OVERVIEW
COURSE FOR
STUDENTS OF
MANAGEMENT

COMPUTER GRAPHICS

WHO IS WHO: ME

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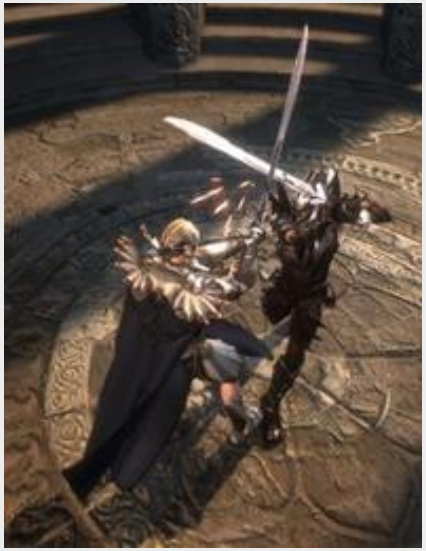
COMPUTER GRAPHICS AT FMPH

COMPUTER GAMES DEVELOPED BY OUR GUYS

Conan (Cauldron)
Elveon (10tacle)
Neverend (Mayhem)
Killzone series (Sony), ...





COMPUTER GRAPHICS AT FMPH

SOFTWARE DEVELOPED BY OUR GUYS

TrueSpace (Caligari, Microsoft)
Virtual Bratislava
MUVIS

WHO IS WHO: YOU

MANAGEMENT

Information technologies
Computer science

MANAGERS, DIRECTORS, ANALYSTS

WHY DO YOU NEED TO KNOW ABOUT CG?

Computer graphics is an important part of information technologies, modern media, research & development

ENCOUNTERS WITH COMPUTER GRAPHICS IN MOVIES

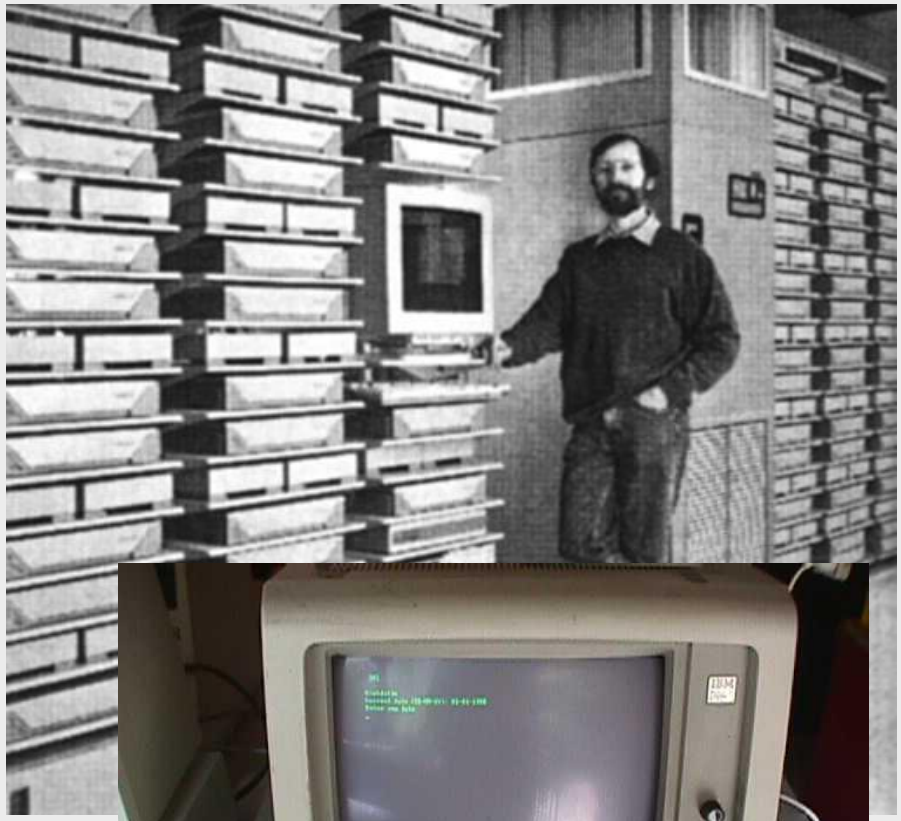
BEGINNINGS

STAR WARS (1977)
first 3D animation

TRON (1982)
15 minutes of CGI

WRATH OF KHAN (1982)
Particles, fractals

LUXO JR. (1986)
Shadows, Emotions

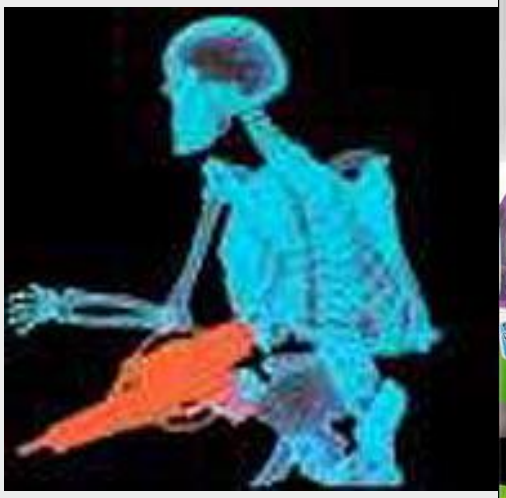


COMING OF AGE

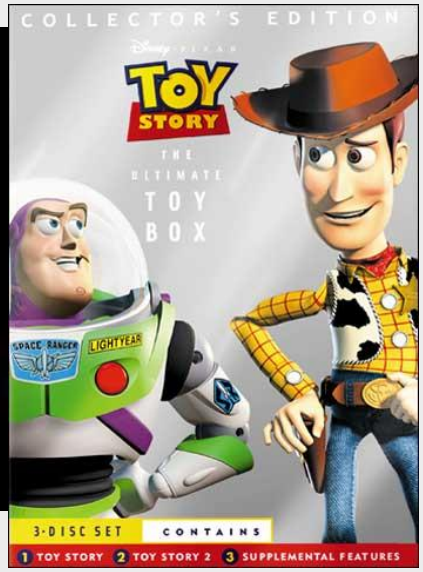
TIN TOY (1988)
animated Oscar

ABYSS (1989)
water rendering

TOTAL RECALL (1990)
motion capture



TOY STORY (1995)
Fully CG movie
$30 / $360 mil



MODERN AGE

LORD OF THE RINGS (2001)

