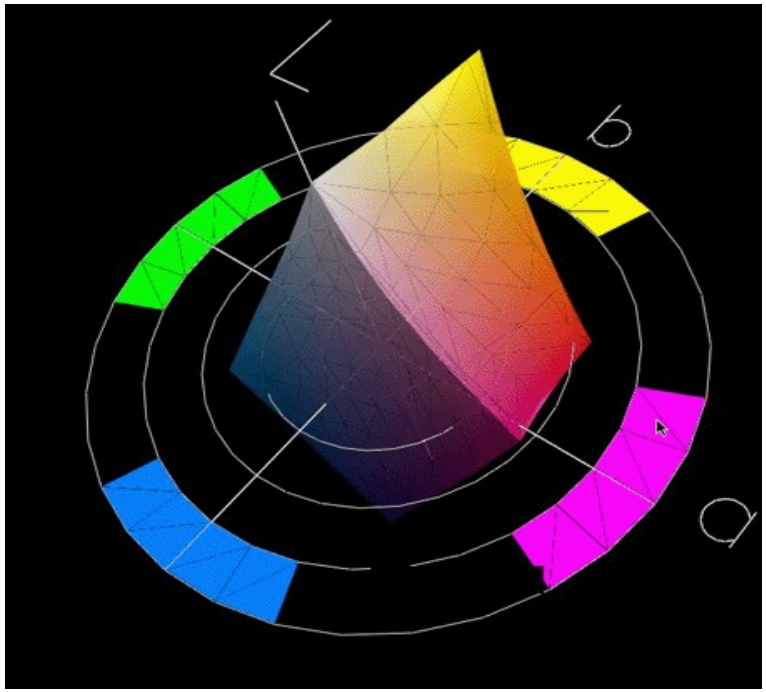


Source-color-spaces for selfmade pictures or target-color-space for special functionalities (e.g. data-transmission)

