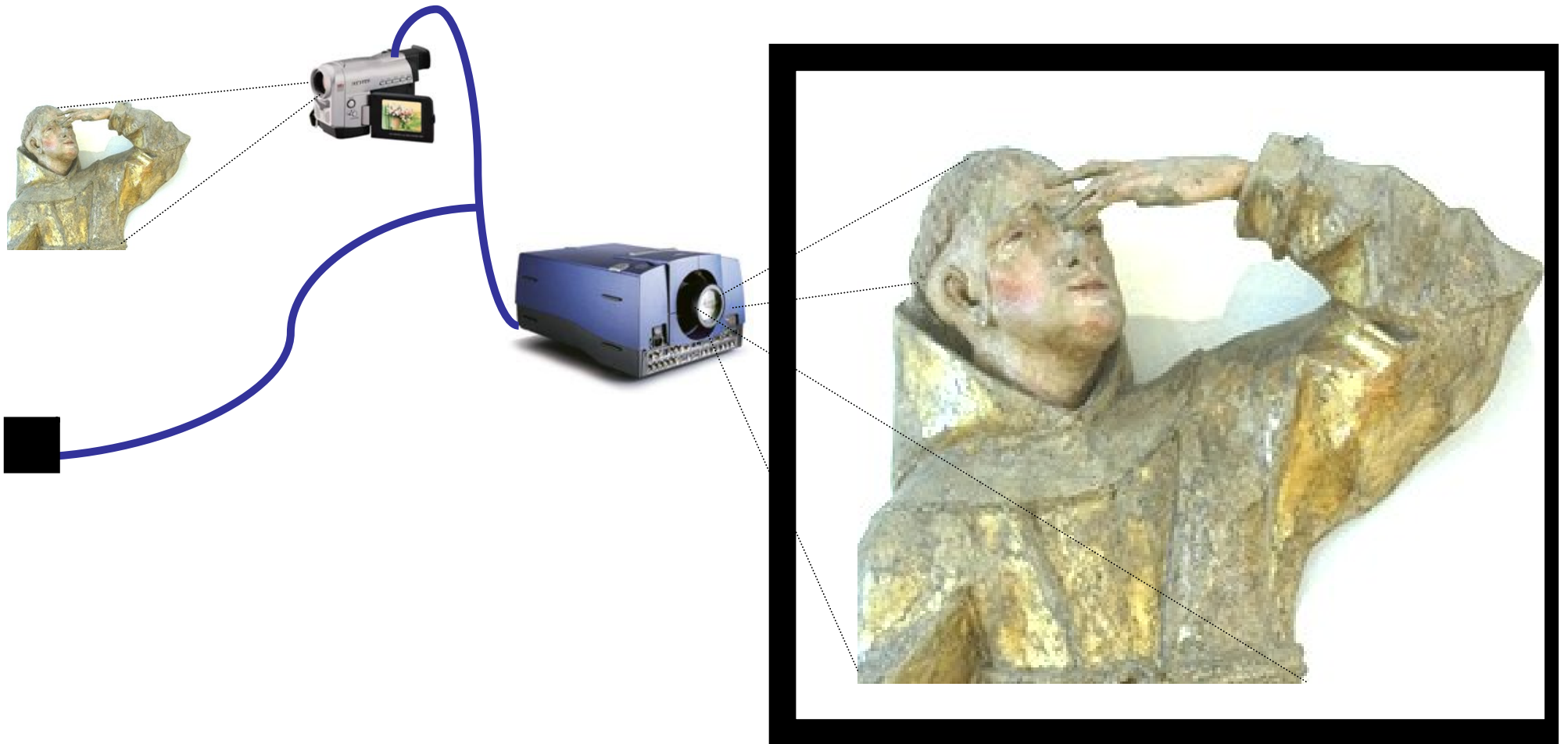


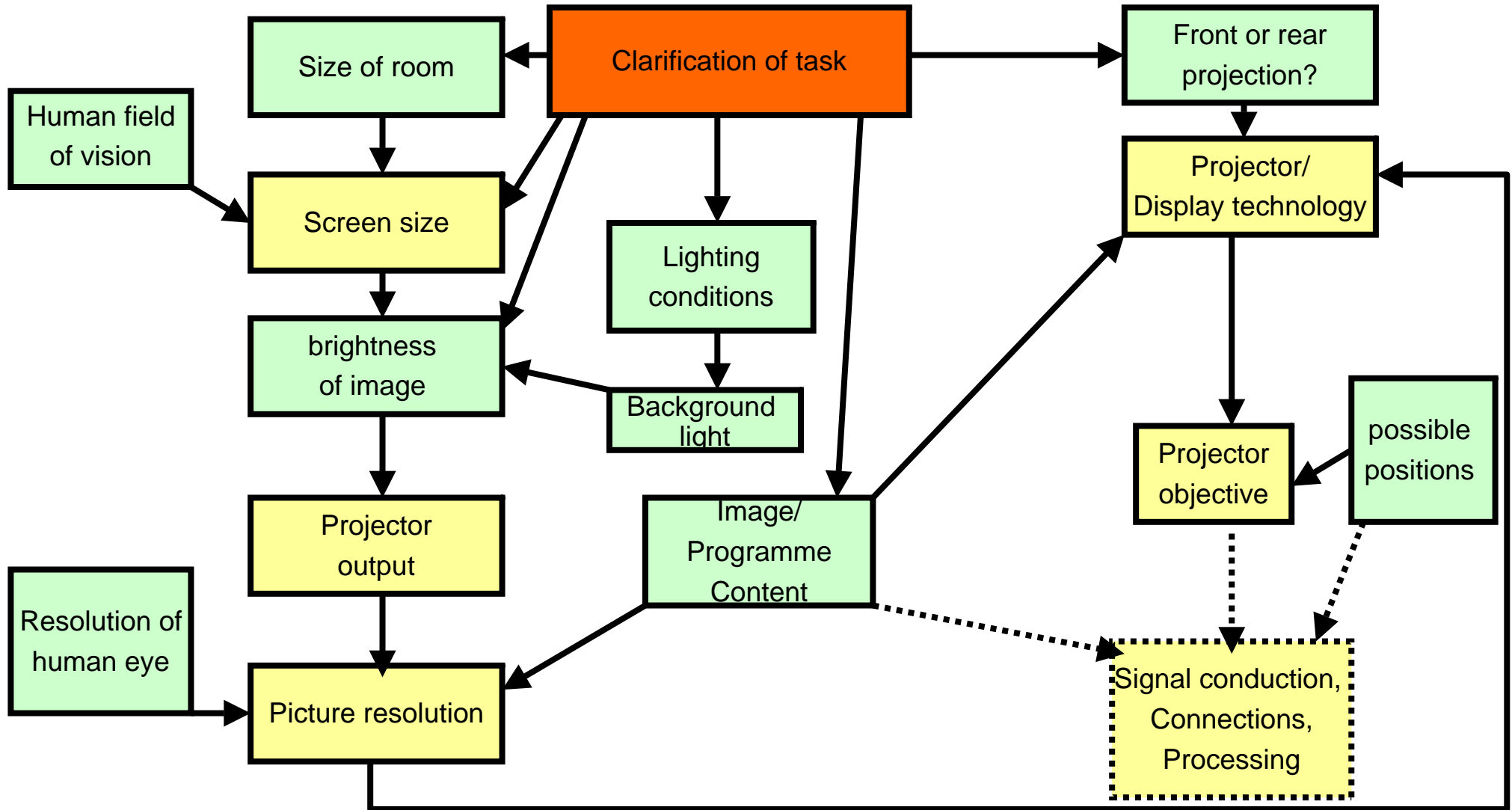
Media technology / Basics

Practical big screen projection made simple.