Mass scenes
Facial motion capture

BEOWULF (2007)

Digital copies of actors

AVATAR (2009)

3D reinvented

COMPUTER GRAPHICS IN VIDEO GAMES

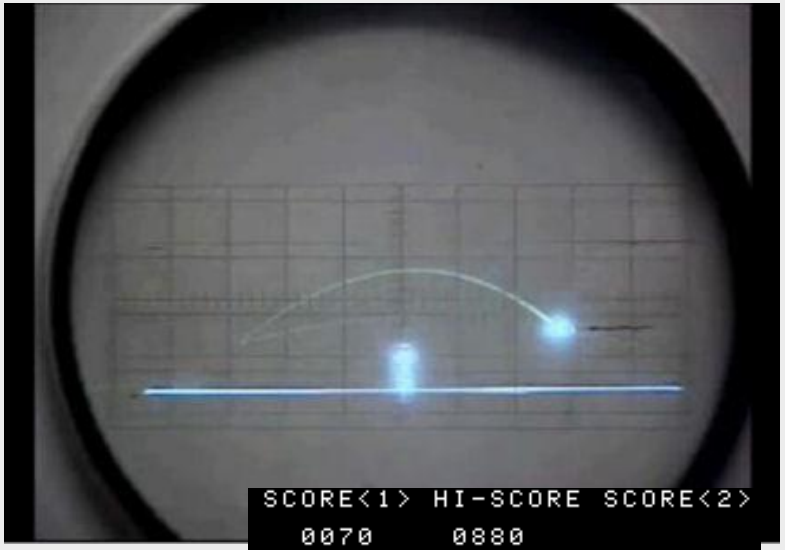
FIRST VIDEO GAMES

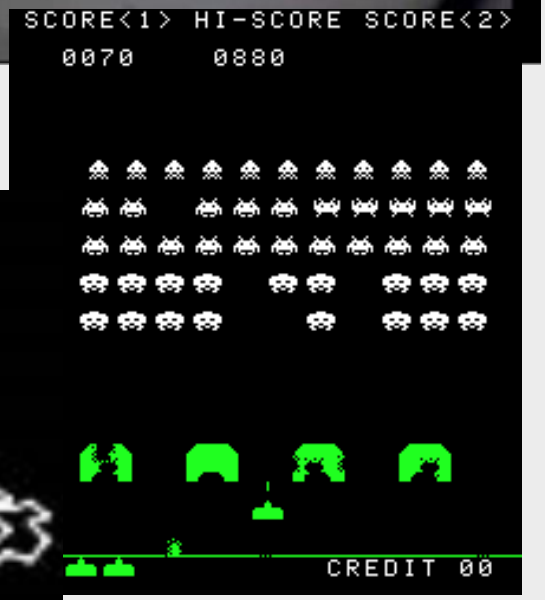
TENNIS FOR TWO (1958)
Oscilloscope

SPACEWAR! (1961)

SPACE INVADERS (1978)
raster graphics

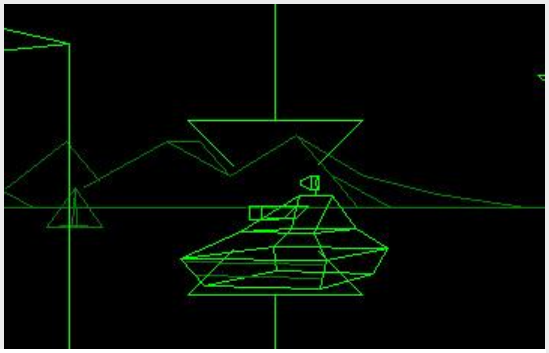
LUNAR LANDER, ASTEROIDS (1979)
vector graphics
vector displays



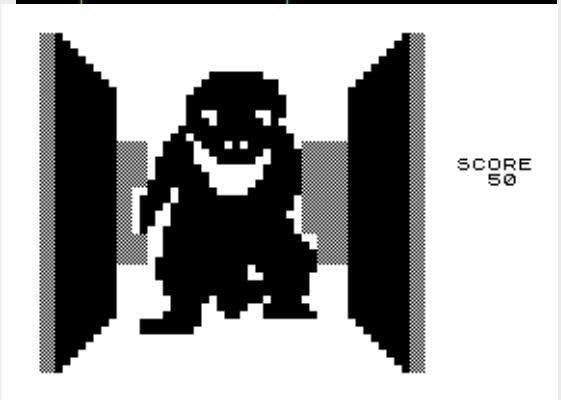


BEGINNINGS

BATTLEZONE (1980)
First 3D vector game



3D MONSTER MAZE (1981)
First 3D raster game



HOVERTANK3D (1981)
Raycasting

ULTIMA UNDERWORLD (1982)
Texture mapping

DAWN OF MODERN GAMES

QUAKE (1996)

real 3D space (free look in all 3 dimensions)
Gouraud shading, Lightmaps, HW acceleration

GAMES TODAY

Dynamic lights, soft shadows,
shader effects, normal maps, tesselation, parallax mapping, environment mapping, deferred shading, global illumination, raytracing...