ISO(un)coated standardprofile FOGRA

- Profile for printing by Proces Standard Offset

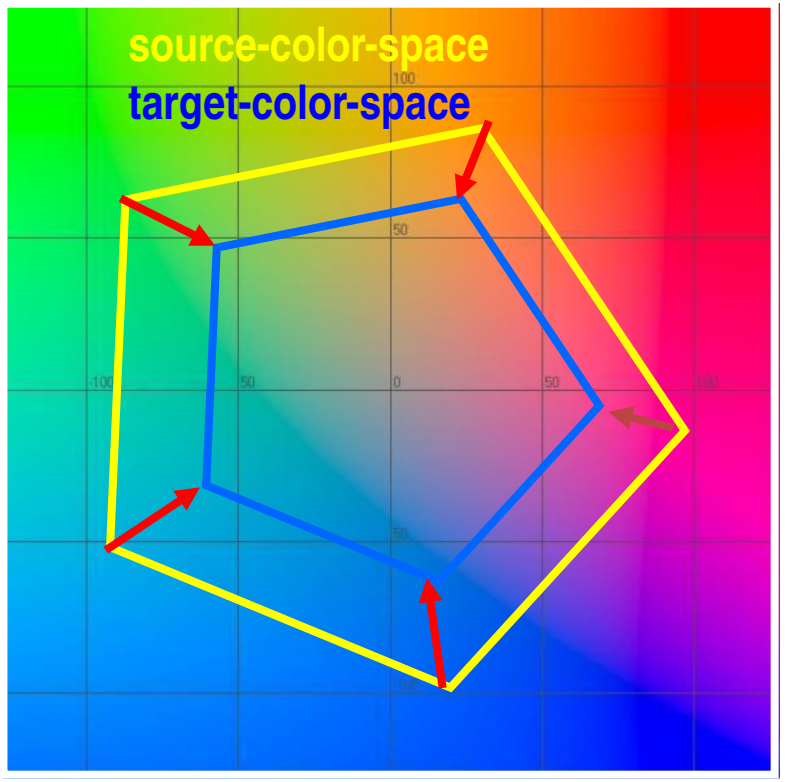




Advantage of ECI-RGB:
Contains these and most other standardprofiles

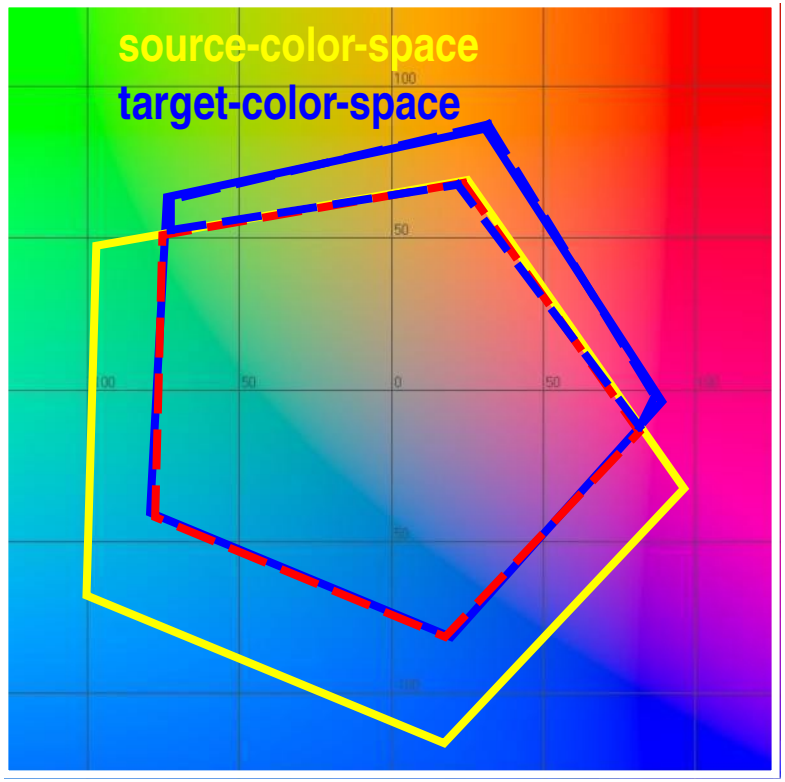
Transformation of color-spaces Methode 1

- Greater color-space will be compressed into smaller one
- colormetric all colors will be changed
- Appropriate to conserve the visual impression of the original



Transformation of color-spaces Methode 2

- Keep colors 1:1 with adjustment to smaller color-space (smallest distace of colors)
- Identical colors will be preserved
- Visual impression of colors not in destination-color-space may change

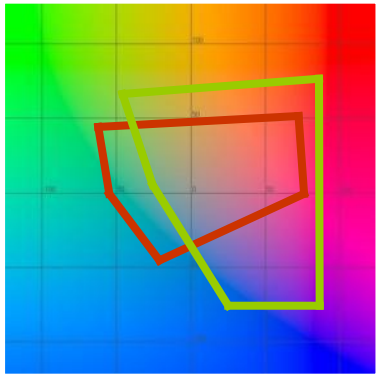


Rendering Intents

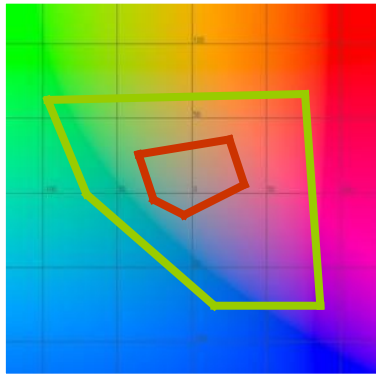
- Perception
  - Colors adjusted to visual impression(Compression)
  - Generating data for production (pictures)
- Relative colormetric
  - Smallest distance of colors
  - Generating data for production (pictures/Logos)
  - Proof to paper for print-run
- Absolutely colormetric
  - Smallest distance of colors with simulation of paper in destination-color-space (Whitepoint)
  - Proof to white proof-paper
- Saturation
  - Colors adjusted to max. saturation & hue
  - Business art work & chart

Rendering Intent

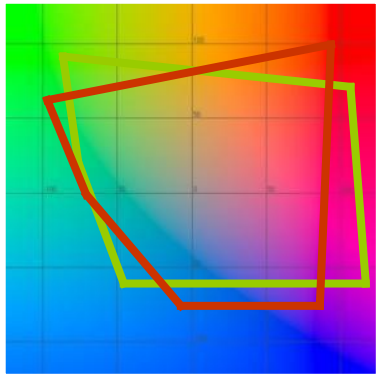
- How do i decide in real?
  - Use Rendering Intent with fewest changes of colors in picture (Photoshop: use preview)