In the jungle of apparatus, cables and formats
– a crash course



Dimensioning process

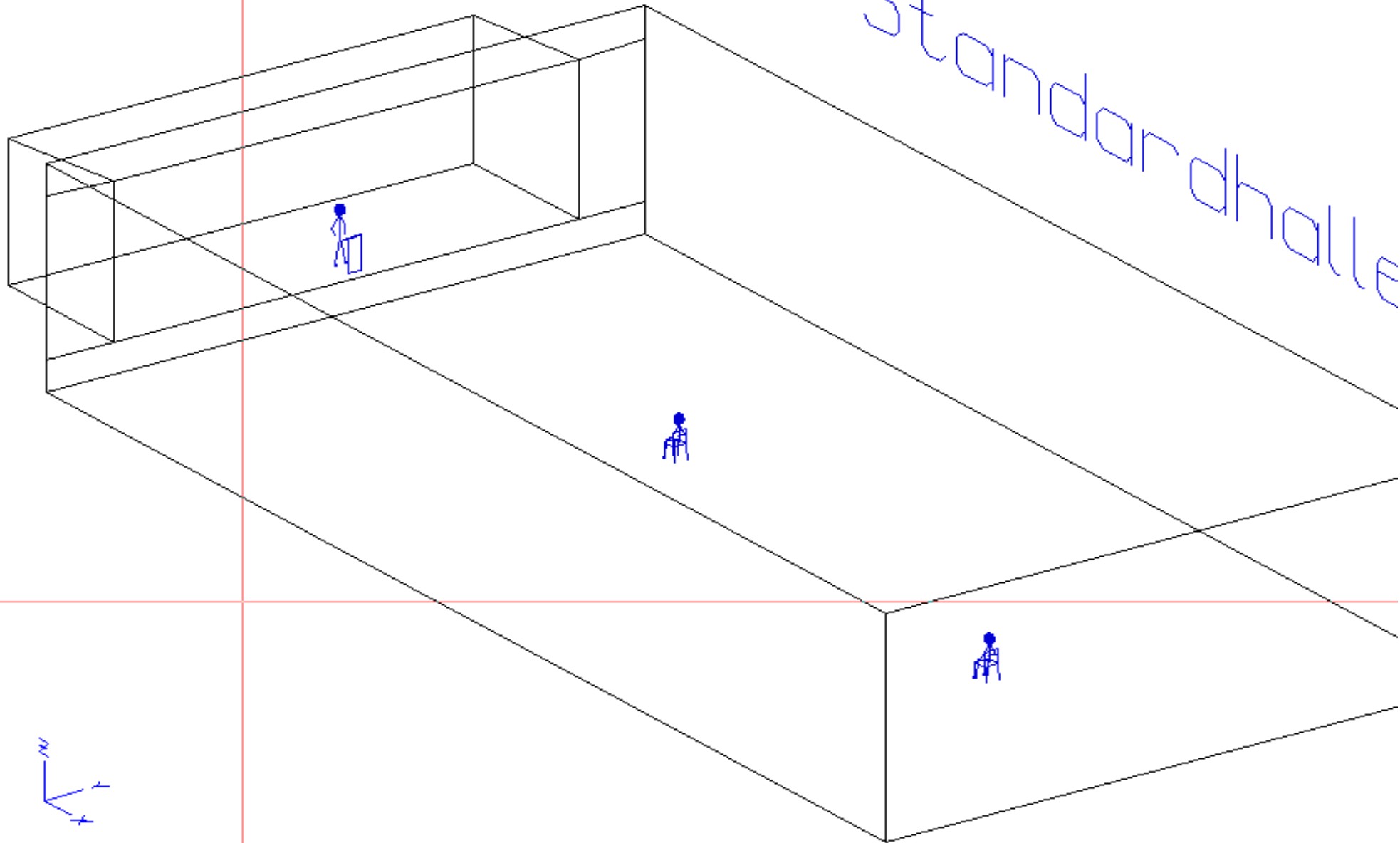


Comprehensive source of information on standards:

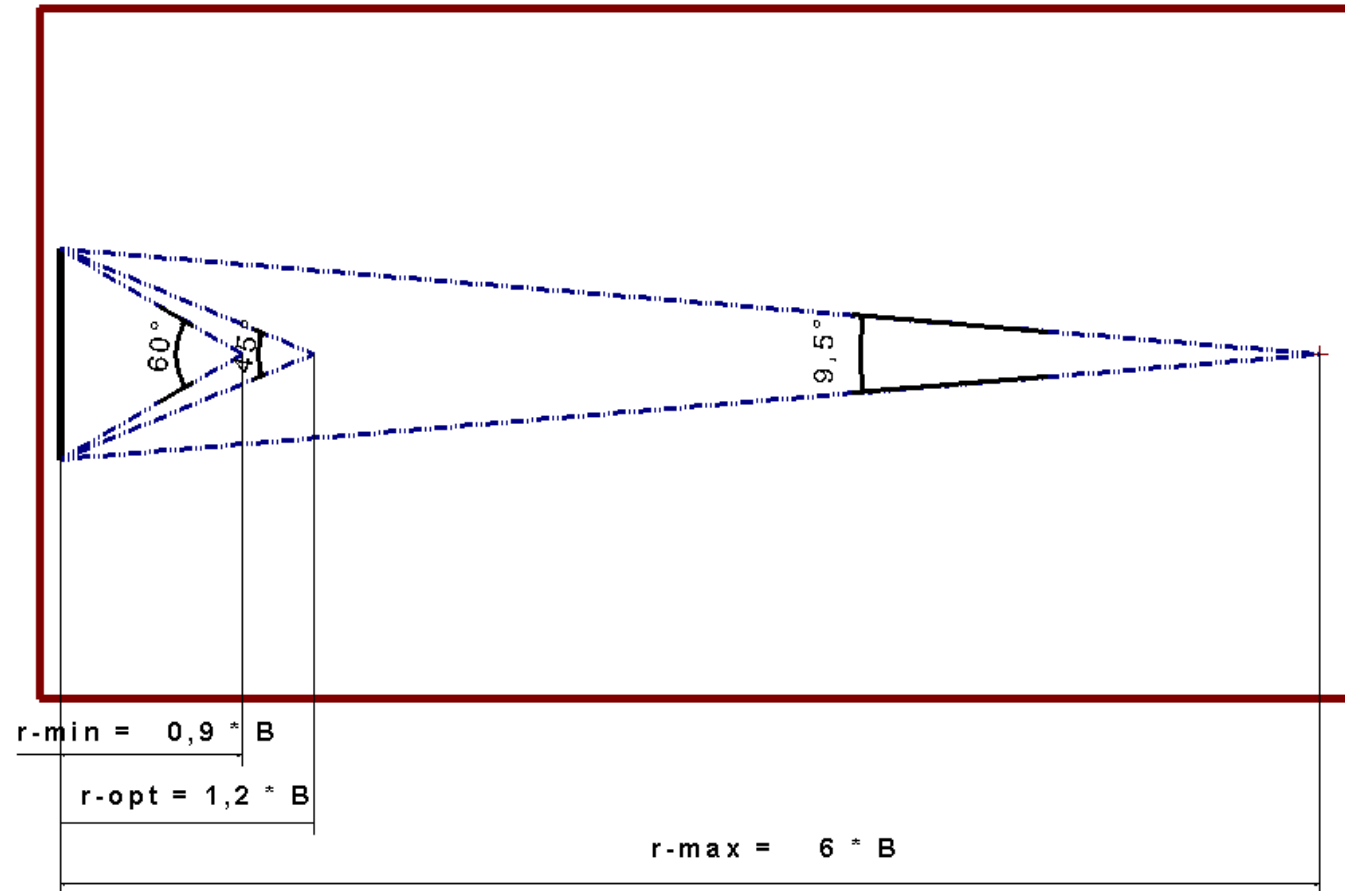
DIN 19045 Part 1

“Conditions for projection and viewing with all types of projection equipment”

Standardhalle



Angle of vision and distance



Width of projection screen??

$$B_{\min} = r_{\max} / 6$$

(angle of vision rd. $9,5^\circ$)

better:

$$B = r_{\max} / 5$$

optimum spectator distance:

angle of vision 45°

equivalent to:

$$r_{\text{opt}} = B * 1,2$$

minimum spectator distance:

angle of vision 60°

equivalent to:

$$r_{\min} = B * 0,9 \text{ (DIN: 1,5)}$$

Calculation of projection size using an example project: “Standard hall”

Length = 36 m
max. viewing distance

Breadth = 17 m
 $r_{\max} = 35$ m

Height = 7 m

→ Appropriate breadth of projection $b_{p\text{-opt}} = 35 \text{ m} / 5 = 7 \text{ m}$

→ Projection height
for 4:3-format $h_{p\text{-opt}} = b_{p\text{-opt}} * 3/4 = 7 \text{ m} * 3/4 = 5,25 \text{ m}$

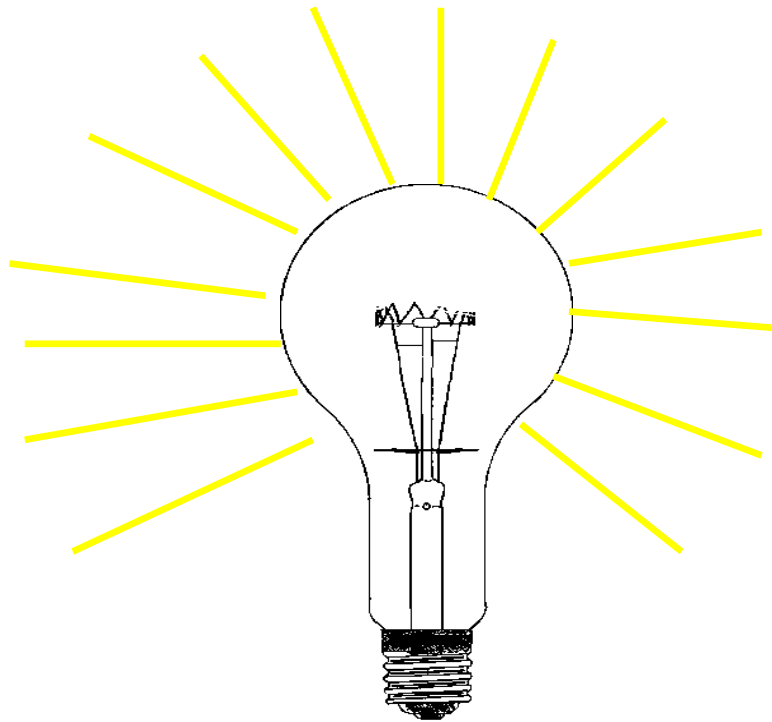
→ Projection surface $A_{p\text{-opt}} = b_{p\text{-opt}} * h_{p\text{-opt}} = 7 \text{ m} * 5,25 \text{ m} = \text{ca. } 37 \text{ m}^2$

but final screen width dependant on maximum image format (aspect ratio)

→ min. viewing distance $r_{\min} = b_{p\text{-opt}} * 0,9 = 7 \text{ m} * 0,9 = 6,3 \text{ m}$

Luminous Flux Φ_v

(„Light output“)



Derived from the radiant power - after factoring by spectral sensitivity of the human eye - equals the amount of light energy Q per unit of time t (Q/t)

Unit:

LUMEN (lm)

Contrast level = Difference between the brightest light and black

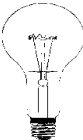
Necessary for satisfactory image quality:

ca.  ca. 1:10

Adequate in some circumstances (Computer graphics):

ca.  ca. 1:5

For high quality cinema projection: 500 ...1000 : 1 required

Dependent on: 

Background light and projector illuminance E



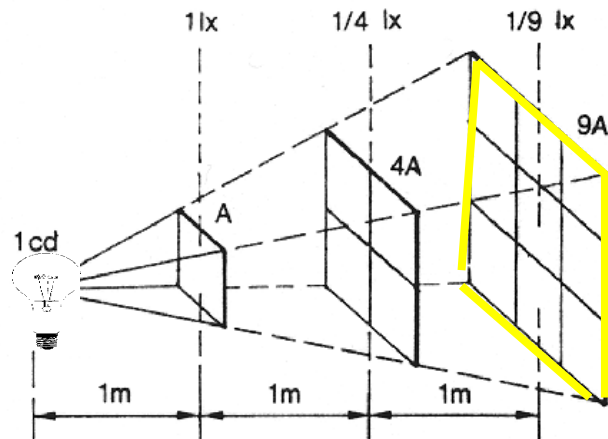
ILLUMINANCE E_v

(Luminous flux per unit of surface area)

Illuminating luminous flux Φ_v [Lumens] per unit of area A [square metres]

Unit

Lux (lx = lm/m²)



Typical illuminance in Lux (benchmark values)

complete blackout	< 1 lx
darkened room	5 20 lx
partially darkened room	20 ... 100 lx
room with unimpeded daylight	50 1.500 lx
typical work-place illumination	mind. 300 lx
open air with overcast sky	5.000 ... 15.000 lx
open air in sunshine	> 20.000 lx

Luminous flux required from projector for the example project “Standard hall”

given: projection surface $A_p = b_p * h_p = 7 \text{ m} * 5,25 \text{ m} = \text{ca. } 37 \text{ m}^2$

?? background light (Illuminance E in Lux) on the projection surface ??