GAMES NOW VS. MOVIES THEN

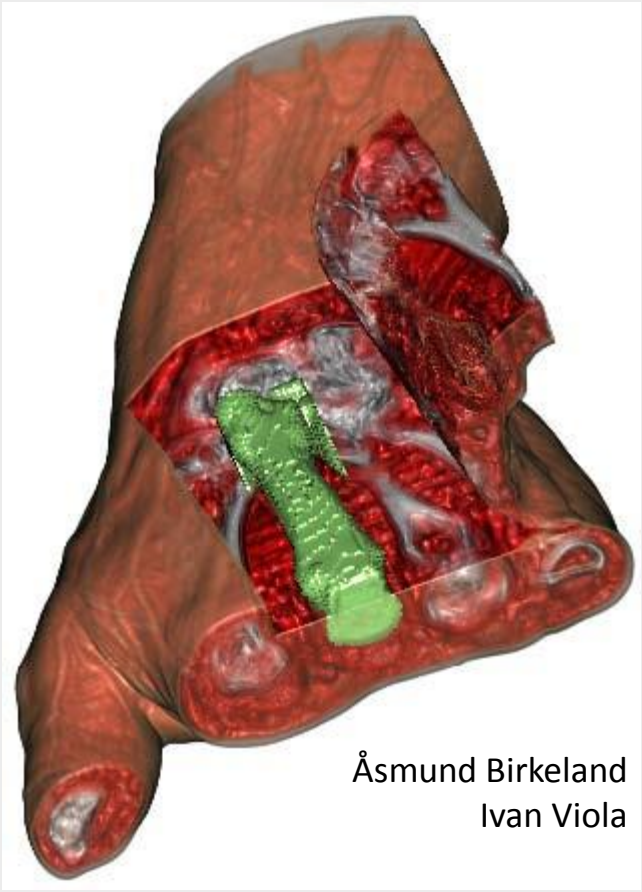
HEAVY RAIN
2010, 0.02 seconds

FINAL FANTASY
2001, 5400 seconds

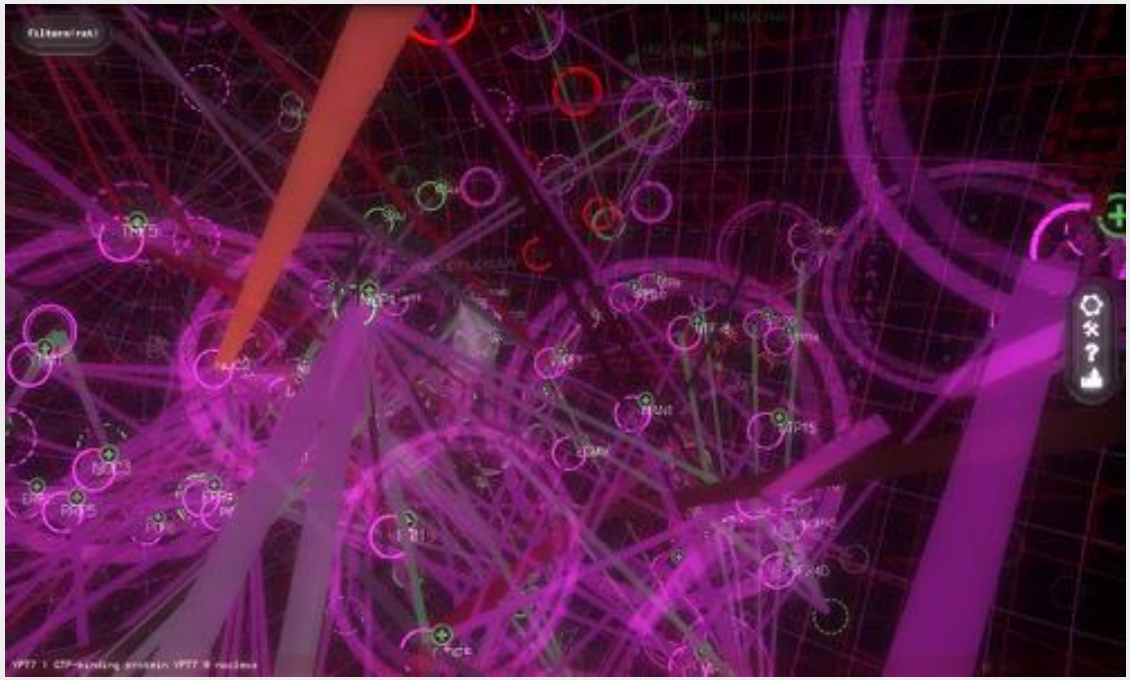
COMPUTER GRAPHICS IN INDUSTRY AND RESEARCH

