ECSE-4750 10/22/12 p1

2 D CARTESIAN

(x_c, y_c)

2 D HOMOGENEOUS (x_H, y_H, w)

$x_c = x_H / w \qquad y_c = y_H / w$

H $(2,3,4) \rightarrow$ C $\left(\frac{2}{4}, \frac{3}{4}\right)$

LINE THRU 2 PTS

C. $ax + by + c = 0$

$(1,2), \ (3,4)$

$$\begin{array}{r} a + 2b + c = 0 \\ 3a + 4b + c = 0 \\ \hline 2a + 2b = 0 \\ b = -a \end{array}$$

$ax - ay + c = 0$

$-a + c = 0 \qquad c = a$

$$\boxed{x - y + 1 = 0}$$

H $(1,2,1), \ (3,4,1)$

$ax + by + cw = 0$

$$\boxed{x - y + w = 0}$$

$(1,2,1), (6,8,2)$

$ax+by+cw=0$

$a+2b+c=0$ $\qquad c=-a-2b$

$6a+8b+2c=0$ $\qquad a=1$, $b=-1$, $c=1$

$4a+4b=0$ $\qquad \underset{-1}{b}=-\underset{1}{a}$

$$\boxed{x-y+w=0}$$

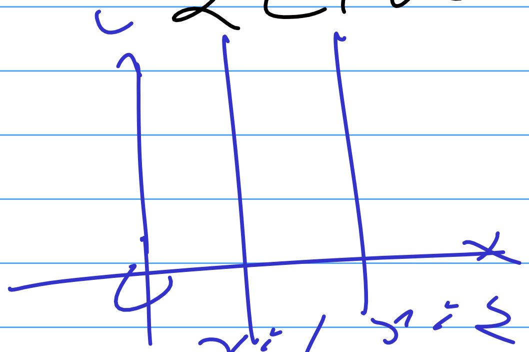
SCALING A H. POINT BEFORE COMPUTING EQUATION GIVES SAME EQN

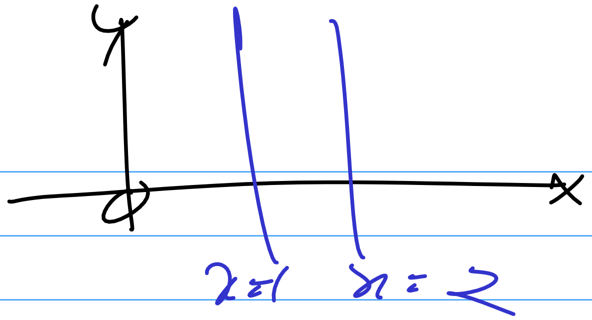
C. LINE $\quad x+y-1=0$, $x-y-1=0 \rightarrow (1,0)$

