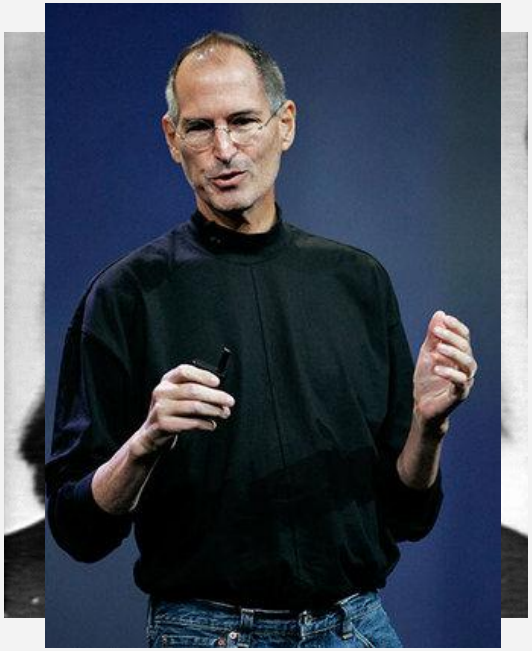
Graphical systems, visualization and multimedia

Who is who: Part 1 – Me

- Matej Novotný, I-4
- To: mnovotny@sccg.sk
- Subject: GSVM blah blah blah
- More:
  - Web graphics 1-INF-550
  - Information visualization 2-AIN-262

Who is who: Part 2 – You

- Future developers, analysts, researchers, visionaries, authors, consultants, experts



Steve Jobs, Apple

Bill Gates, Microsoft

FMFI UK @ CG

- trueSpace (ex-Caligari, now Microsoft)

FMFI UK @ CG

- Computer games:
  - Conan (Cauldron), Elveon (10tacle), Neverend (Mayhem), Killzone (Guerrilla Games), ...

FMFI UK @ CG

- Virtual Bratislava, Multimedia Historic Bratislava
- MUVIS

The name of the game

- **Graphical systems**
  - rendering, interaction, 3D objects, animation,
  - APIs, CG reference model, rendering pipeline
- **Visualization**
  - Scientific, medical, illustrative visualization, infovis, augmented reality
- **Multimedia**
  - Audio/video formats
  - New media: virtual reality & real virtuality

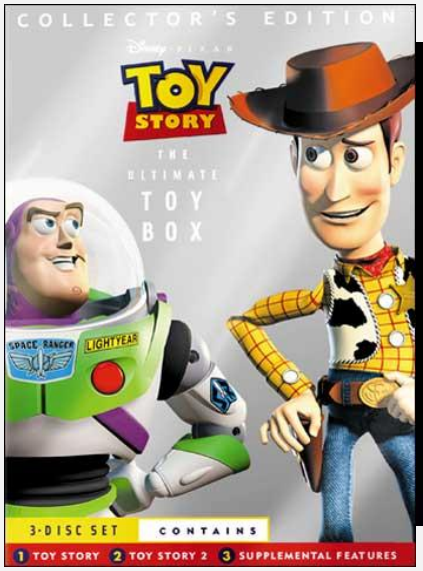
Development of CG

... in movies

- Star Wars (1977)
  - first 3D animation
- Tron (1982)
  - 15 minutes of CGI
- Wrath of Khan (1982)
  - Particles, fractals
- Luxo Jr. (1986)
  - Shadows
  - Emotions

... in movies

- Tin Toy (1988)
  – animated Oscar
- Abyss (1989)
  – water rendering
- Total Recall (1990)
  – motion capture
- Toy Story (1995)
  – fully CG movie

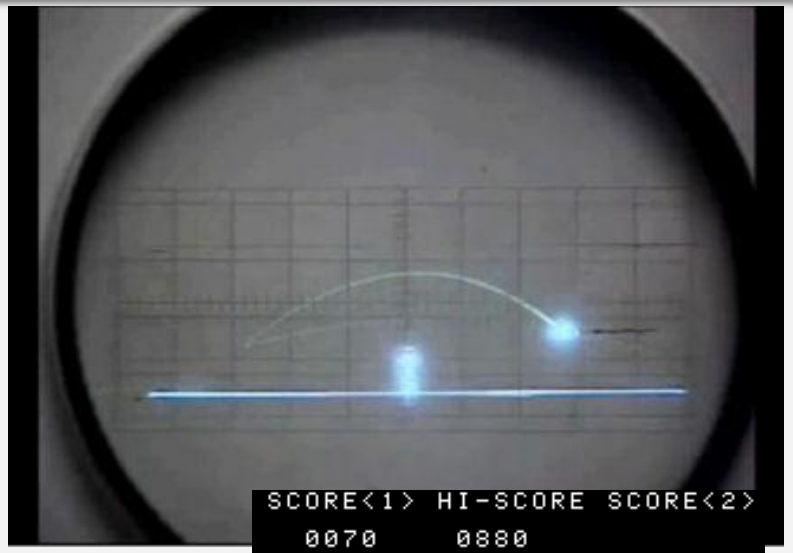


... in movies (today)