SCIENCE, MEDICINE

Medical imaging
Scientific visualization
Information visualization



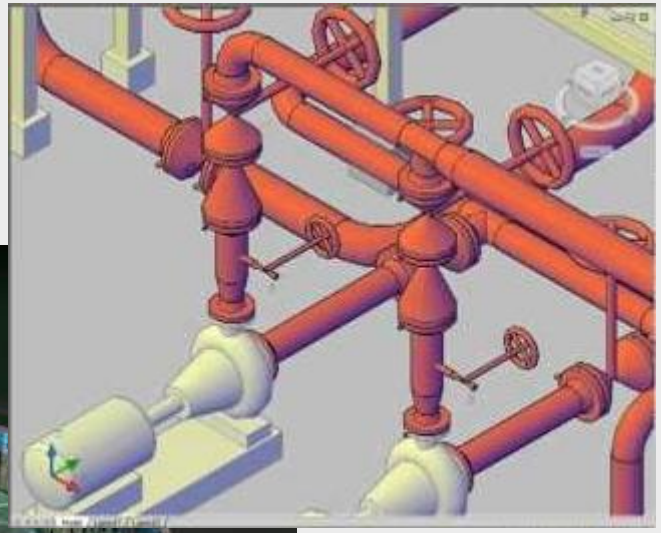
Åsmund Birkeland
Ivan Viola



Widjaja et al.
The Interactorium

INDUSTRY

COMPUTER AIDED DESIGN



OTHER APPLICATIONS

(GRAPHICAL) USER INTERFACES
VIRTUAL REALITY, AUGMENTED REALITY, ...

WHAT'S IT GOING TO BE ABOUT

COURSE OUTLINE

COURSE OUTLINE

RENDERING
MODELING & ANIMATION
INTERACTION
VISUALIZATION
MULTIMEDIA
IMAGE PROCESSING
GAME DEVELOPMENT
APPLICATIONS
GRAPHICAL HARDWARE

+ WHATEVER CG YOU'RE INTERESTED IN

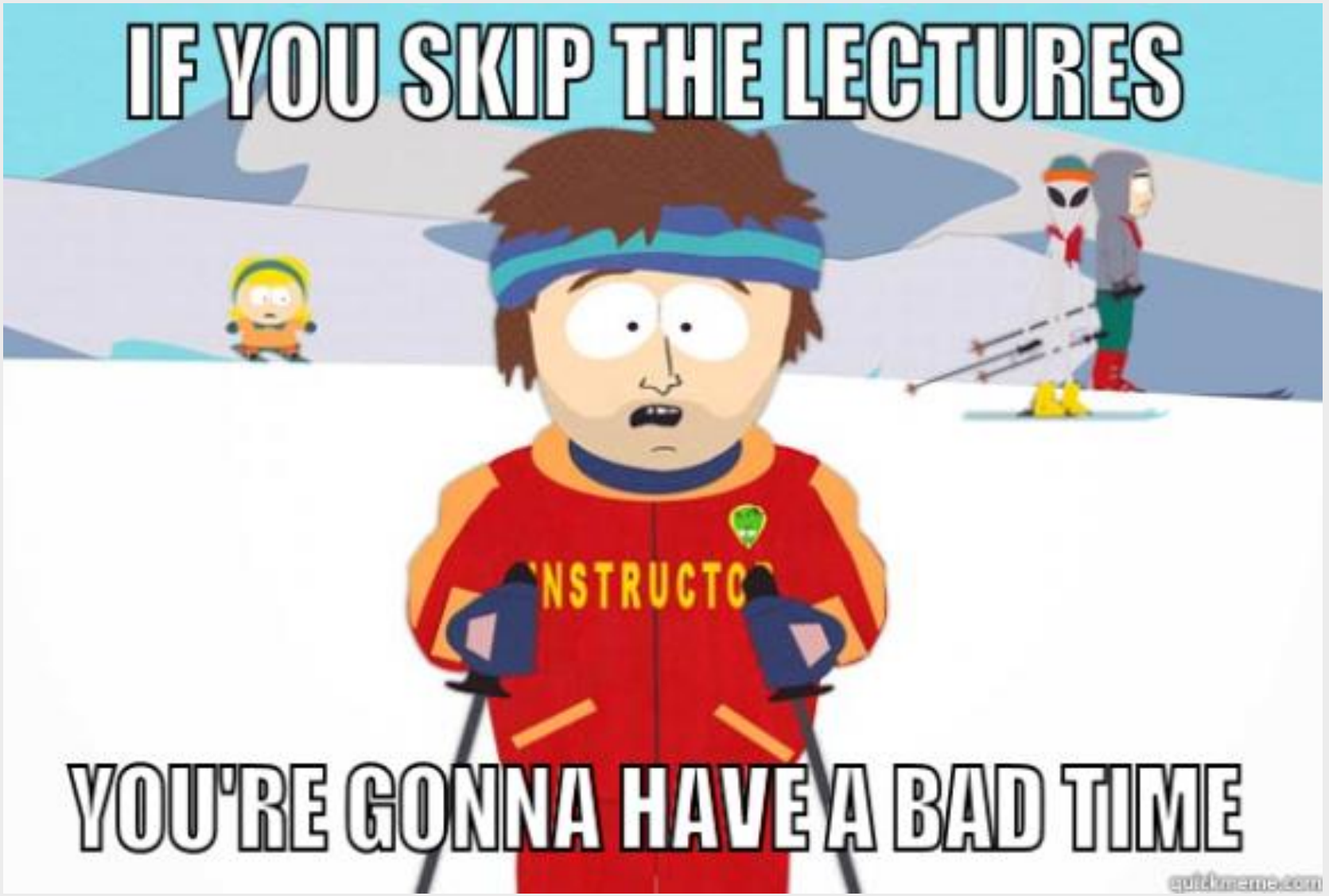
SOURCES

MODERNÍ POČÍTAČOVÁ GRAFIKA
Žára, Beneš, Sochor, Felkel:

THE COMPUTER GRAPHICS MANUAL
Solomon

COMPUTER GRAPHICS:
PRINCIPLES AND PRACTICE
Hughes, van Dam, McGuire, ...