H $\quad x+y-w=0$, $x-y-w=0 \rightarrow (1,0,1)$

DUALITY $\quad$ 2 POINTS → LINE
2 LINES → POINT

C. $x=1$
$\cancel{x}=2$





C: $x-1=0$
H: $x-w=0$

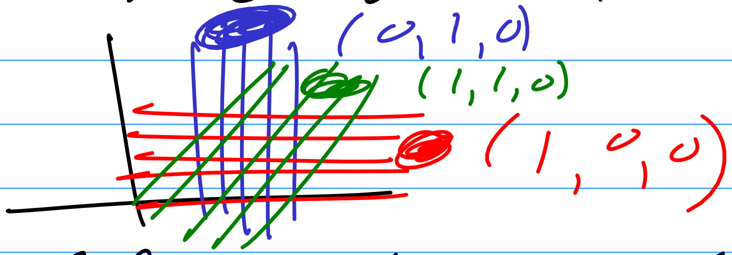
C: $x-2=0$
H: $x-2w=0$

INTERSECT 2 PARALLEL LINES

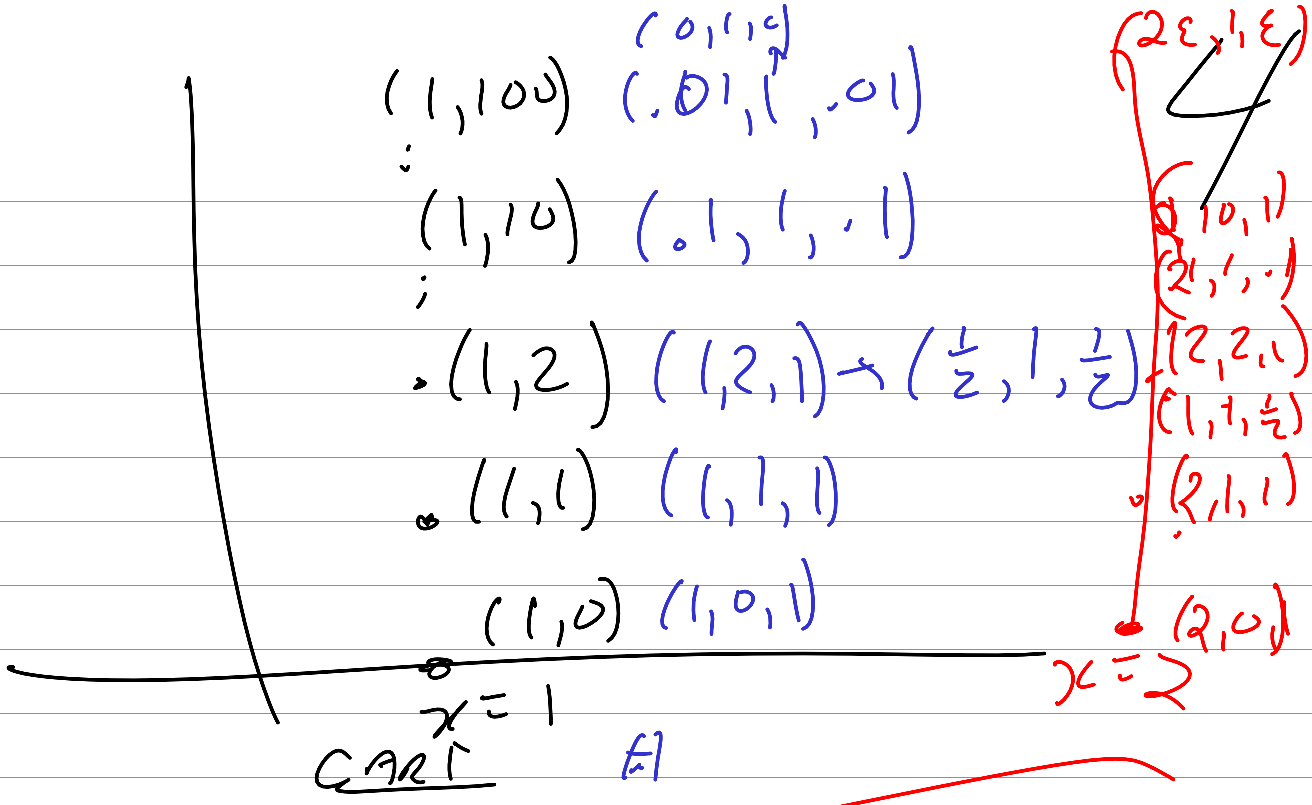
$$\left.\begin{array}{l} x-w=0 \\ x-2w=0 \end{array}\right\} \to (0,1,0)$$

$w=0$ IN A POINT MEANS A POINT AT ∞.