- Lord of The Rings (2001)
  - mass scenes
  - facial motion capture
- Beowulf (2007)
  - digital copies of actors
- Avatar (2009)
  - 3D

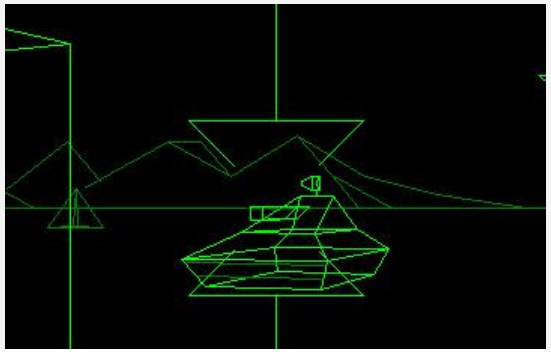
... in games

- Tennis For Two (1958)
  - oscilloscope
- Spacewar! (1961)
- Space Invaders (1978)
  - raster graphics
- Lunar Lander, Asteroids (1979)
  - vector graphics
  - vector displays



... in games

- Battlezone (1980)
  - First 3D vector game
- 3D Monster Maze (1981)
  - First 3D raster game
- Hovertank3D (1981)
  - Raycasting
- Ultima Underworld (1982)
  - Texture mapping



... in games

- Quake (1996)
  - real 3D (vertical axis look), Gouraud shading
  - Lightmaps

... in games (today)

- Dynamic lights, soft shadows, shader effects, normal maps, tesselation, parallax mapping, environment mapping,...

Games now vs. Movies then

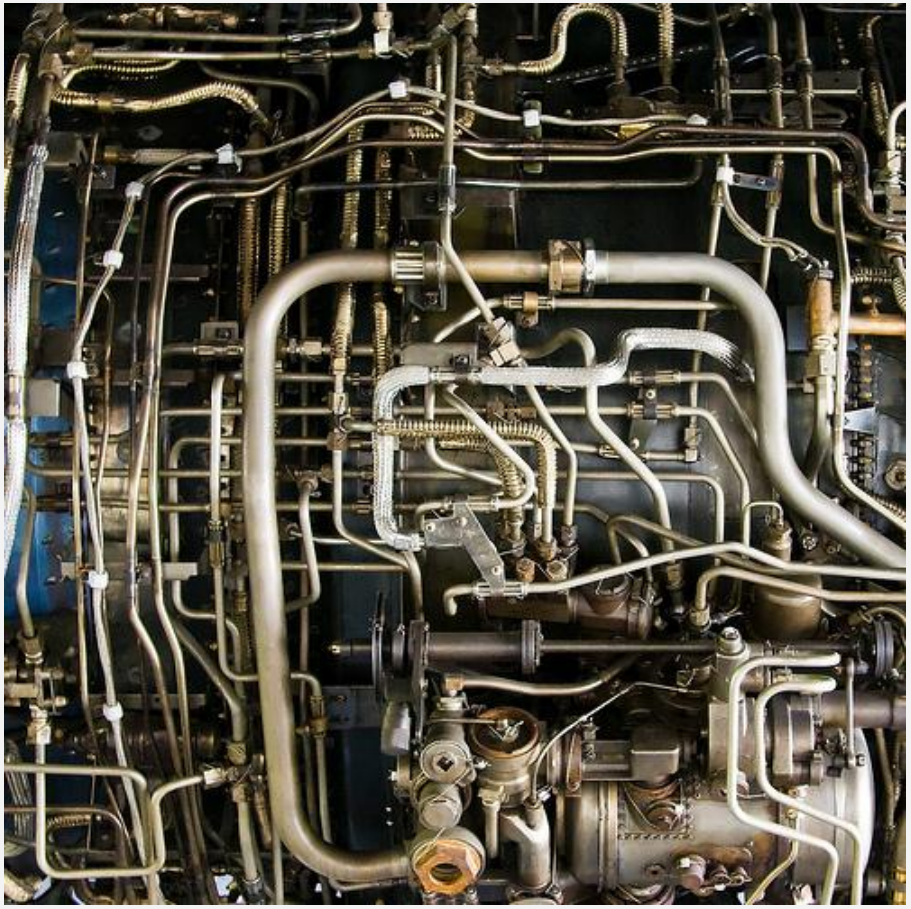
Heavy Rain (2010), PS3
50 frames per second