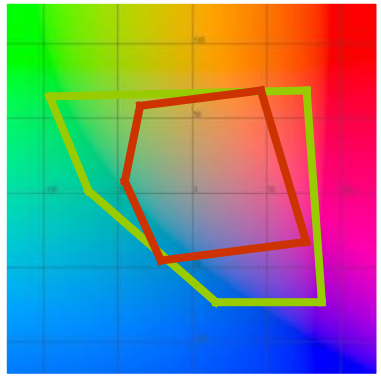
sRGB-RGB
ISO-Coated-CMYK



Adobe-RGB
Zeitungs-CMYK



Scanner-RGB
ECI-RGB



Adobe-RGB
Fotolabor

Rules

- Rendering Intent mostly dependent on motive

  but

  - Never convert absolutely colormetric (Whitepoint will change to white of paper → color on none-printing areas)
  - Never proof perceptive (colors will change to original → but goal of a proof is printig color mosty unchanged 1:1 if possible)
  - Never convert perzeptive from smaller color-space to bigger ones (unwanted displacements of colors e.g. CMYK to RGB → 1:1 possible otherwise use relative colormetric)

We need

- Technical equipment to get color information
- Software to generate profiles
- ICC-Profiles
  - source-profile
  - target-profile
- Software with integrated Colormanagement (Adobe-Products/Corel/Quark/Scribus/Gimp)
- Knowledge about how to use color-profiles

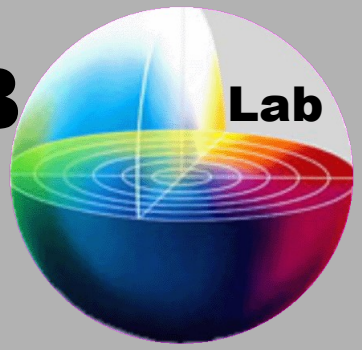
Problem solved

RGB LAB

ICC-Profile scanner

RGB LAB

ICC-Profile display



CMYK LAB

ICC-Profile print

Advantages of Colormanagement?

- reduces workload
- cost-efficiency
- quality-assurance
- less consumption of materials
- time-saving
- reduces customer complaint-rate

Calibrating & profiling displays

- Calibrating means standard adjustments of
  - Lightness/Luminance
  - Contrast
  - Adjusing color-temperature
    - D50 production & proofing (PSO)
    - D65 (still in use but obsolete)

      → CRTs need ca.1h reaching color-temperature

      → LCDs & LEDs lose luminance after some time

- Profiling means generate translation-matrix for LAB to RGB-device-color-space
  - send special RGB-Values to display
  - measure RGB-output of display
  - Generate profile by measured Values of RGB based upon D50
    - Translation-matrix from display (Lab to RGB)

Periodically repaeting calibration and profiling display

- Depends on type (cheap / high class)
- Depends on kind of display (LED / TFT / CRT / Plasma)
- Take care of cleaner-factor
- rough-and-ready-rule: once per month

TAKE CARE: dependent on Software the activation of profile will be done by operating-system, Adobe CS or special calibration- and profiling-software

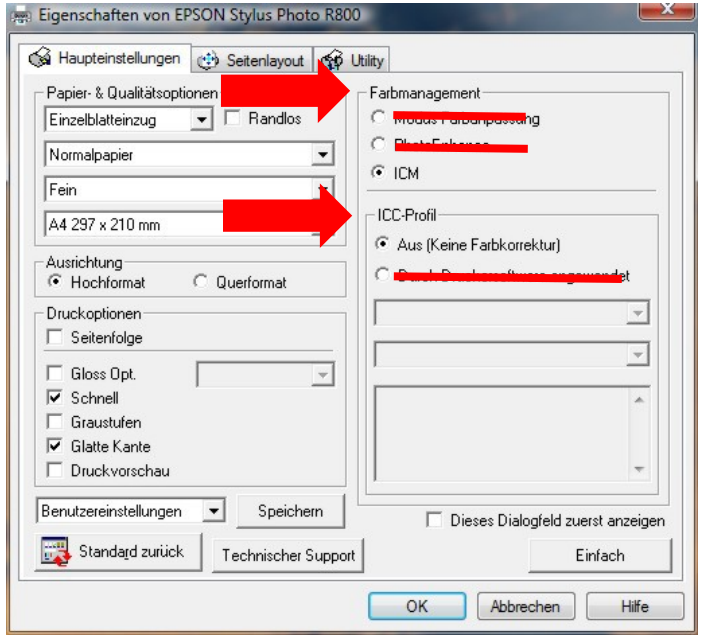
Printing process RGB or CMYK

- Printing by driver: RGB
- Controlled by RIP: CMYK
- Printing on printing press: CMYK