BUT REMEMBER



EVALUATION + CONTACT

TEST (END OF SEMESTER)

LABS (SEVERAL 2D GRAPHICS TUTORIALS)

FINAL GRADE = AVERAGE (TEST, LABS)

CONTACT ME

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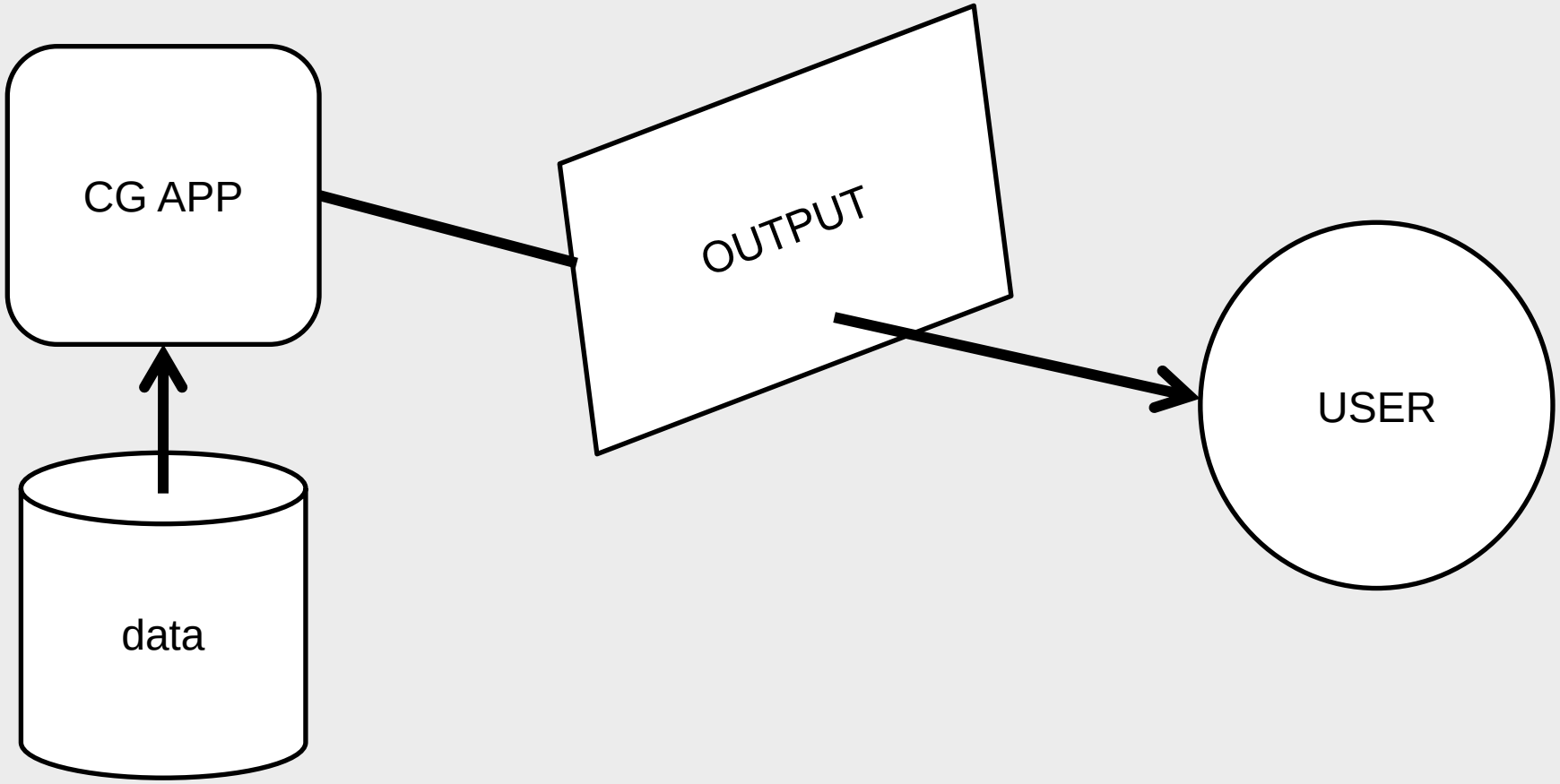
WEBSITE OF THE COURSE

HTTP://WWW.SCCG.SK/~MNOVOTNY/MIPG

GRAPHICAL SYSTEM

COMPUTER GRAPHICS TASK

DELIVER IMAGES FROM COMPUTER TO USER



EXAMPLE PROCESS

Program

Monitor

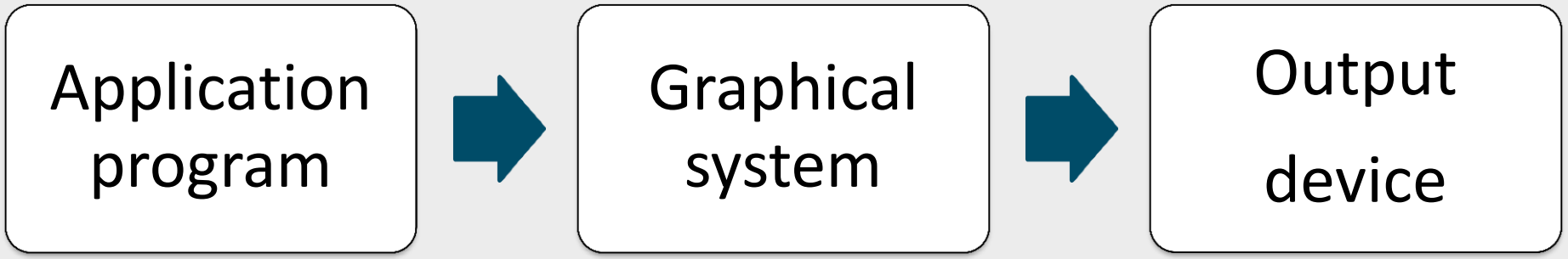
3D model, 2D shape,
animation, CT scan....