Final Fantasy (2001)
90 minutes per frame

GSVM course outline: Graphic systems

CG basics

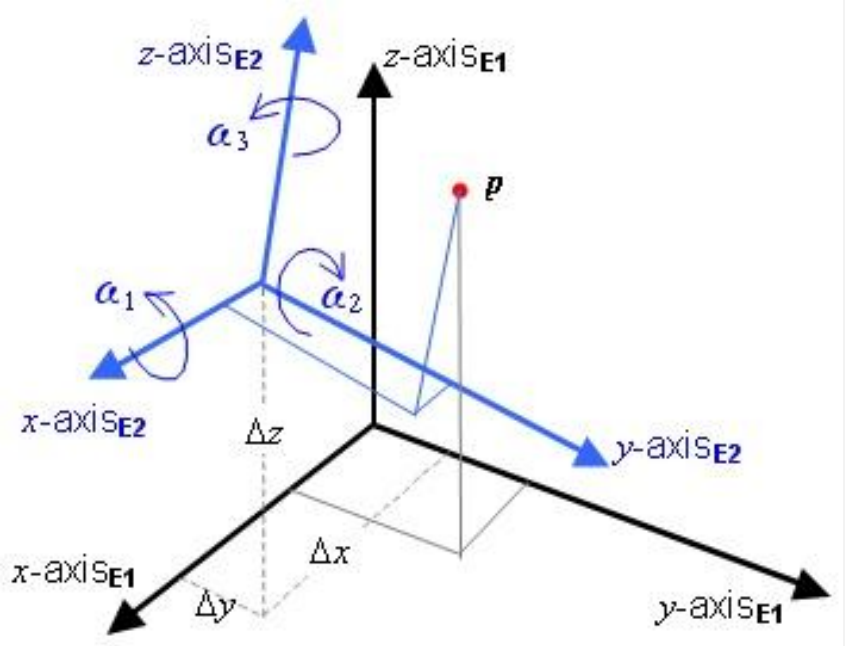
- Computer graphics reference model
- Graphics pipeline



A small section of the pipework on a Pratt and Whitney J58 turbojet engine. © Fragments of Eternity