Profiling printer with testchart

- Testchart with plenty of color-fields
  - ECI 2002 Testchart (1485 colors)
- Linearisation (RIP-) Software
- Deactivate color-adjustments in driver and RIP
- Dot-gain must be known

- Testchart (RGB or CMYK) will be sent to printer and after that measured (Lab)
- Assign Lab-Values to CMYK- or RGB-Values
- Generate device-profil



Standard oder individual printer-profile

- Preferably individual profile because
  - A printer of same type is not YOUR printer
  - Individual profiles allow cosideration of YOUR whole workflow
  - Paperprofiles:
    - White paper will be read from every test-chart
    - Will be used by abs. colormetric Rendering Intent
    - New paper → new profile

Profiling scanner

- Read testcharts (Lab)
- Scan testcharts (RGB)
- Generate color-matrix RGB – Lab

  TAKE CARE: even lamps in scanners will perish

  Mostly the profile can be imported directly to scanner-software

Profiling of cameras

- Because of unstable process individual profiles are very difficult and almost impossible to generate

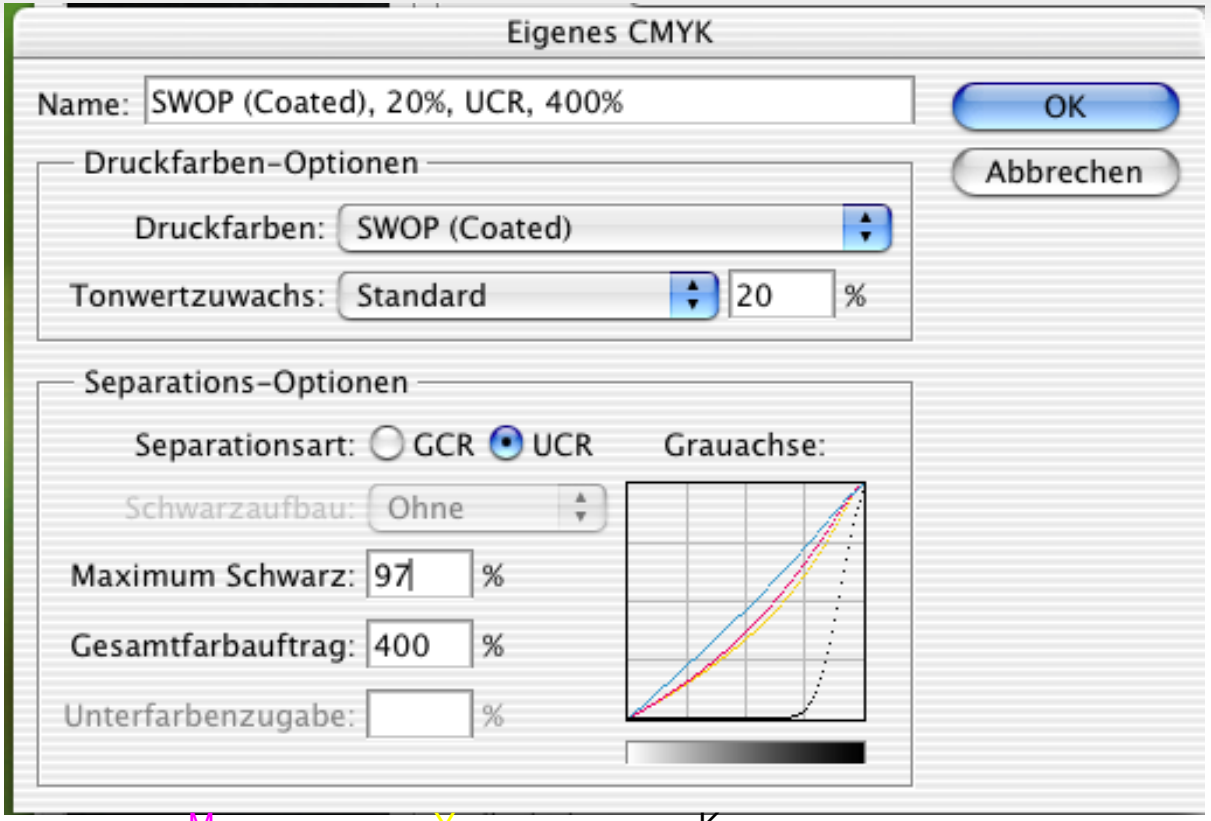
- Possible when continuous shooting or stable lighting conditions
  - Needed when taking photos from products or fashion
  - Generating profile for camera equals generating profile for scanner