(0,1,0) IS THE POINT AT THE END OF ALL VERTICAL LINES



ALL THE PARALLEL LINES IN A GIVEN DIRECTION CONVERGE AT AN ∞ POINT



PROJECTION PARALLEL

C. $x' = x$ $\qquad x_c = x_H/w$

$y' = y$

$z' = 1$

If $x'_c = x'_H/w' = x_H/w$

$y'_c = y_c/w$

$z'_c = z'_H/w' = 1 = w/w$

WORKS IF

$x'_H = x_H$

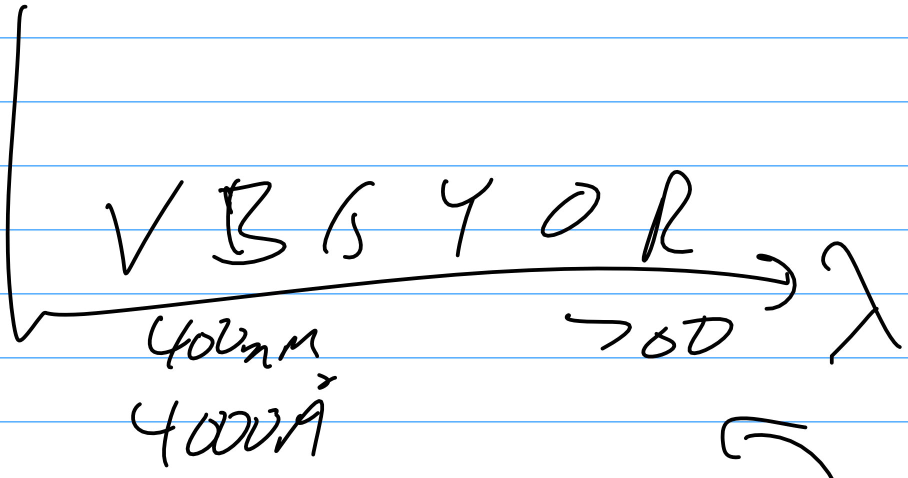
$y'_H = y_H$

$z'_H = w$

$w' = w$

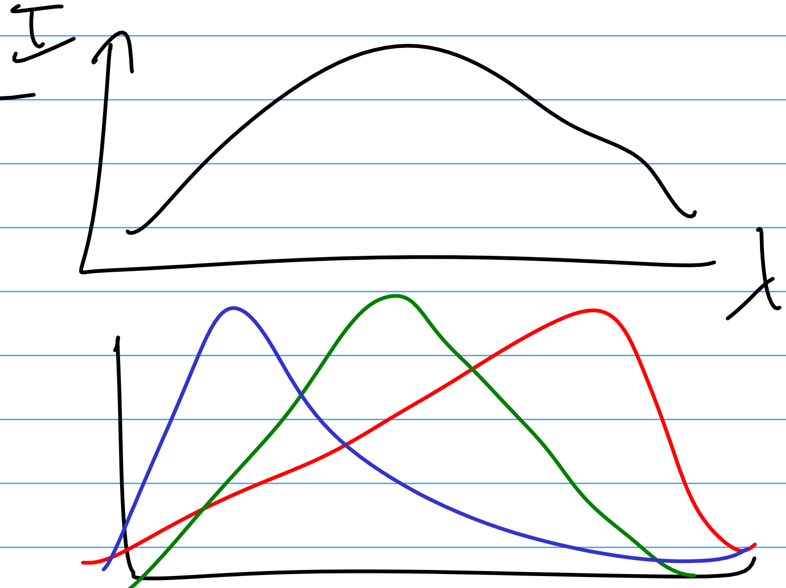
$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