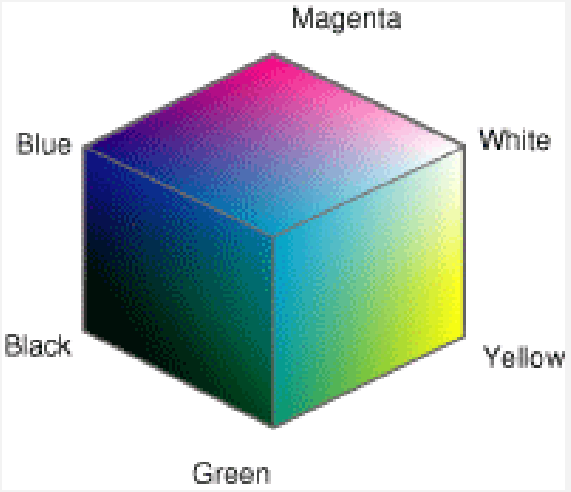
Necessary geometry

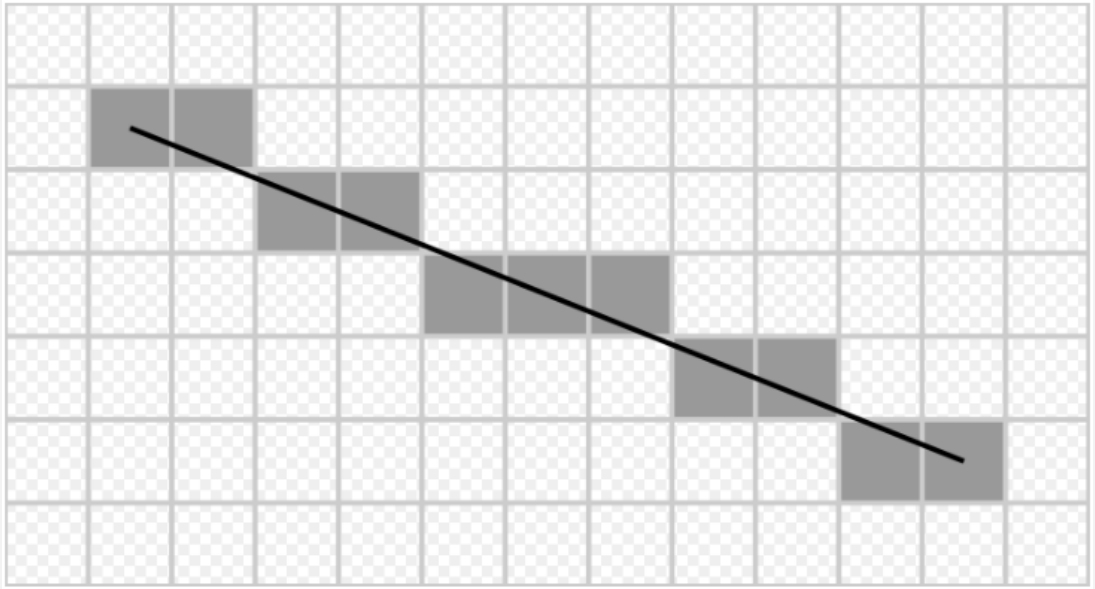
- Coordinate systems
- Vectors, matrices
- Affine spaces
- Transformations, projections



Elementary graphics

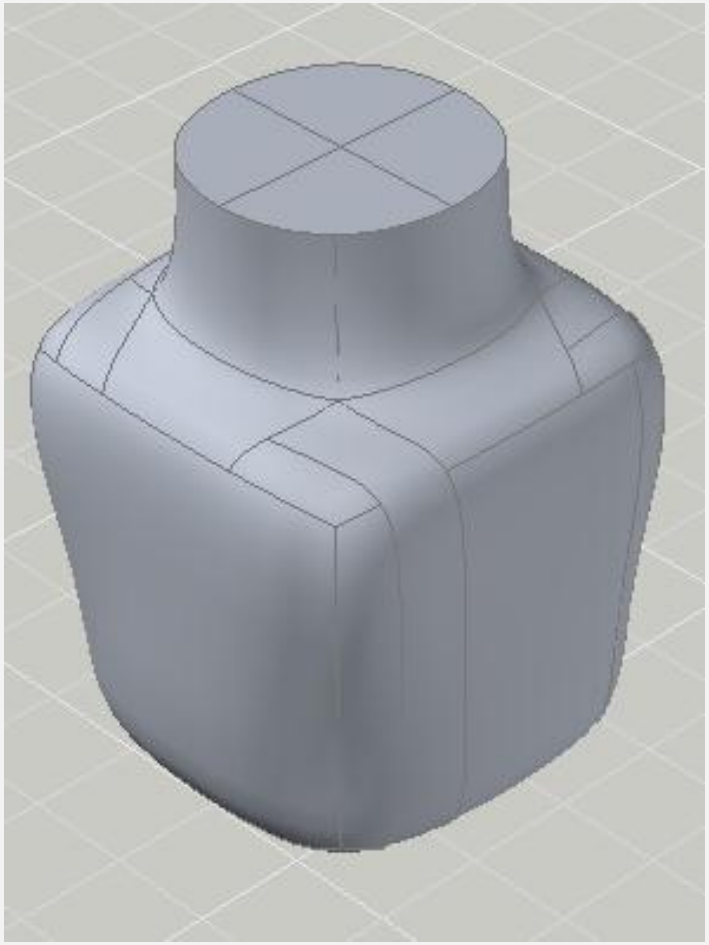
- Color models
- Rasterization
- Cropping
- Alpha blending
- Anti-aliasing