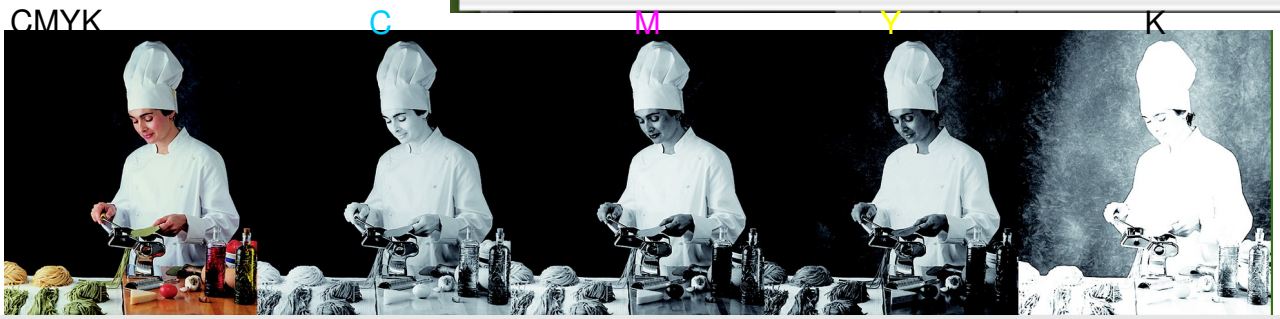
- No color-management inside of closed system camera

- But correct translation of values to Lab is possible
  - Cameras for private use mosty deliver sRGB
  - Cameras for professional use deliver AdobeRGB or
  - High-End devices use RAW-Format (no influence from outside)
    - After taking picture userdefined profiling in RAW-conve

Colorisation with CMY with black as skeleton

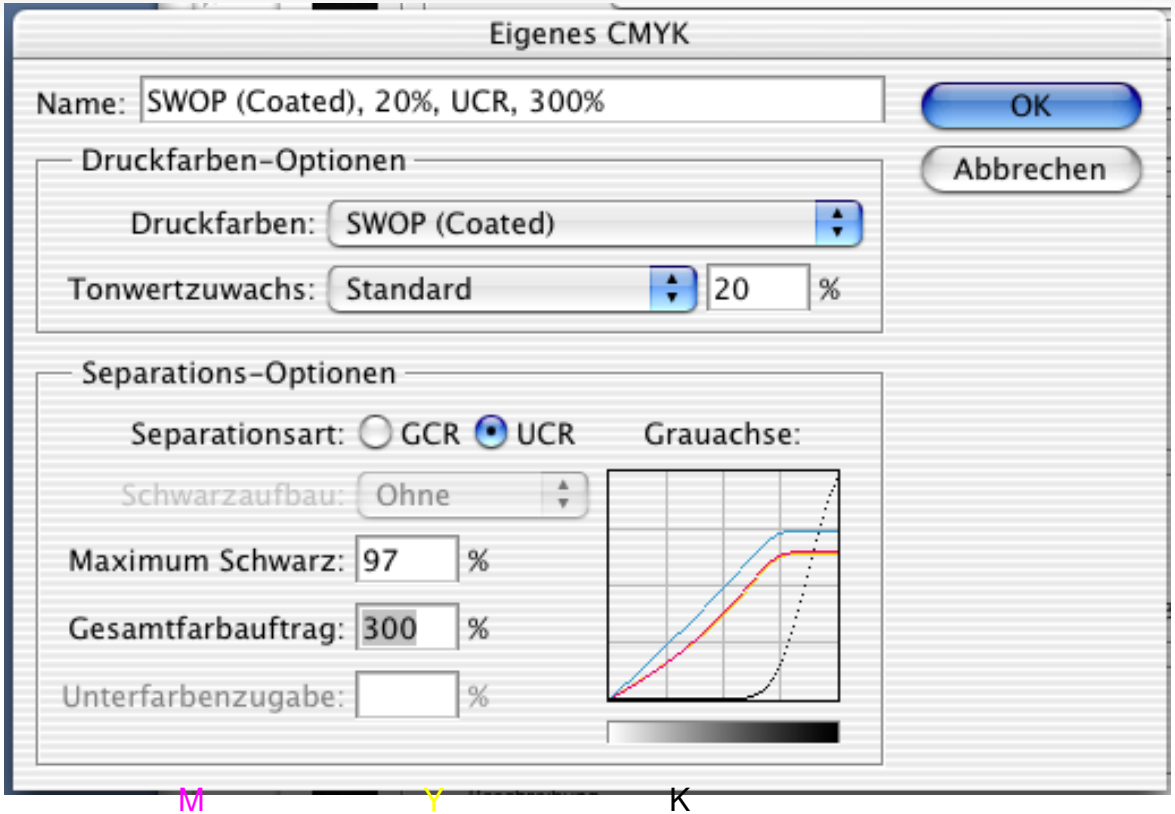
- All colors and also grey areas will be composed by CMY
- Black only as an skeleton with ¾ coverage
- Darkest color: 97%K 100%C 100%M 100%