Printer, projector, plotter, movie file,
picture file, stereolitograph..

Platform

PC Win, PC Lin, Mac, SGI...
PS, XBOX, Wii, ...

COMPUTE GRAPHICS REFERENCE MODEL



INSIDE THE BOXES

code and technology

BETWEEN THE BOXES

standard interfaces

Separate modeling and rendering
Separate device-dependent and device-independent parts

REFERENCE MODEL – DETAILED

APPLICATION PROGRAM

Graphical data

Models, textures, description, mapping...

Animation

Scripted, procedural (physics), interactive

Application logic / business logic

DATA SOURCES

Modeling, capturing, simulation...

REFERENCE MODEL – DETAILED

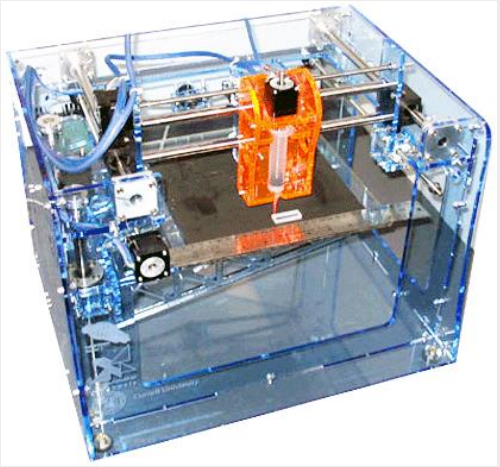
GRAPHICAL SYSTEM

Data processing (input, conversion)
Transformations
Projection
Clipping
Visibility
Lighting
Rasterization
Physics
Collision detection