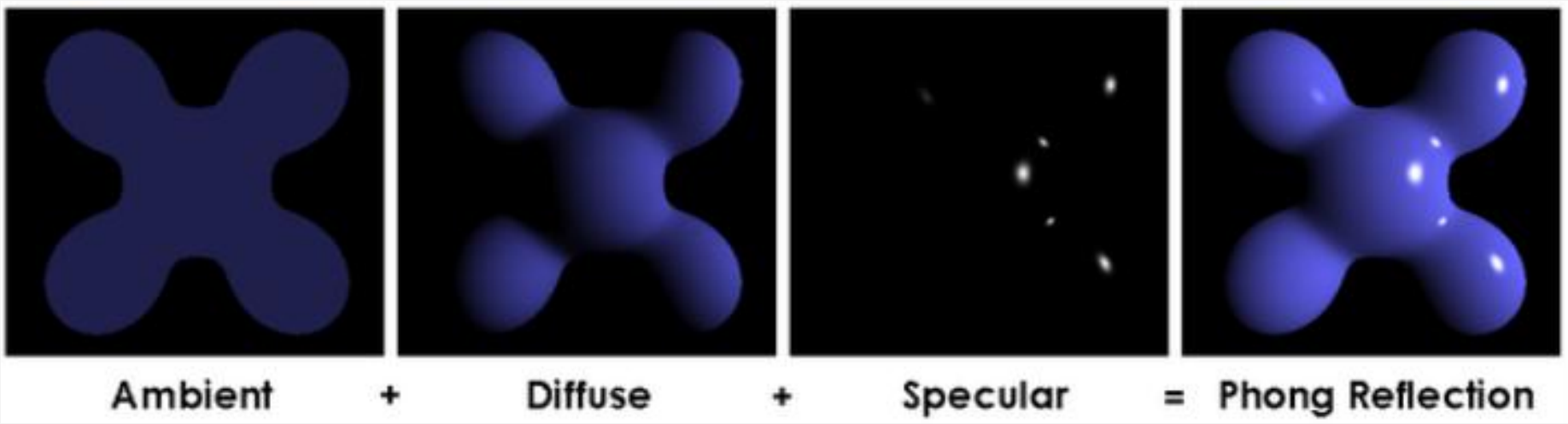
Object representation

- Points
- Curves
- Surfaces
- Solids
  - Boundary representation
    - Polygons, NURBS
  - Volumetric representation
  - Functional representation