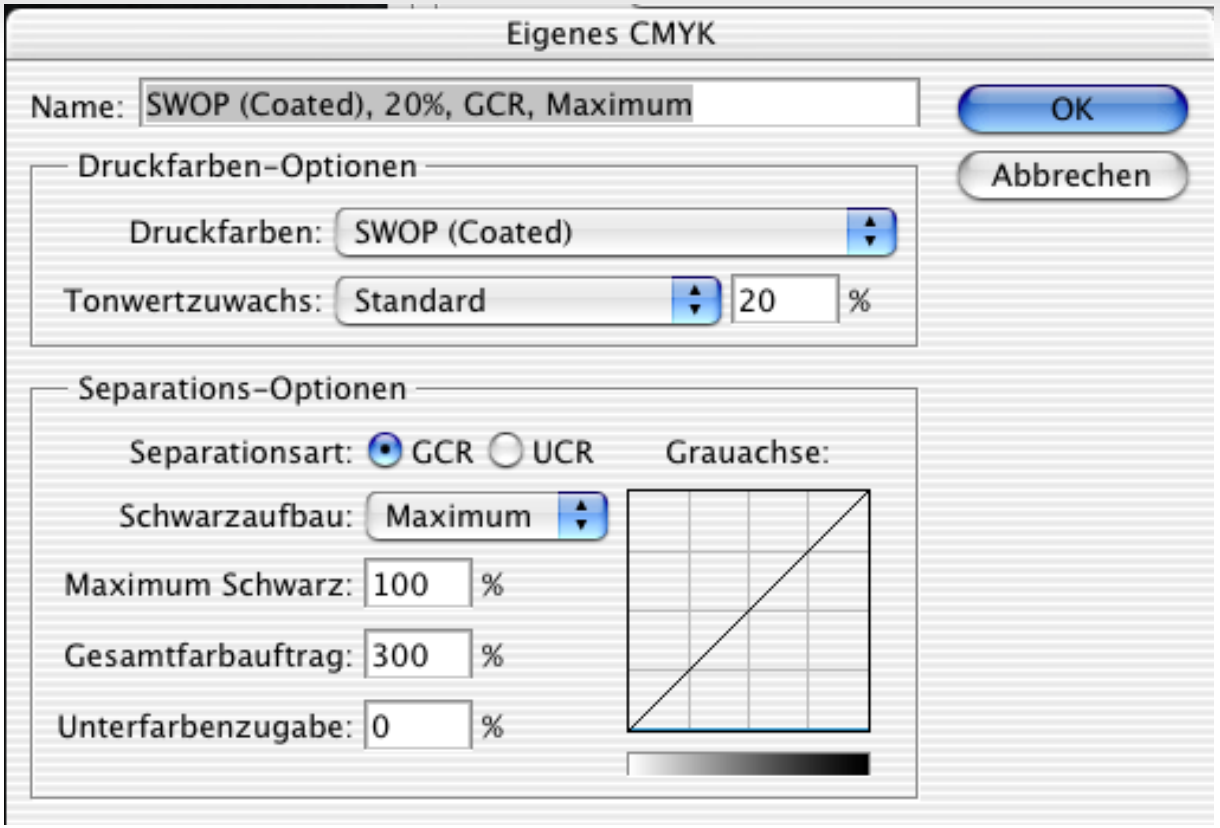
UCR (Under Color Reduction)

- For every point composed by CMY the amount of CMY will be reduced and replaced by black
- Darkest color: 97%K 60%C 60%M 60%Y



GCR (Gray Component Replacement)

- Every composition of CMY will be replaced by black
- Enhances stability in printing process
- Smallest amount of color needed
- Losing brilliance



Under Color Addition

- Real gray (amount of C=M=Y) replaced by black
- Adding CMY at ¾-tones for better contrast