CH 11 LIGHTING

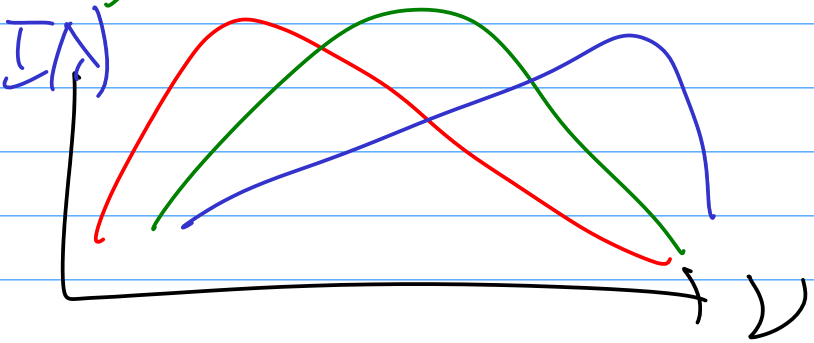


NO PURPLE THERE

LIGHT

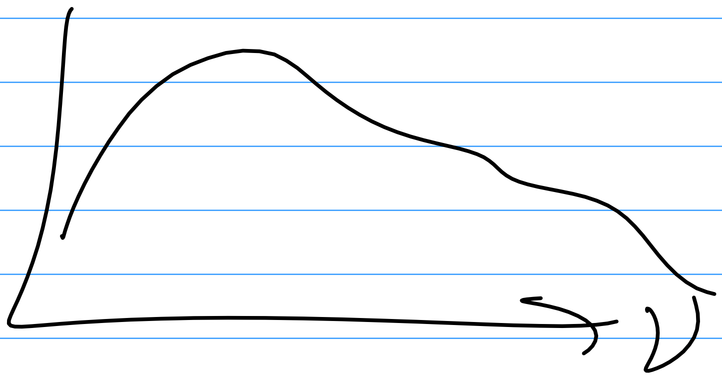


~~LIGHT~~



MATERIAL REFLECTIVITY

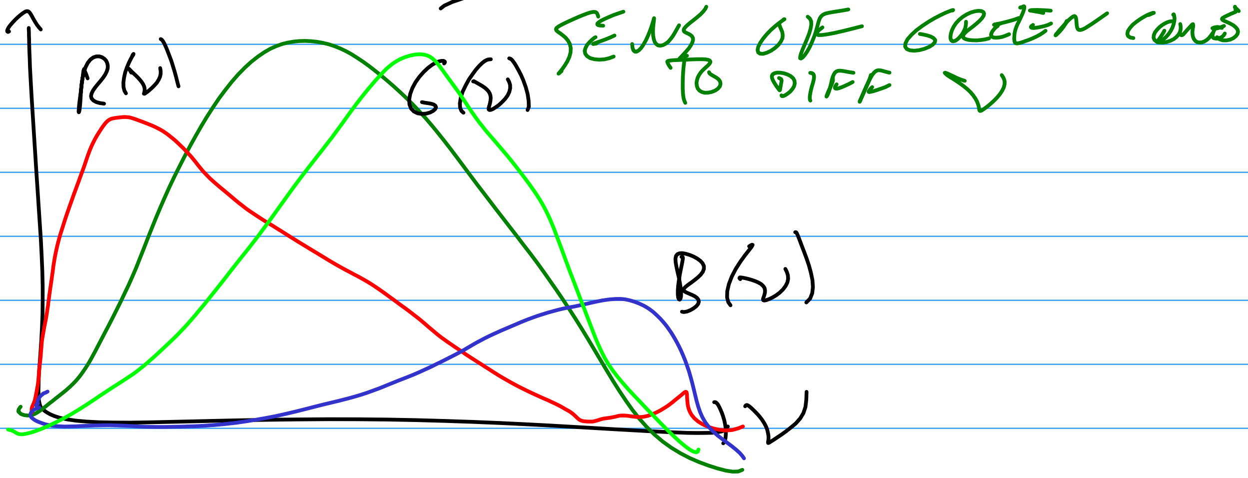
$R(\nu)$



BRIGHTNESS OF MATERIAL IN LIGHT

$$\int I(\nu) R(\nu) d\nu$$

HUMAN EYE 3 TYPES OF COLOR RECEPTORS



TETRACHROMATS HAVE 2 TYPES OF GREEN CONES WITH SLIGHTLY DIFFERENT PEAK ν.

COLOR YOU SEE FOR A LIGHT?