Measured or pre-established → example: background light = $E_{\text{BGRND}} = 30 \text{ Lux}$

Minimum contrast → example: contrast = $E_{\text{PROJ}} / E_{\text{BGRND}} = 10 : 1$

→ Necessary projection light = $E_{\text{PROJ}} = E_{\text{BGRND}} * \text{Kontrast} = 30 \text{ Lux} * 10 = 300 \text{ Lux}$

→ luminous flux required

$$= A_p * E_{\text{PROJ}}$$

$$= 37 \text{ m}^2 * 300 \text{ Lux}$$

$$= \underline{11.100 \text{ Lumens}}$$

The problem of picture resolution

Picture resolution with different numbers of lines

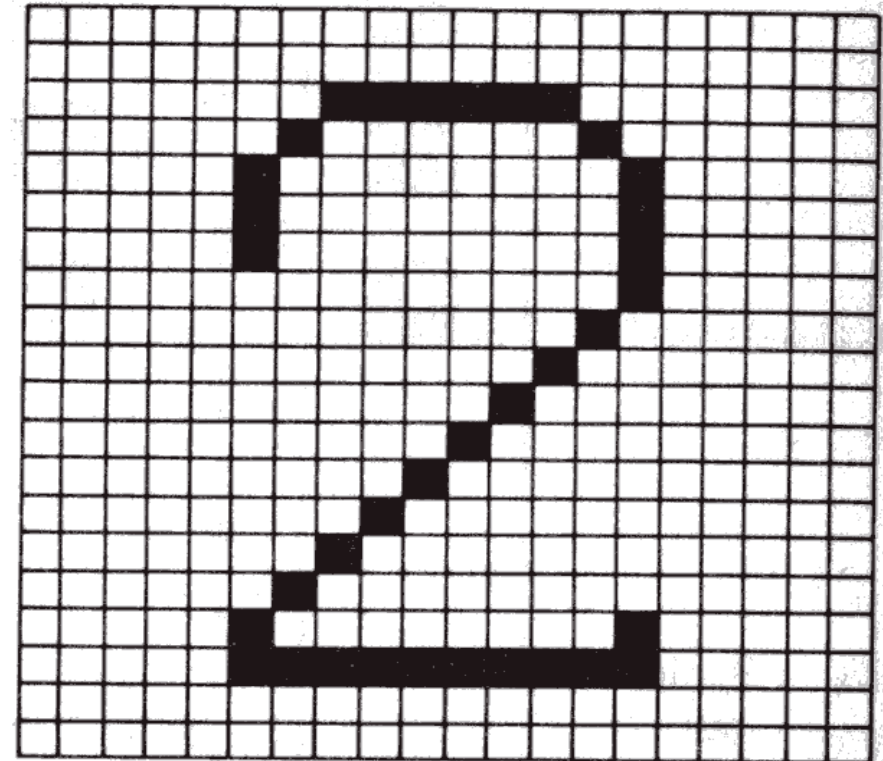
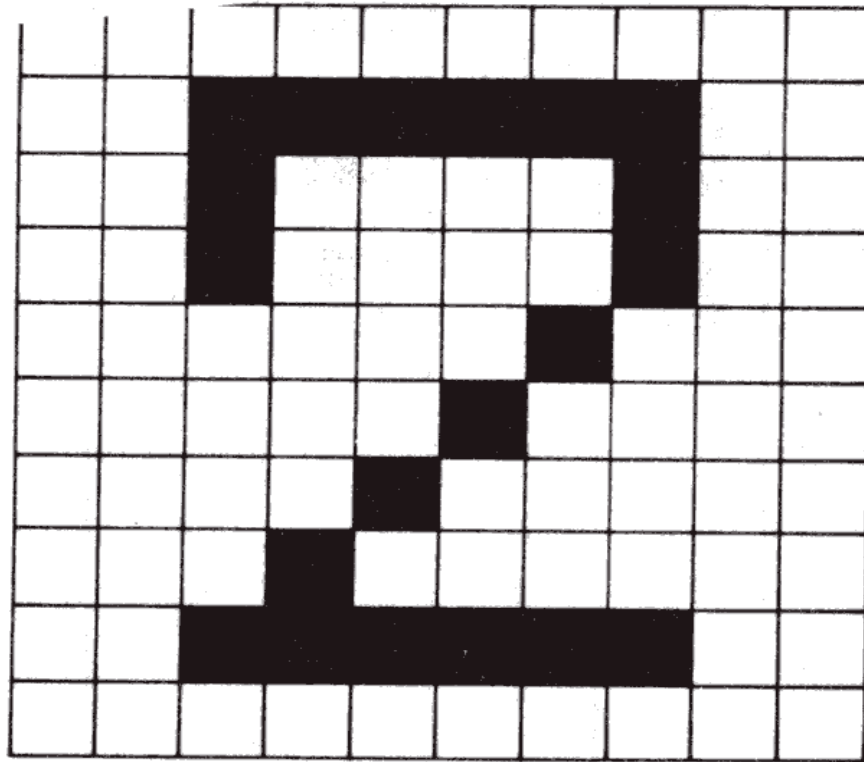
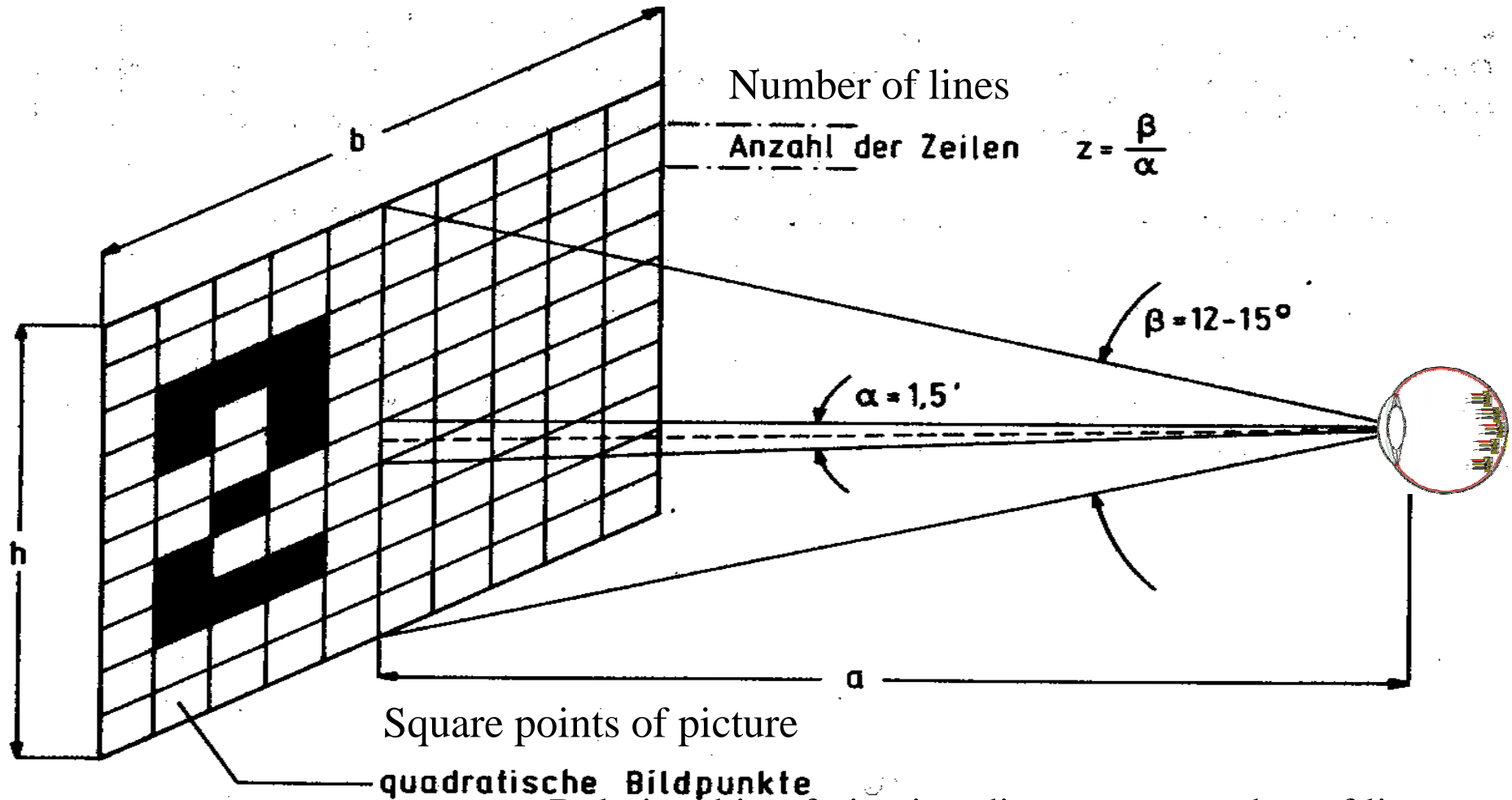


Abb. C3-8 Auflösung eines Bildes bei verschiedener Zeilenzahl

... 640x480 ? 800x600 ? 1024x768 ? 1280x1024 ? 1600x1200 ? 2048x1536 ...???