REFERENCE MODEL – DETAILED

OUTPUT DEVICE

Device driver
Physical device
Output format



REFERENCE MODEL IN REAL LIFE

Application program

Graphical system

Output device

ADVANTAGES OF THE REFERENCE MODEL

DEVICE-INDEPENDENT APPLICATION DEVELOPMENT

APPLICATION-INDEPENDENT DEVICE DEVELOPMENT

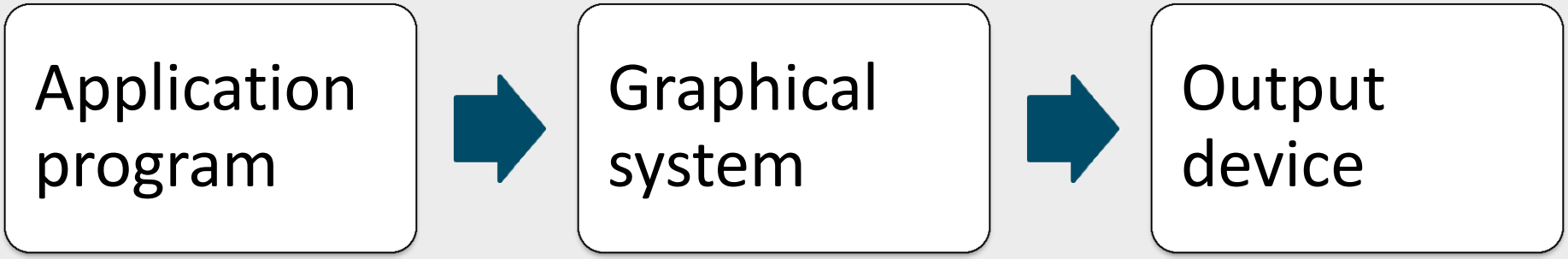
STANDARD INTERFACE GS ↔ DEVICE

Hardware acceleration, optimization

STANDARD INTERFACE APP ↔ GS

Rapid development, transferrable code

COMPUTER GRAPHICS REFERENCE MODEL



WHAT GOES ON ON THE OUTPUT SIDE

DIGITAL IMAGERY FUNDAMENTALS

BASIC VISUAL STIMULI

GEOMETRY
COLOR
MOTION

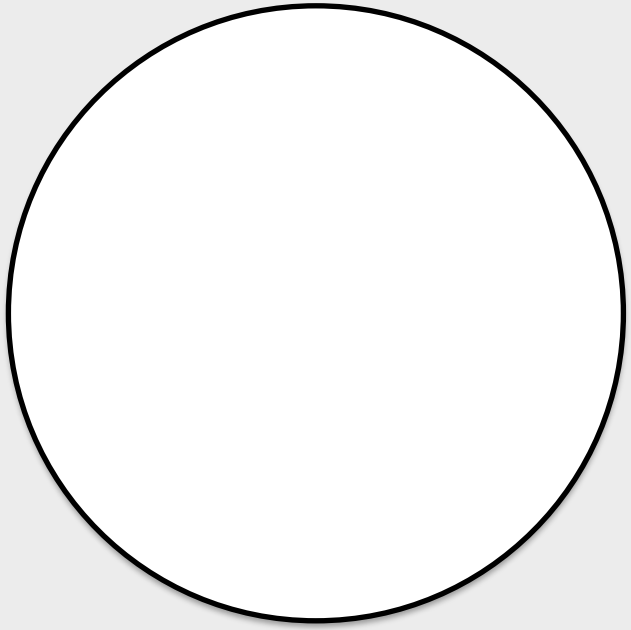


IMAGE SIGNAL

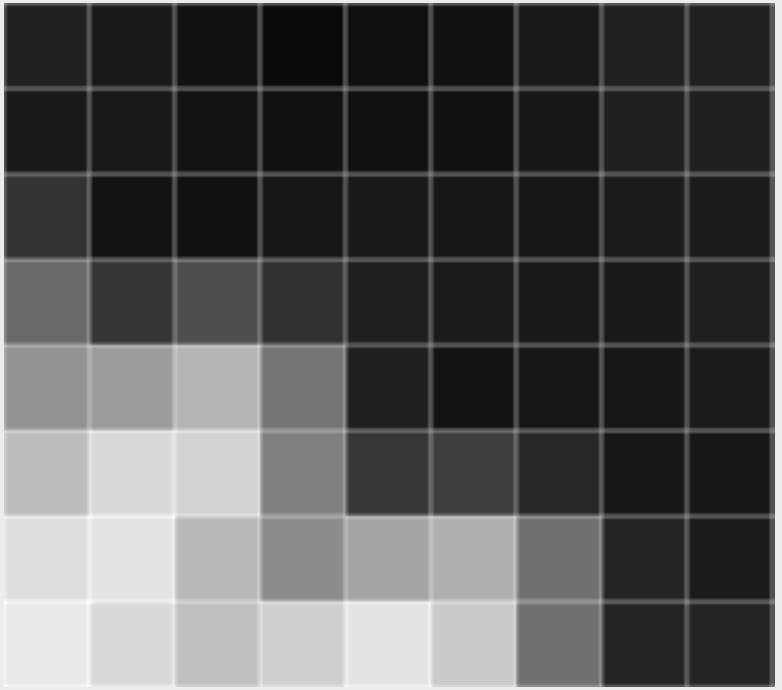
CONTINUOUS (ANALOG) VS. DISCRETE (DIGITAL)

DISCRETE REPRESENTATION

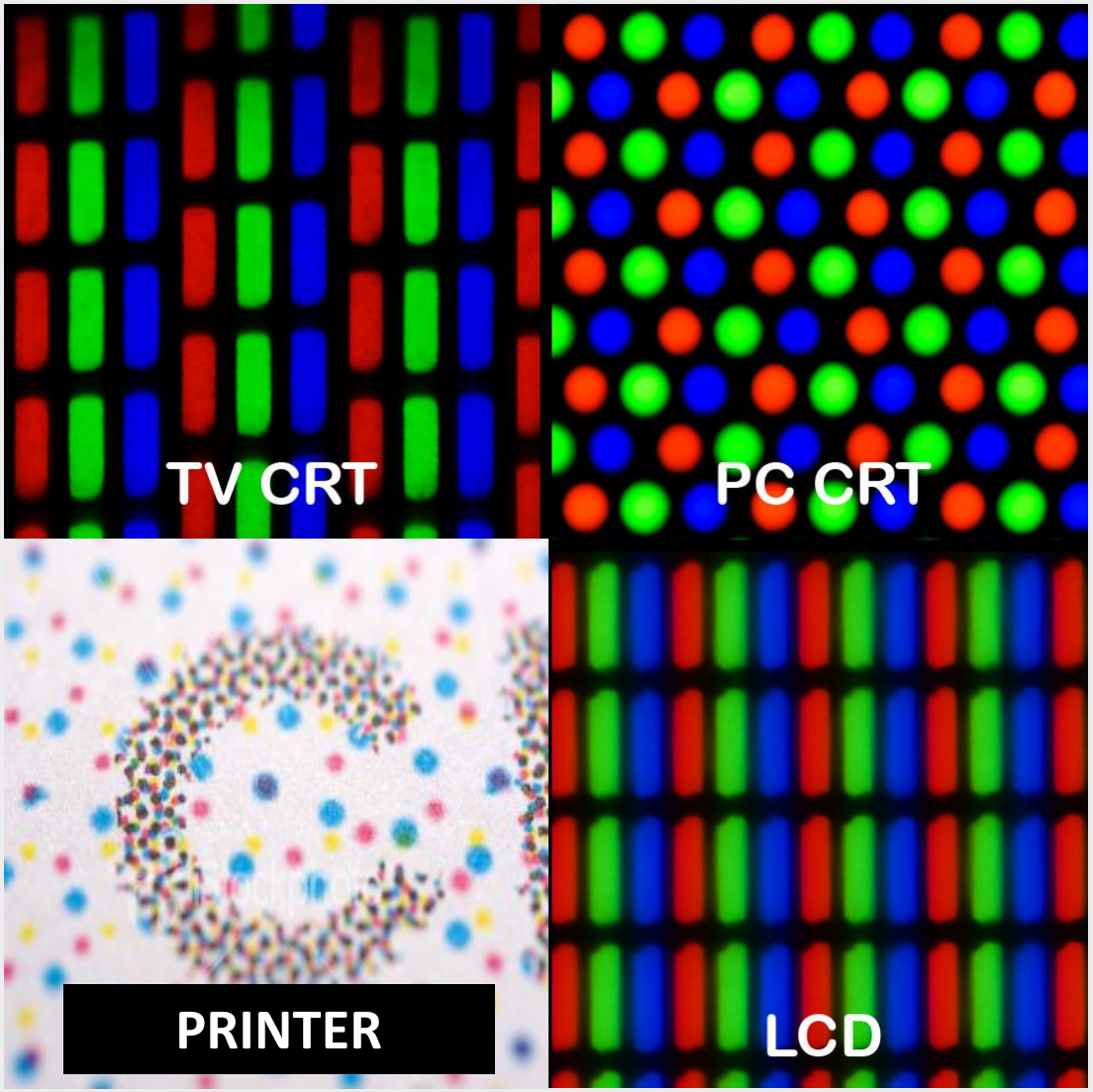
PIXEL = PICTURE ELEMENT

IMAGE RESOLUTION =
DIGITAL SIZE : PHYSICAL SIZE

DPI, PPI (dots per inch, points)
72 - 130 dpi (monitors)
150 - 600 dpi (print)
600 - 1200 dpi (scanners)