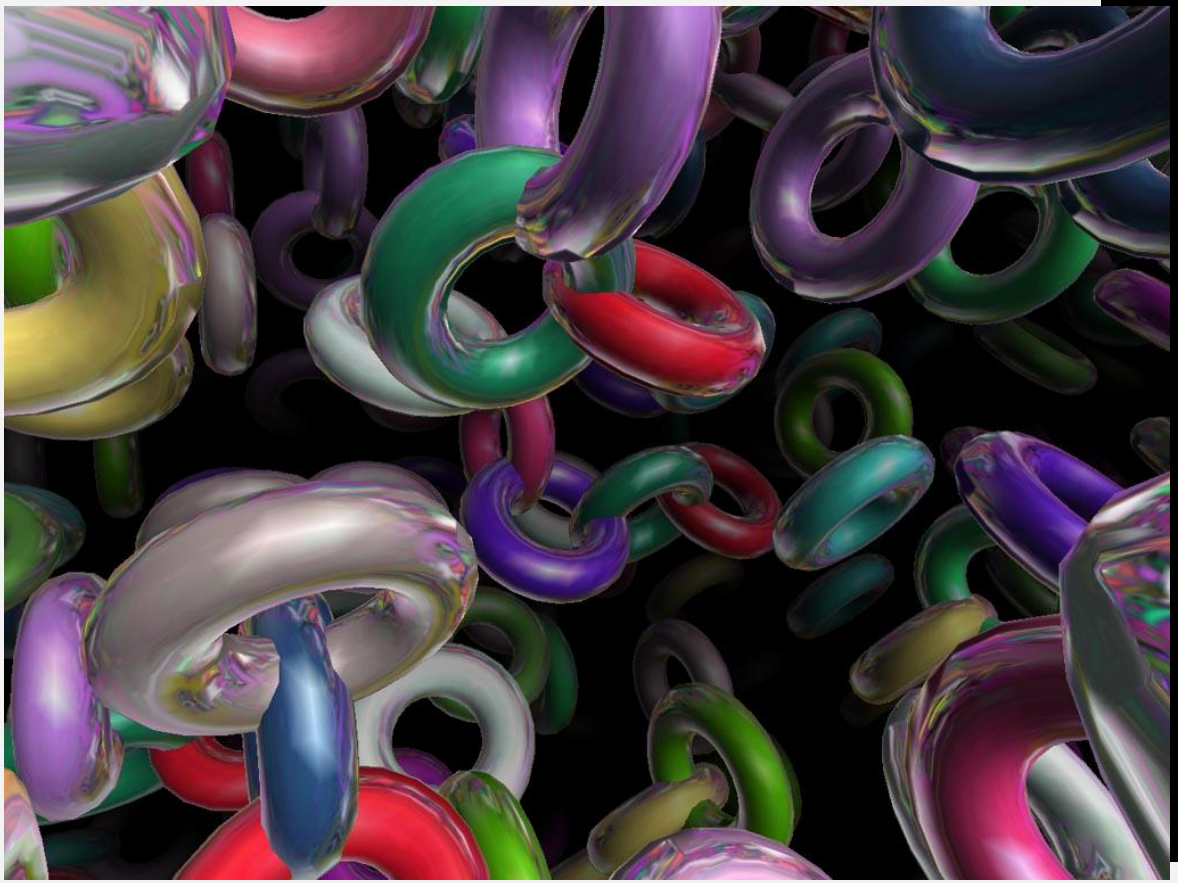
Projection, rendering

- Geometric projections – perspective, ortho
- Visibility algorithms
- Lights and shadows



Real-time CG APIs

- OpenGL, DirectX



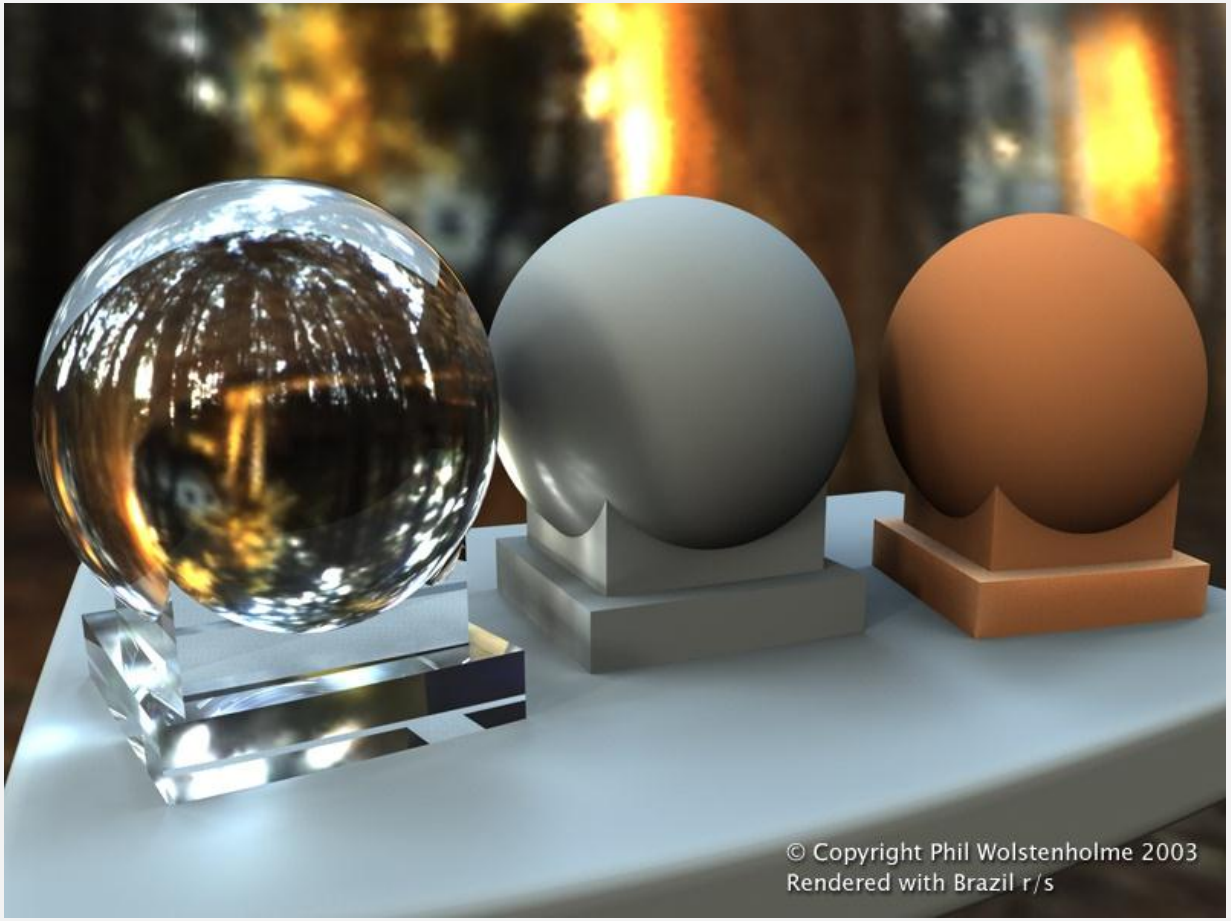
```
glEnable(GL_NORMALIZE);
glEnable(GL_LIGHTING);
glEnable(GL_BLEND);
glPolygonMode(GL_FRONT_ANI
glDisable(GL_POLYGON_SMOOT
glLineWidth(0);
glPushMatrix();
glTranslatef(x,y,z);

// first the boxes
glColor4f(0.5f,0.5f,1.0f,0

glCallList(box);


// and now contours
glEnable(GL_LINE_SMOOTH);
glDisable(GL_LIGHTING);
glDisable(GL_BLEND);
glColor4f(1.0f,1.0f,1.0f,1

glCallList(wire);
```