Resolution of human eye



Relationship of viewing distance to number of lines

Abb. C3-9 Abhängigkeit des Betrachtungsabstandes von der Zeilenzahl

Picture resolution for “standard hall” project

given: Projection surface $A_p = b_p * h_p = 7 \text{ m} * 5,25 \text{ m} = \text{ca. } 37 \text{ m}^2$

Resolution requirement???– a sensible example here:

Example : on assumption that 50 text lines to be shown → approx. factor 14 needed

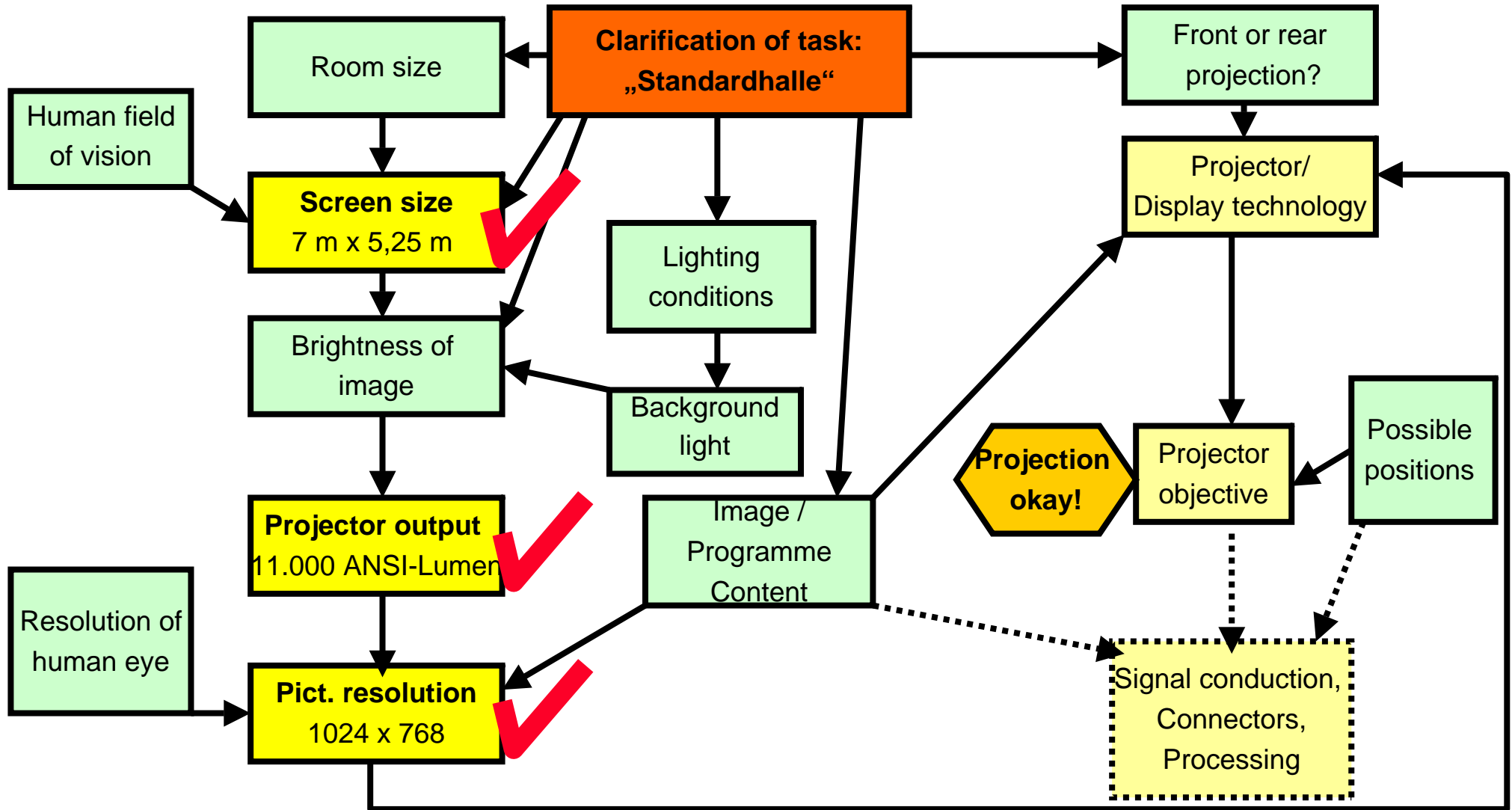
→ 50 lines of characters * 14 = 700 lines vertical resolution necessary

→ as example, requirements met with resolution of: 1024 * 768

→ Height of picture line = $h_p / \text{no. of vert. lines} = 5,25 \text{ m} / 768 = 6,8 \text{ mm}$

With this size of picture line then no individual lines of text will be distinguishable beyond about 16m ($\alpha=1,5'$) (Character height $6,8\text{mm} * 7 = 48 \text{ mm}$),

Flowchart of dimensioning process for projection



RGB-HV

RGBs

Y-CR-CB

SDI

S-VHS

Component

RGB



DVI

Y/C

VGA

Composit

Secam

NTSC

Betacam

NTSC

S-XGA

MPEG

Signals and data can for instance be divided up as follows:

Analogue Signals

- **RGB Component Signals**
- **TV and video signals**
- **Component-difference signals**

Digital Signals und Data

- **Digital RGB component signals**
- **Digital data streams**

The different picture signals and data formats, of course, also have different qualities of picture information.

The picture information here consists of:

- **Colour-brightness information for red, green and blue**
- **Sync Information**

Red-brightness information, R

Green-brightness information, G

Blue-brightness information, B

Horizontal-Sync H-Sync

Vertical-Sync V-Sync

There are many different kinds of RGB signals.

Most have the letters R G B in their name.

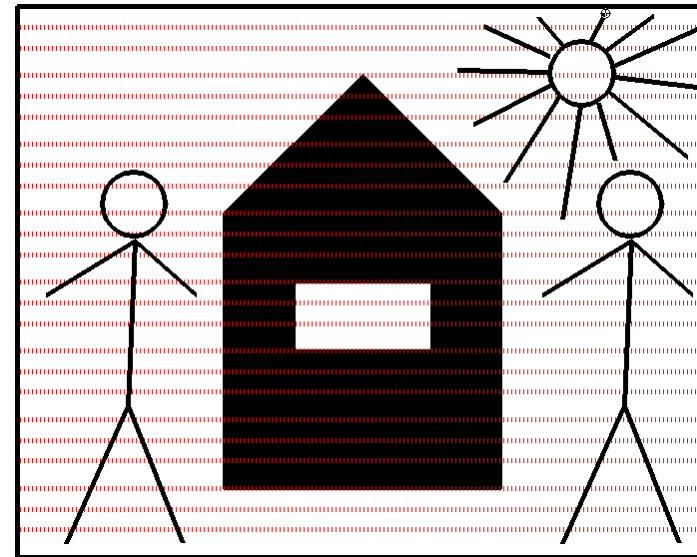
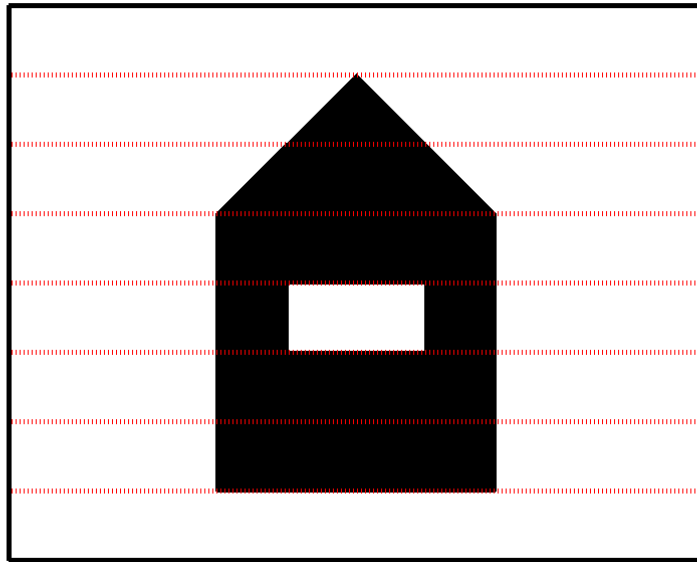
RGB-Signals are completely universal,

they are in no way stipulated for particular qualities or bandwidths, hence, for
example → VGA, SVGA, XGA, SXGA, QXGA, ...
→ 50 Hz, 60 Hz,, 100 Hz, ... everything is possible

that is also true in principle for **Video signals (F)BAS, Y/C, Y-Cr-Cb,**

but, here, agreed bandwidths and carrier frequencies are stipulated
according to CCIR or ITU TV norms such as PAL, NTSC, SECAM