DEVICES CLOSE-UP



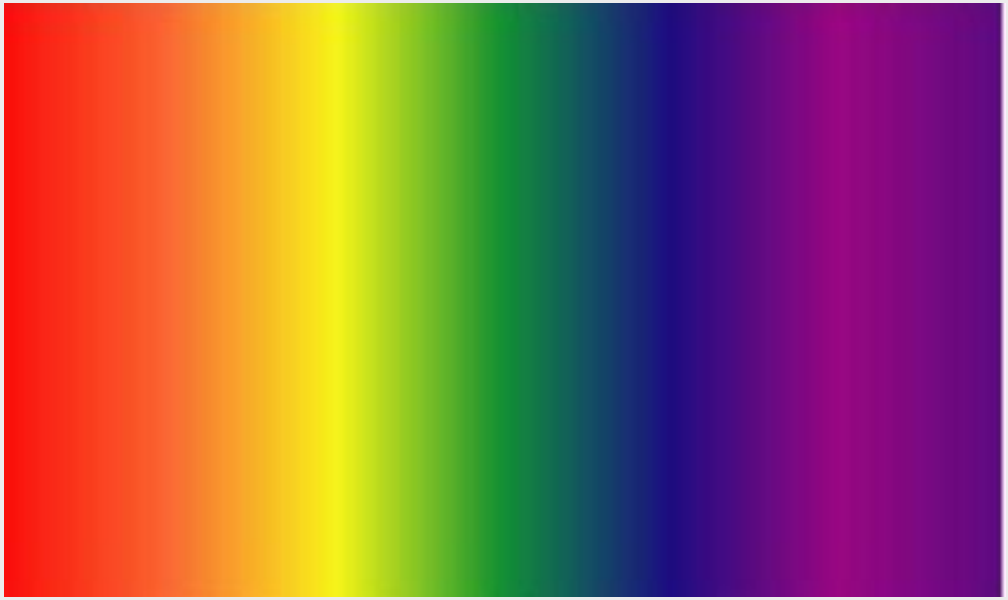
COLOR

COLOR DEPTH 4BIT

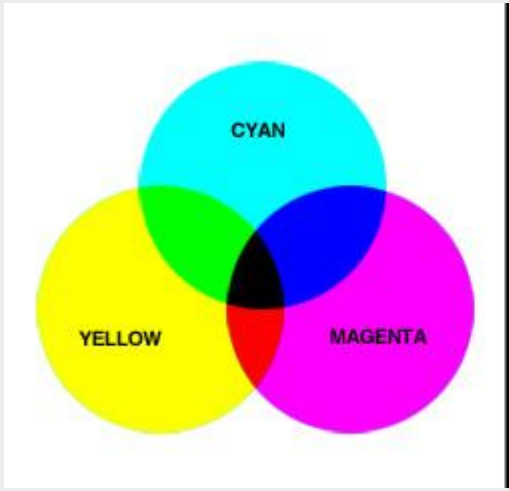
Lenna Sjööblom, miss November 1972

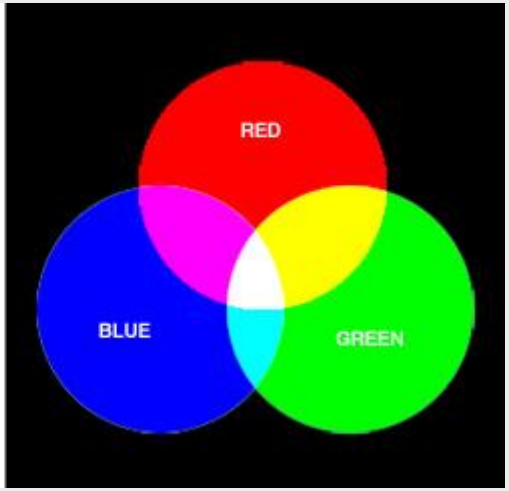
COLOR GENERATION

VISIBLE SPECTRUM
infinite colors



REAL DEVICES
mixing from RGB/CMYK





DIGITAL COLOR REPRESENTATION

R-G-B

e.g. palette mode (remember GIFs ?)

e.g. 24 bit colors, each pixel = 8 + 8 + 8 bits =

= 0..255 red, 0..255 green, 0..255 blue

C-M-Y-K

OTHER COLOR MODELS: HSV, YUV

MOTION

CONTINUOUS (ANALOG) VS. DISCRETE (DIGITAL)

Eadweard Muybridge – The Horse in Motion (1878)

GRAPHICS IN NUMBERS

IMAGE SIZE

128x176 (mobiles) - 1920x1080 fullHD
1600x1200 (2mpix), 2480x3508 (A4@300dpi)

COLOR DEPTH

1 bit (black/white), 8bit (256 colors)
16bit (65 536 color), 24bit (16.7 million)

FRAME RATE, REFRESH RATE

15fps, 24fps, 30fps
50hz, 60hz, 100hz, 120hz

THE ULTIMATE TASK OF COMPUTER GRAPHICS

HOW MANY IMAGES ARE THERE?

1920 X 1080 PIXELS

24BIT = 16777216 COLORS

THAT MAKES IN TOTAL: 35×10^{12} IMAGES

THE ULTIMATE TASK OF COMPUTER GRAPHICS:
Select which out of the 35×10^{12} has to be displayed

... AND PREFERABLY IN REAL-TIME