Advanced rendering

- Texture mapping
  - Texture filtering, anti-aliasing anisotropic filtering
- Materials
- Bump mapping
- Environment mapping

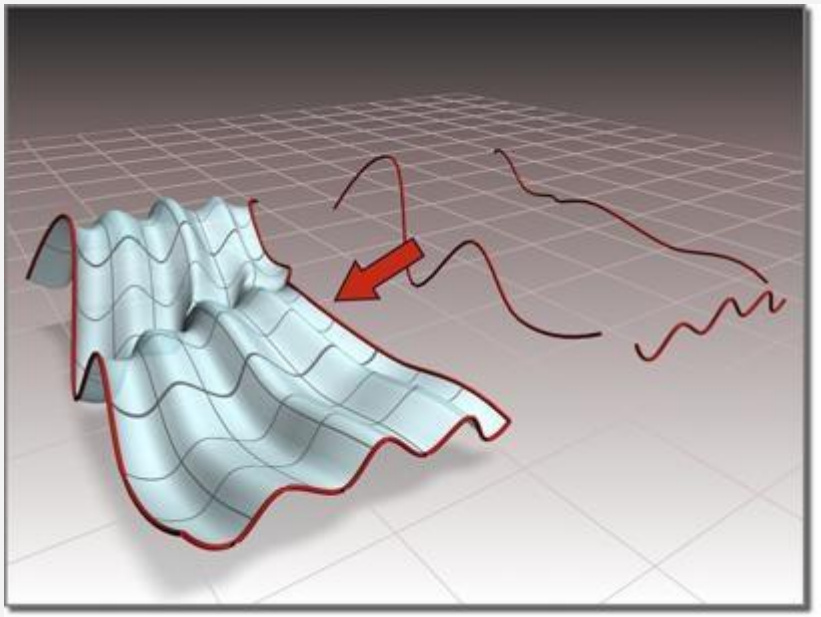
Towards photorealism

- Rendering equation
- Global illumination
- Radiosity
- Raytracing
- Photon mapping