Bandwidth as a function of resolution



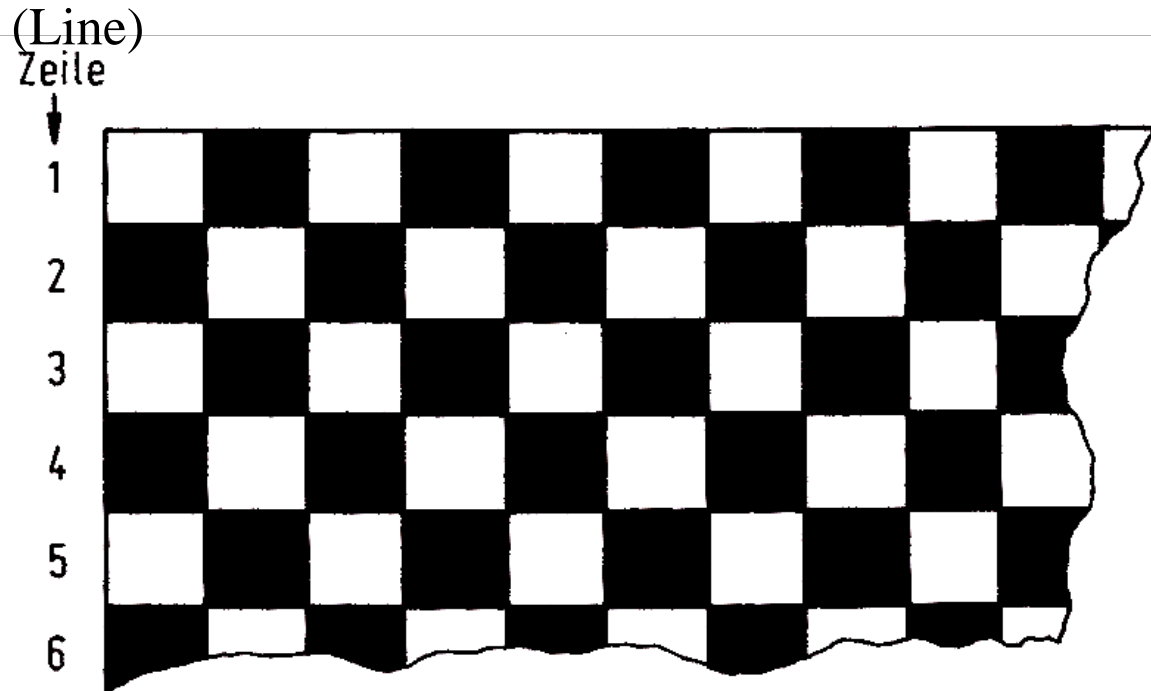
The more accurate the picture reproduction is to be,

- the greater the number of individual lines which need to be included
- the more quickly the sampling has to be able to follow a change of light and dark zones in each line

Bandwidth as a function of resolution

High fidelity of reproduction requires high resolution of sampling i.e.

- many lines per picture
- many light/dark swaps per line

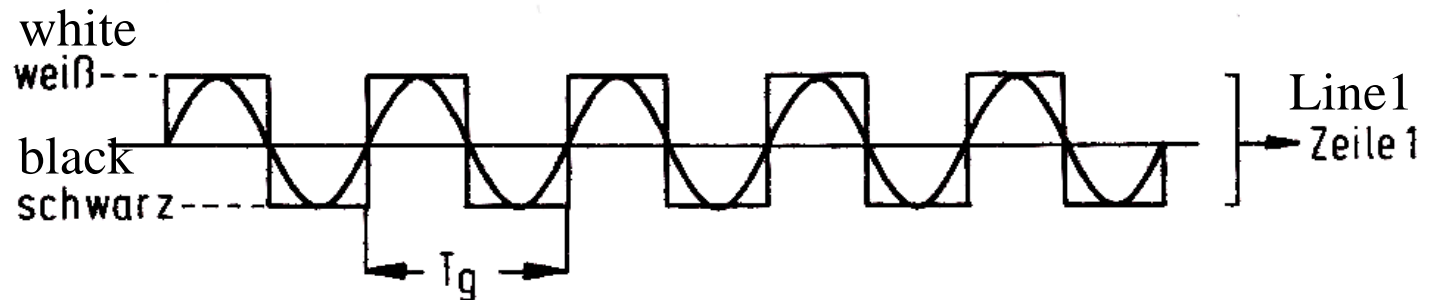


So the number of transmitted electrical oscillations per second increases:

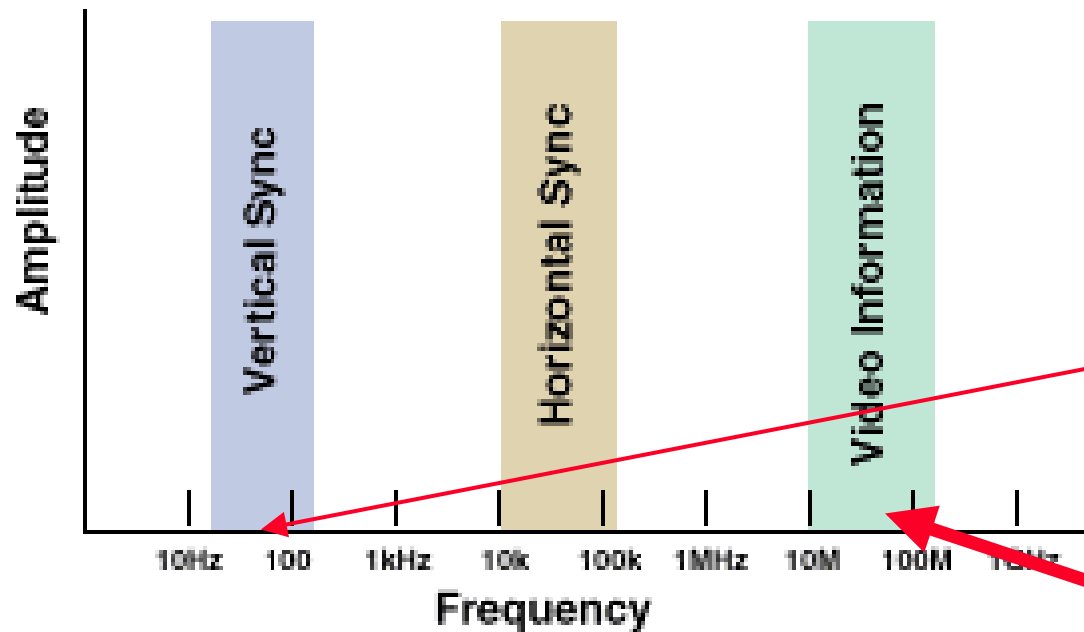
i.e.

High fidelity requires

high transmission frequencies!



Bandwidth for computer graphics output



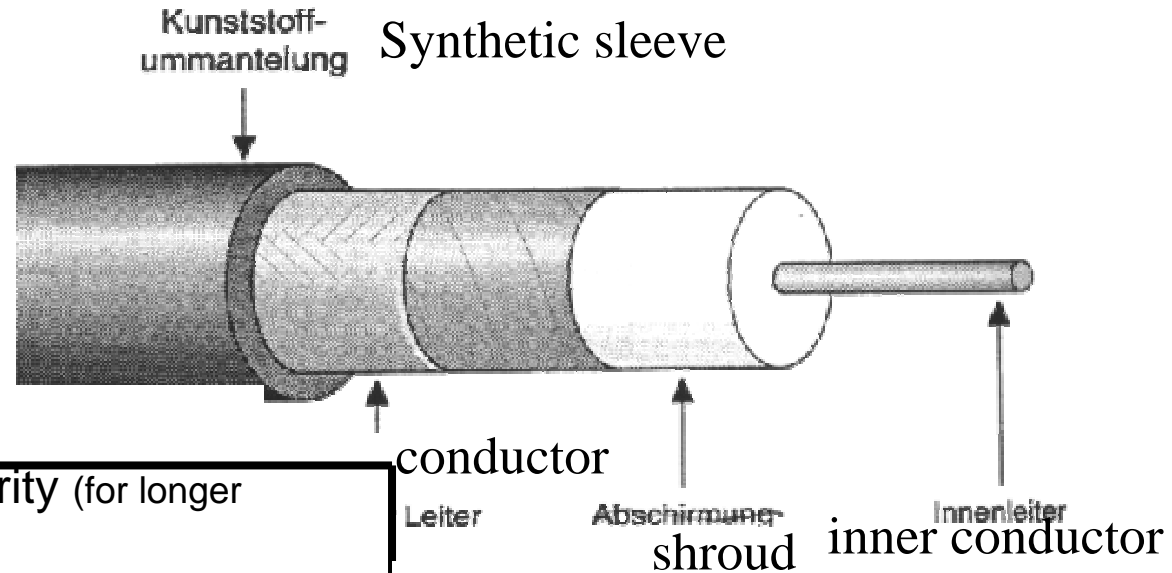
for example XGA
 resolution = 1024 x 768
 Picture refresh rate =
 70 Hz

Signal bandwidth.
 approx. 30 MHz

Video on the other hand:
 only approx. 5 MHz

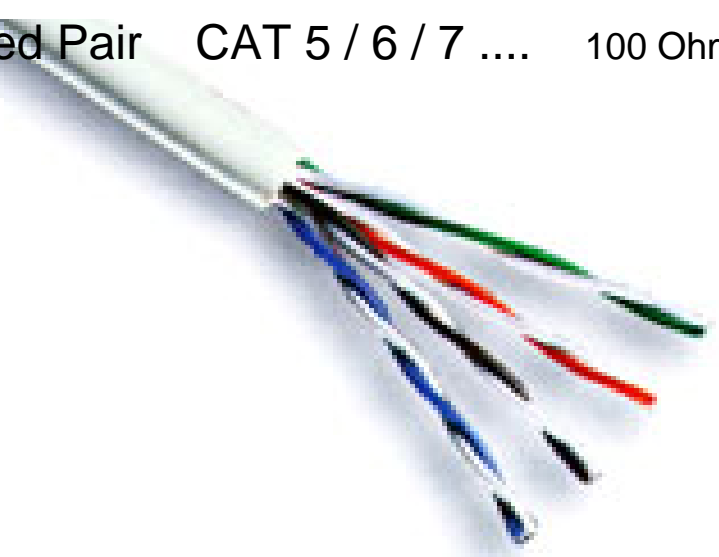
Typical picture transmission cables

classic:
copper coaxial cable
75 Ohm

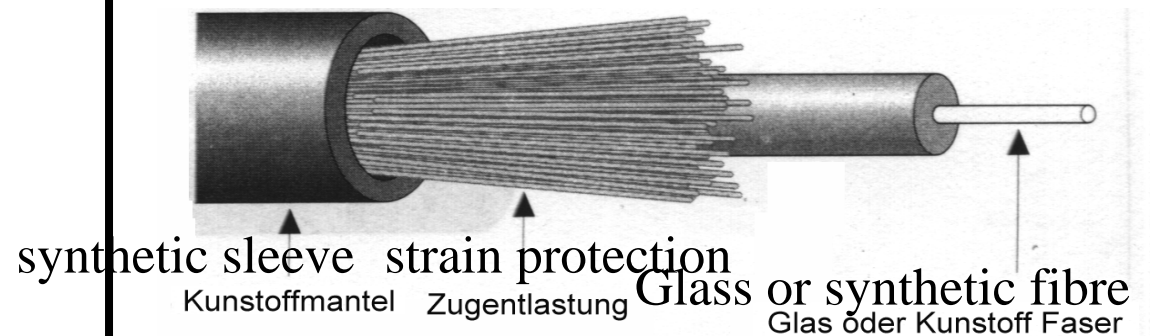


currently increasing in popularity (for longer distances) :