$L(\nu)$ - LIGHT INTENSITY

APPARENT RED = $\int L(\nu) \underset{\text{RED CONE}}{R(\nu)} d\nu$

APPARENT GREEN $\int L(\nu) G(\nu) d\nu$

BLUE $\int L(\nu) B(\nu) d\nu$

LOSS OF INFORMATION

$L(\nu)$ HAS A VALUE FOR EACH ν

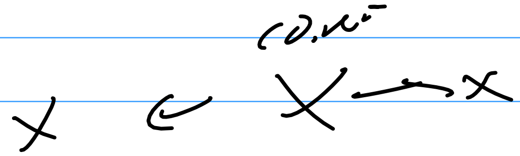
(R, G, B) IS ONLY 3 NUMBERS

THERE CAN BE 2 LIGHTS WITH QUITE DIFFERENT $L(\nu)$ THAT LOOK SAME

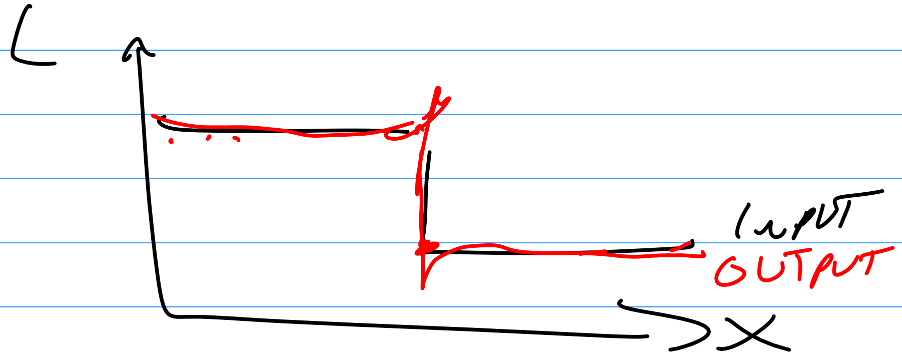
METAMER

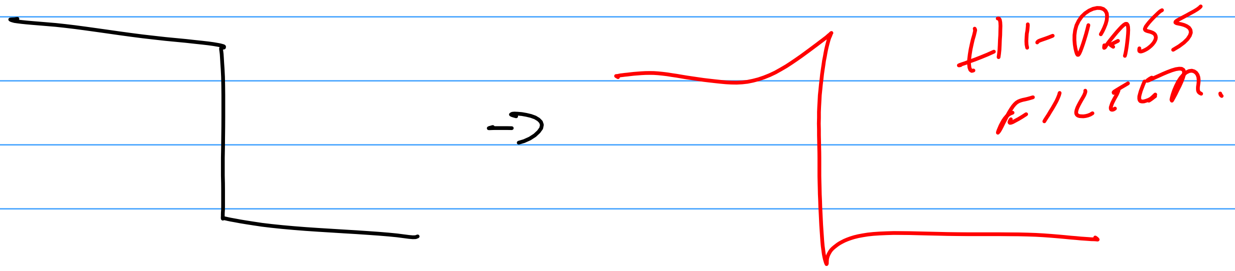
RELATED 2 PAINT SAMPLES MIGHT LOOK SAME UNDER ONE LIGHT BUT DIFFERENT UNDER ANOTHER

RETINA IS A NEURAL NET:
WITH INHIBITION OF NEIGHBURS



IF ONE CONE IS ILLUMINATED, IT FIRES, ALSO IT MAKES ITS NEIGHBURS LESS LIKELY TO FIRE.





ERNST MACH

MACH-BAND EFFECT

ALSO DID - SPEED OF SOUND
MEASURE ROTATION OF UNIVERSE.

WHEN 2 COLORED LIGHTS OVERLAP, YOU SEE ONE MERGED COLOR.

RED+GREEN → YELLOW
R+G+B → WHITE.

THIS HAS ALL BEEN QUANTIFIED.

EACH COLOR GETS A COORDINATE IN 3D SPACE

2D IF BRIGHTNESS IS FIXED.

COMBINE COLORS BY COMPUTING MIXTURE COORDS

EX / 50/50 MIX

RED (.7, .3)
GREEN (.1, .9)

(.4, .6) YELLOW

2/3 R, 1/3 G $\frac{2}{3}(.7,.3)+\frac{1}{3}(.1,.9)=(.5,.5)$

MORE ORANGE.

BOTTOM LINE OF CIE DIAGRAM NOT SPECTRAL COLORS.

<u>PURPLES</u>

NTSC - US COLOR TV

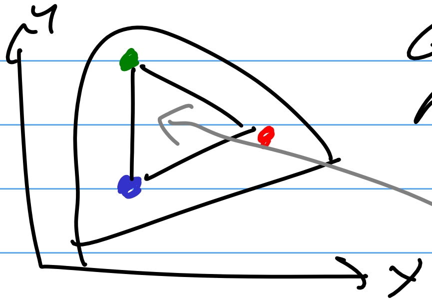
NEVER
TWICE THE
SAME
COLOR

NAT.
TV
STANDARDS
COMMITTEE.

Fr/
SYSTEM
ESSENTIALLY
CONTRARY TO THE
AMERICAN
METHOD

CIE CHROMATICITY DIAGRAM:

COLOR DISPLAY -
EACH PHOSPHOR IS A POINT ON DIAGRAM

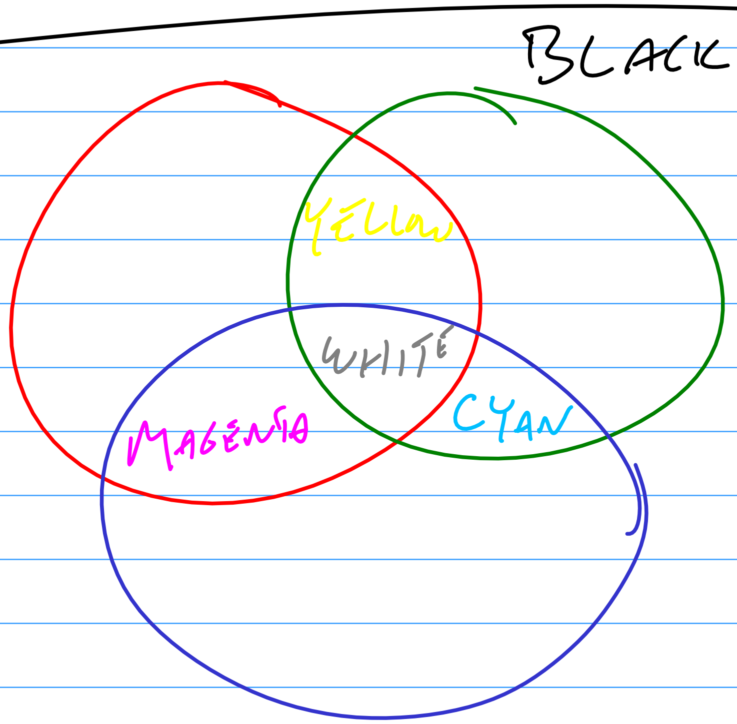


GAMUT OF REPRESENTABLE COLORS IS IN △

DIFFERENT MANUFACTURERS MAY HAVE DIFFERENT VALUES FOR RED ETC.
SONY & PHILIPS

COMMON BUT IMPRECISE TO SPEC COLORS AS (R,G,B) TRIPLE.

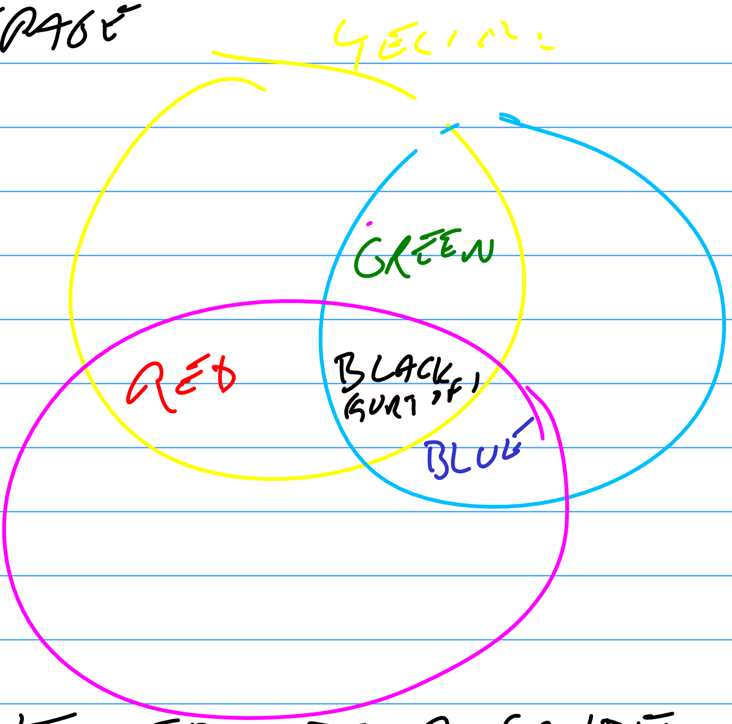
ADDITIVE COLOR



CRT
LCD
LED

SUBTRACTIVE PRINTING

WHITE PAGE



INKS MUST REFLECT A WIDE RANGE OF COLORS OR THEY'LL LOOK BLACK.
EMITTER CAN BE NARROW BAND.

PRINTED IMAGES OF LCD, CRT
LOOK WASHED OUT OFTEN
ADDITIVE + SUBTRACTIVE DON'T MATCH

COLOR PRINTERS ADD BLACK INK

- CHEAP
- MIXING CMY DOESN'T GIVE GOOD BLACK.
- WHEN PRINTING YOU'D NEED TO ALIGN THEM PERFECTLY.
- PRINTING LOTS OF INK GETS PAPER WET (INK JET)
- PRINTING CMY TAKES 3 TIMES AS LONG AS BLACK.

NEXT PHONG LIGHTING