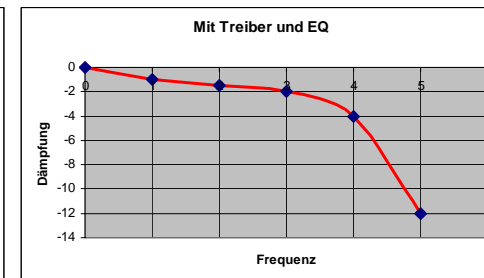
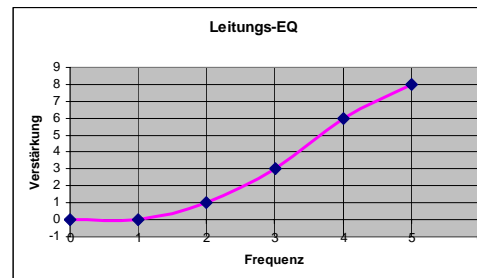
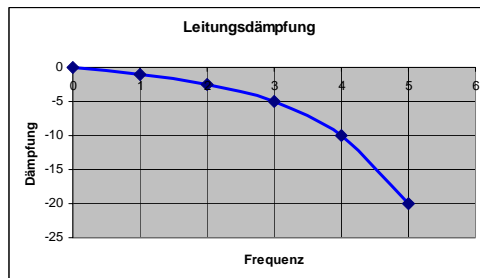
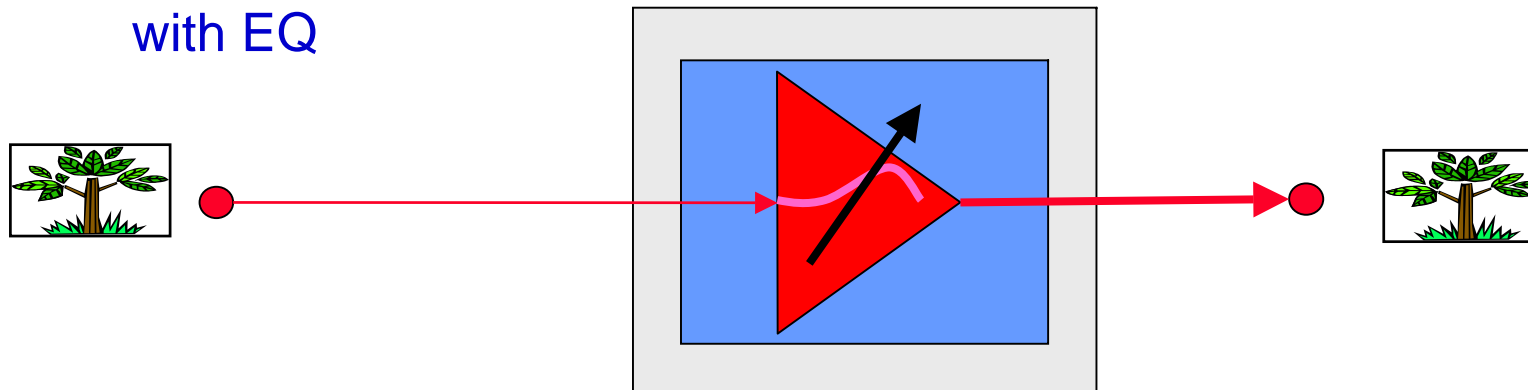
Twisted Pair CAT 5 / 6 / 7 100 Ohm



increasingly frequent (for long distances or the highest quality / bandwidth) :
fibre optic cable

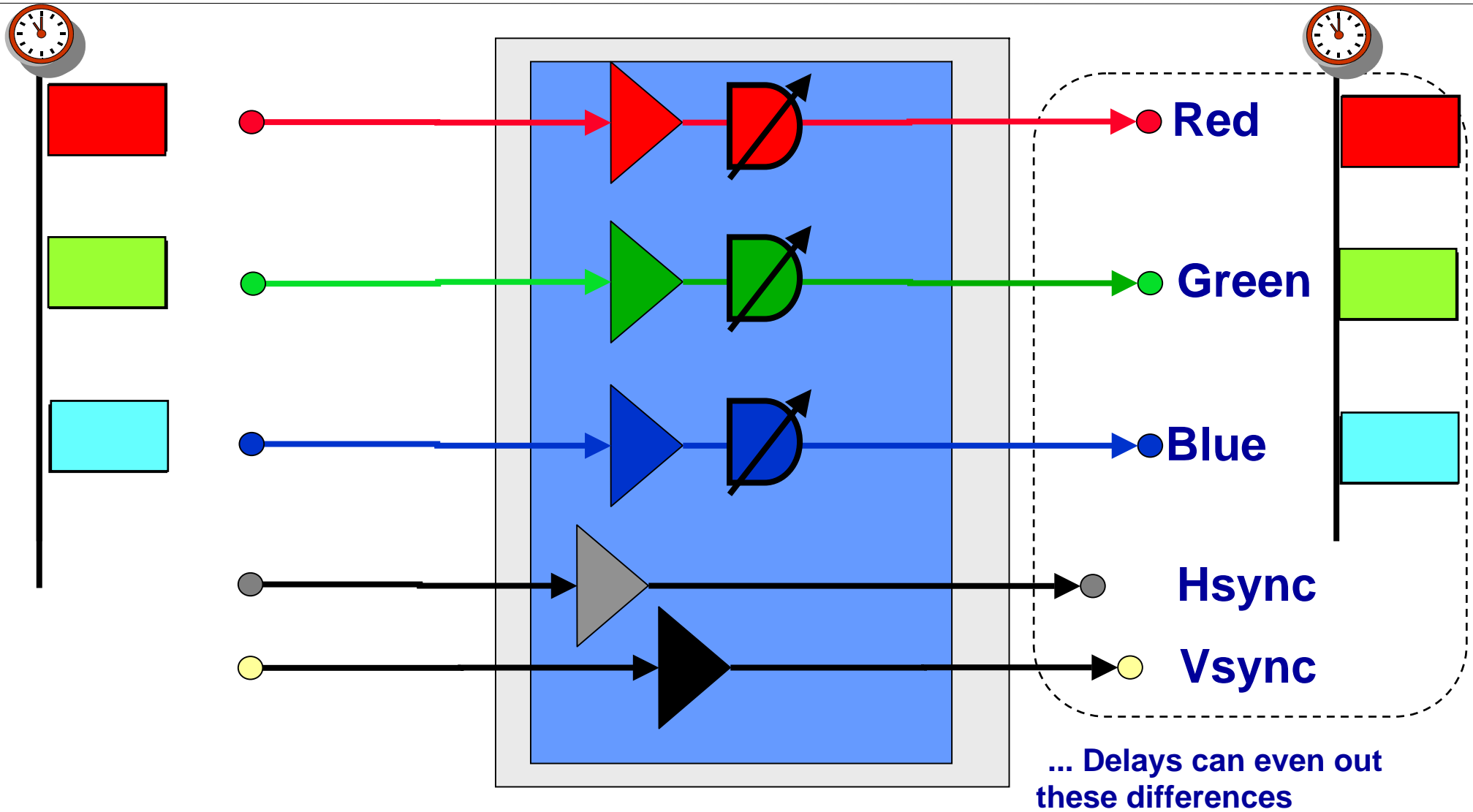


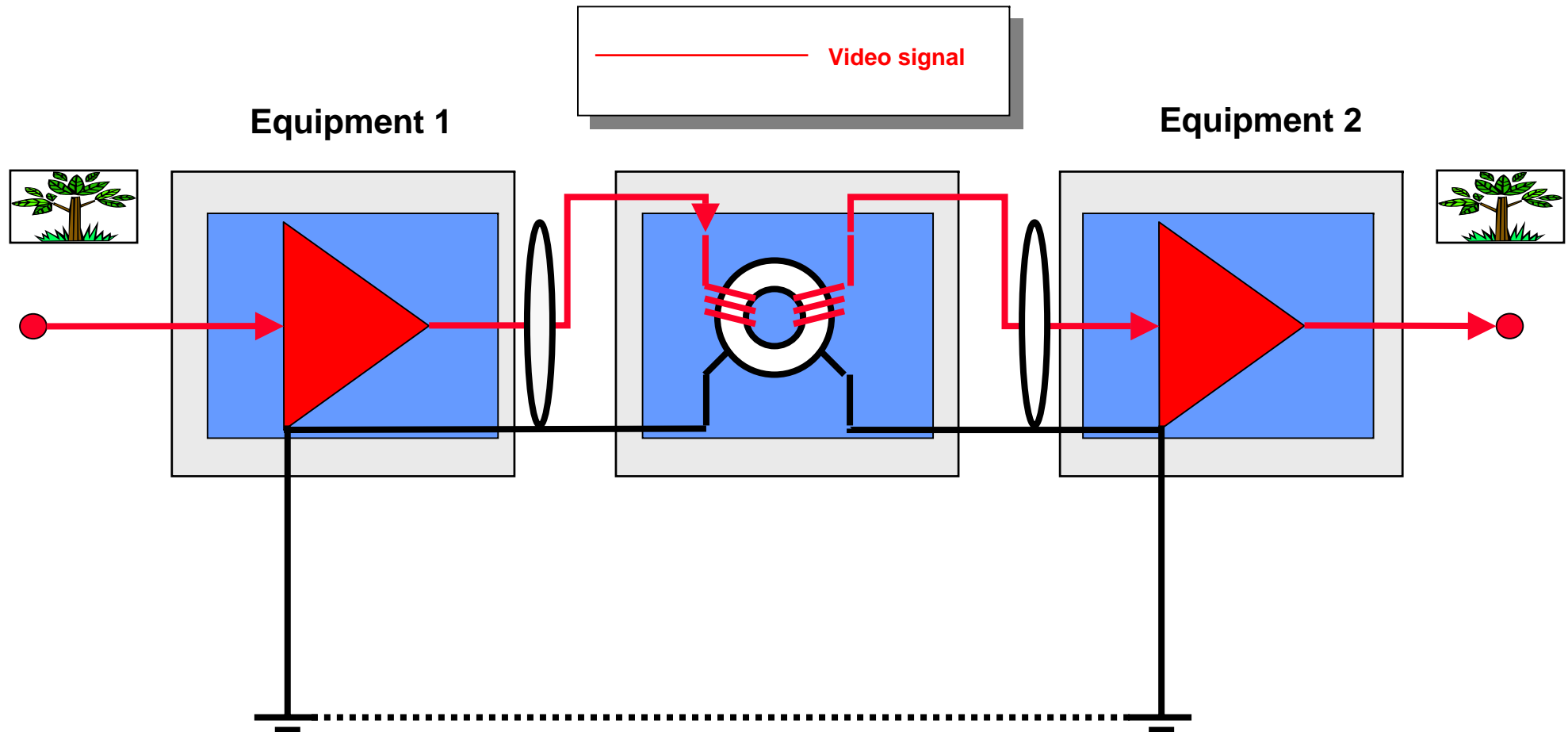
Line Driver Amp, "Interface"
with EQ



... amplify both across whole bandwidth
and selected frequency ranges of the picture signal which suffer
particular loss in the cabling

Line driver amp with delay

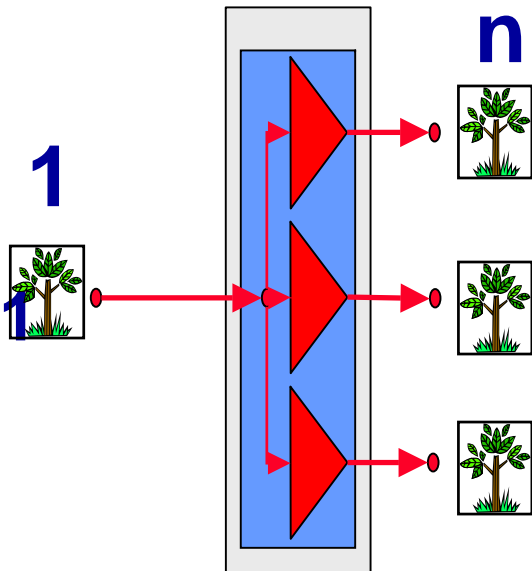




... galvanically isolate video signal to avoid hum loops e.g. via a transmission cable

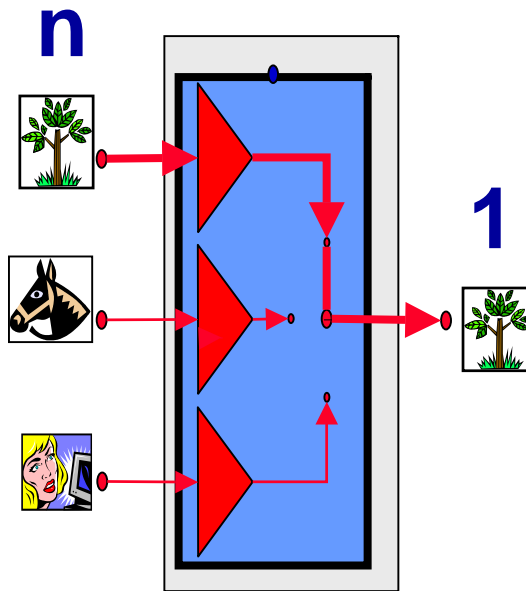
Signal manager

Distribution amp



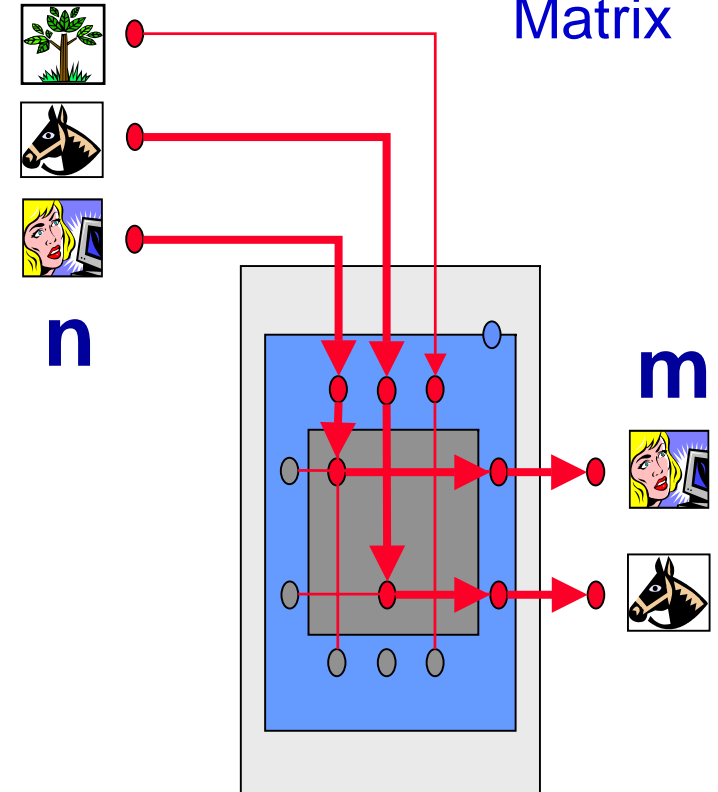
Distributes picture signals from 1 input
.... to n different outputs.

Switcher



Switches picture signals from n inputs
..... to 1 output

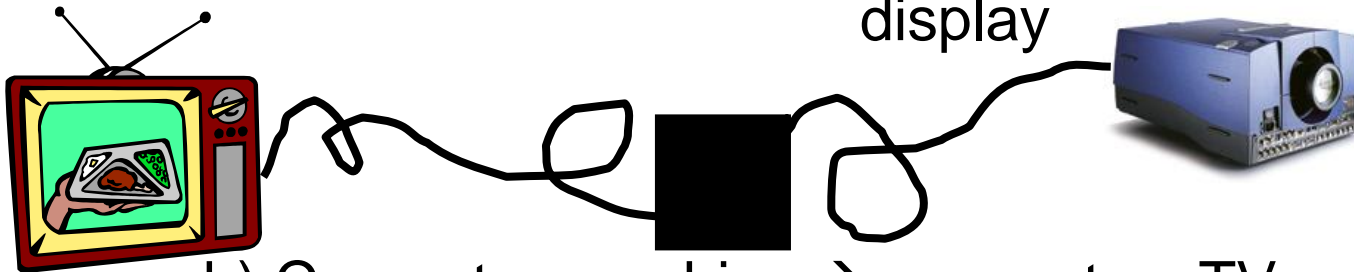
Matrix



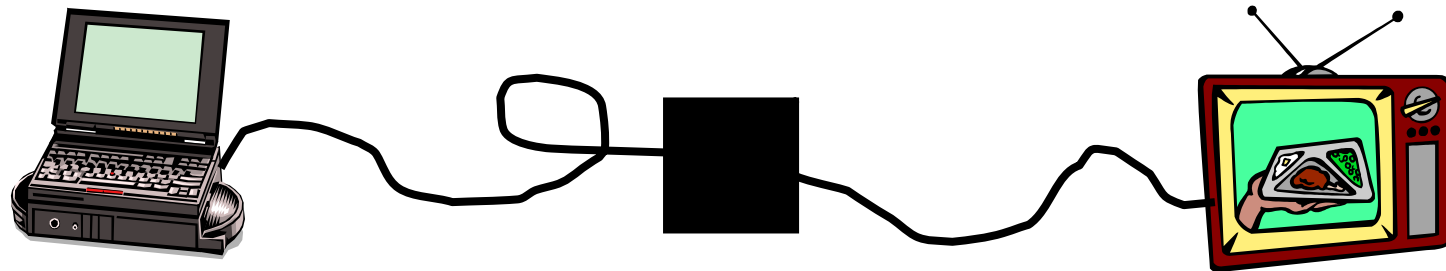
Switches picture signals from n inputs...
.... to m outputs,
simultaneously and independently of each other.

Why do you need a signal converter?

a) TV video picture → suggests a digital projector or graphics display



b) Computer graphics → suggests a TV monitor



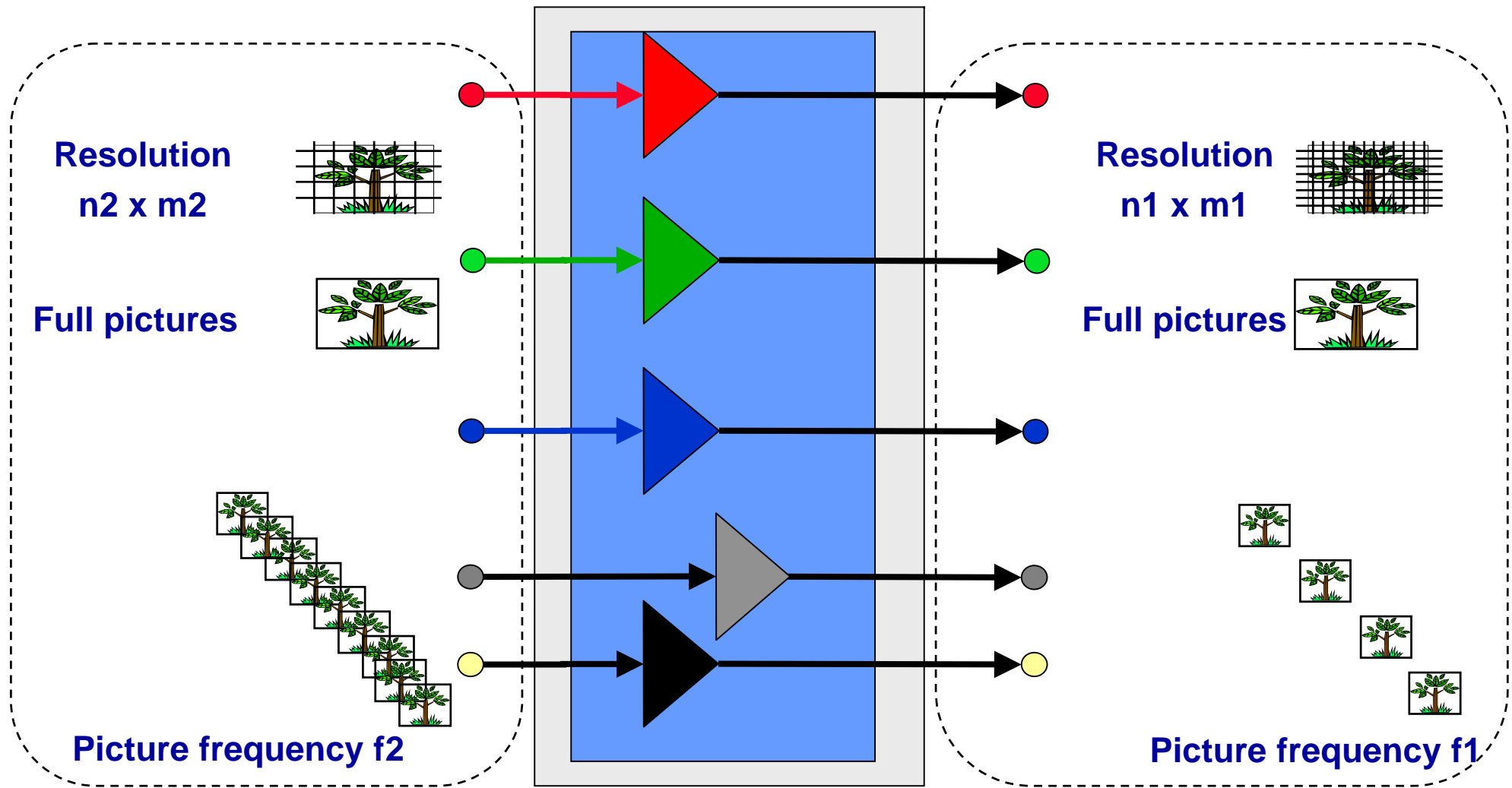
c) Computer graphics with particular resolution / refresh rate
→ suggests digital projector with other resolution / refresh rate

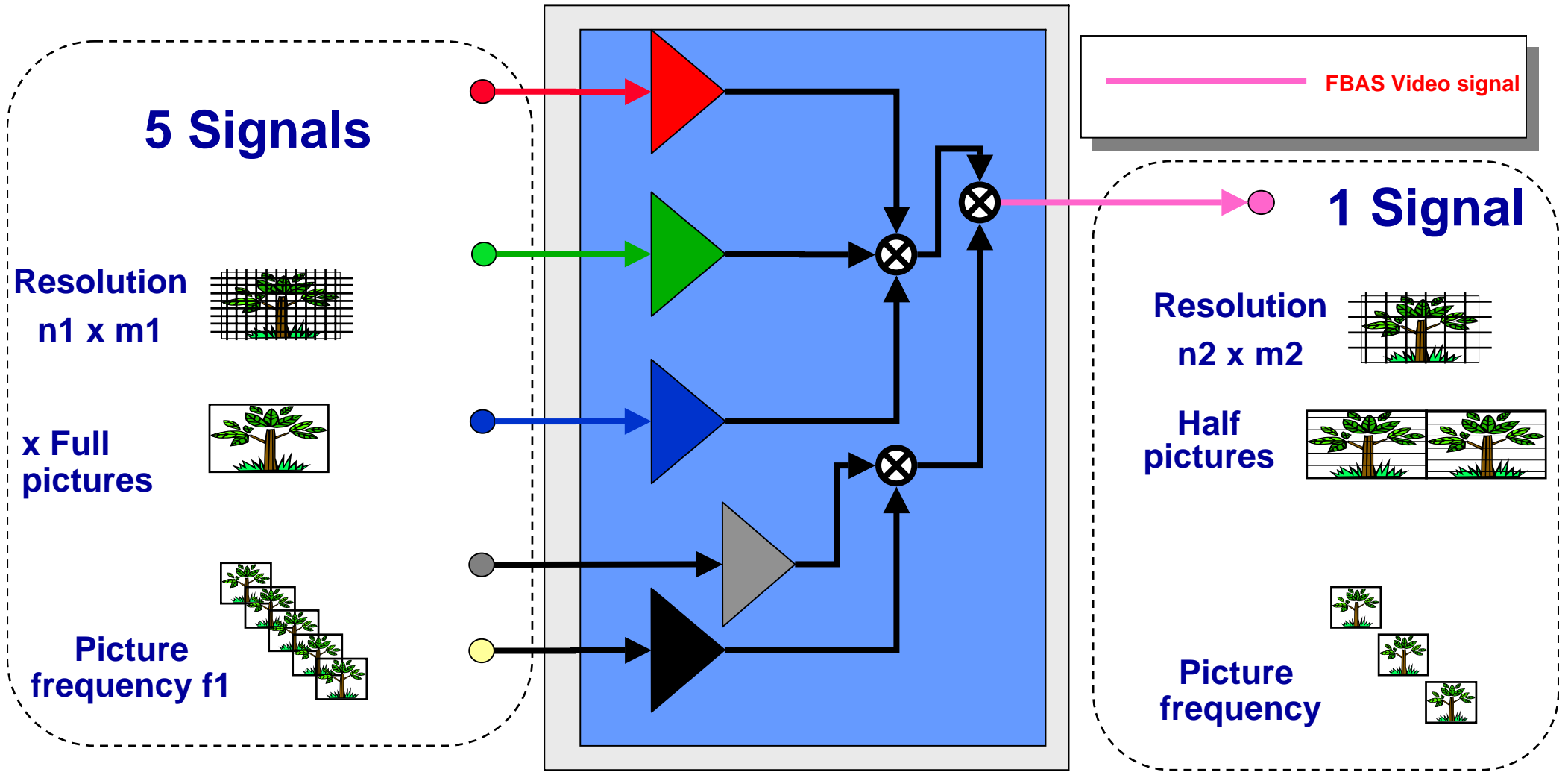


On conversion the following parameters can / should change:

- **Number of transmission channels**
- **Half pictures / full pictures**
- **Picture refresh rate**
- **Resolution (pixels, lines)**
- **Bandwidth (amount of data / frequency)**
- **Picture quality**

Because of the many different picture signals there is a large number of converters.





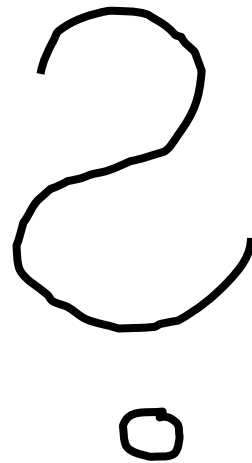
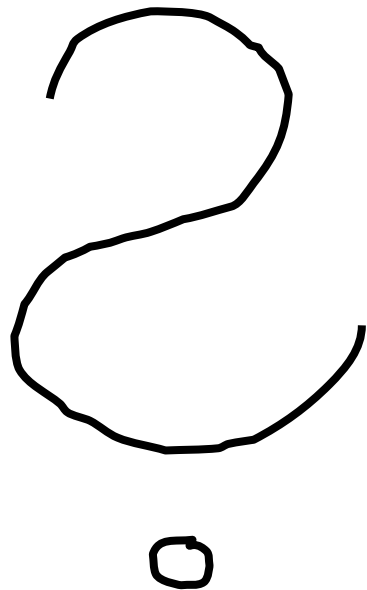
Finally a few rules in summary:

- appropriate screen sizes
can be established with simple rules (v. DIN 19045) for example: $R_{\text{max}} / 5$
 - the required light output of a projector (LUMENS) can be calculated:
from screen size and measured or estimated background/incidental lighting
 - the screen resolution required in a given situation
is principally dependent on how natural the image needs to look.
-

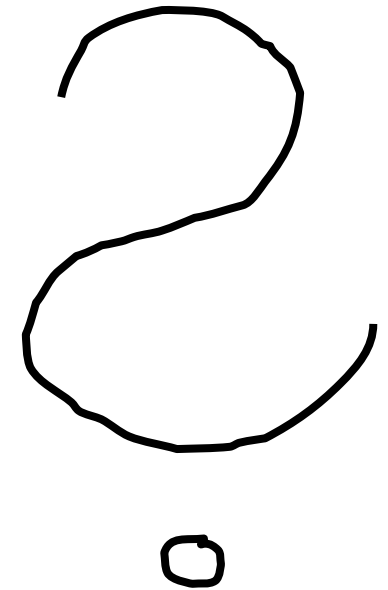
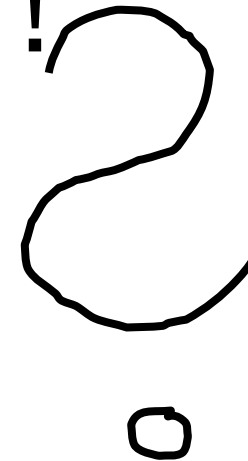
- video signals today are mostly still analogue and so prone to interference.
the “mother of all video signals” is R-G-B plus H- and V-Sync → 5 channels
 - Computer graphics always imply high bandwidth!
... the weakest link in the chain determines picture quality!
... high quality cabling with limited signal loss is important!
... use driver amps with EQ (and delay for RGB)!
-

Every signal conversion costs effort and money and degrades picture quality:
Use only if really necessary, but in that case high quality is a must.

... many thanks for your attention !



Questions ? !



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