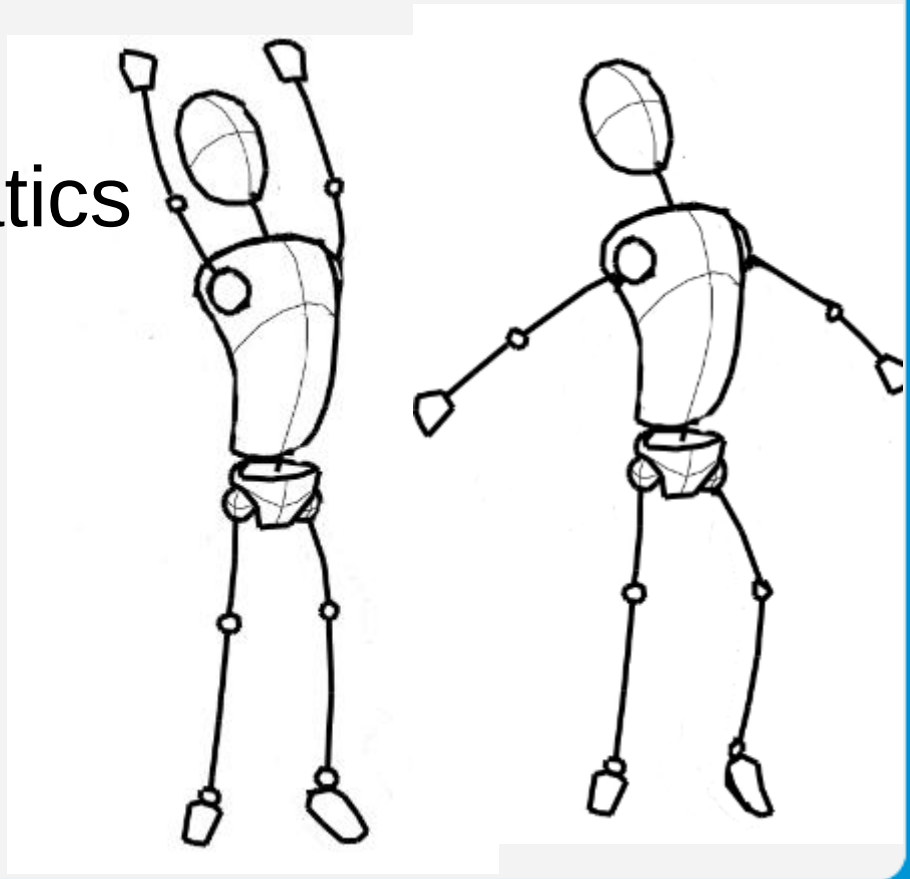
Modeling

- Polygonal modeling
- Procedural modeling
- Constructive solid geometry
- ...



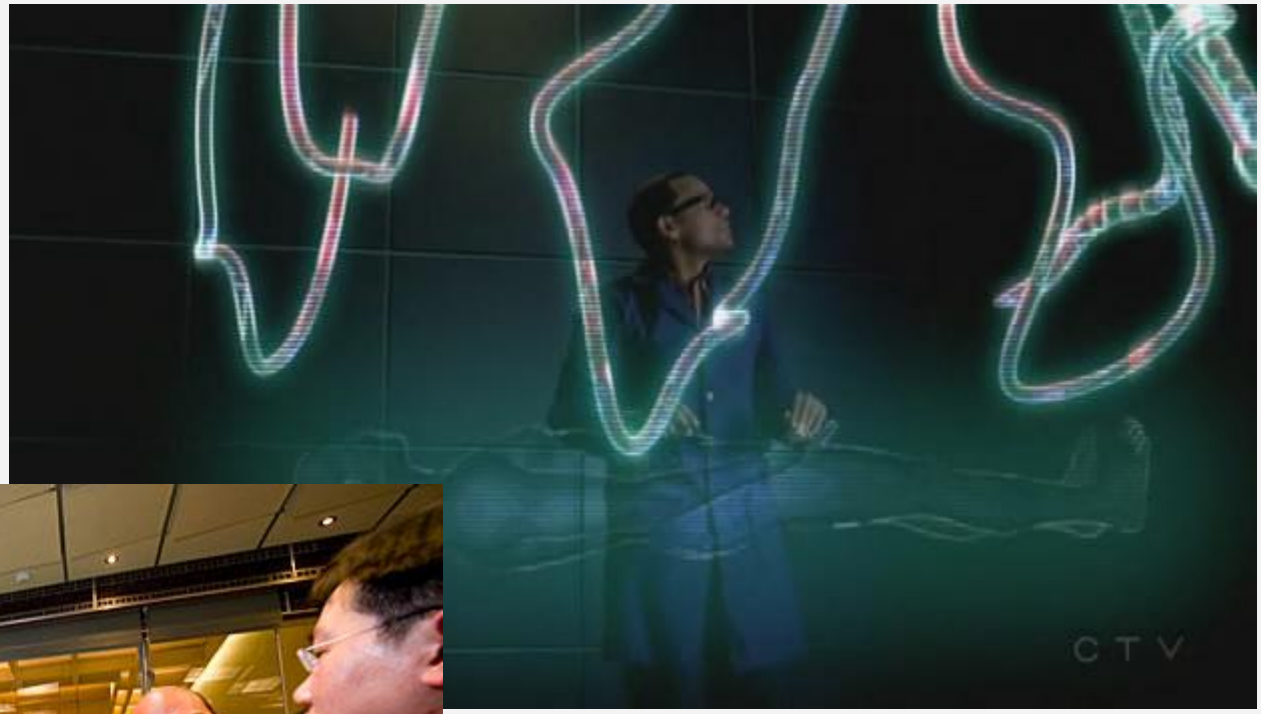
Animation

- Rigid body animation
- Deformations
- Keyframes
- Direct / inverse kinematics
- Compositing, keying



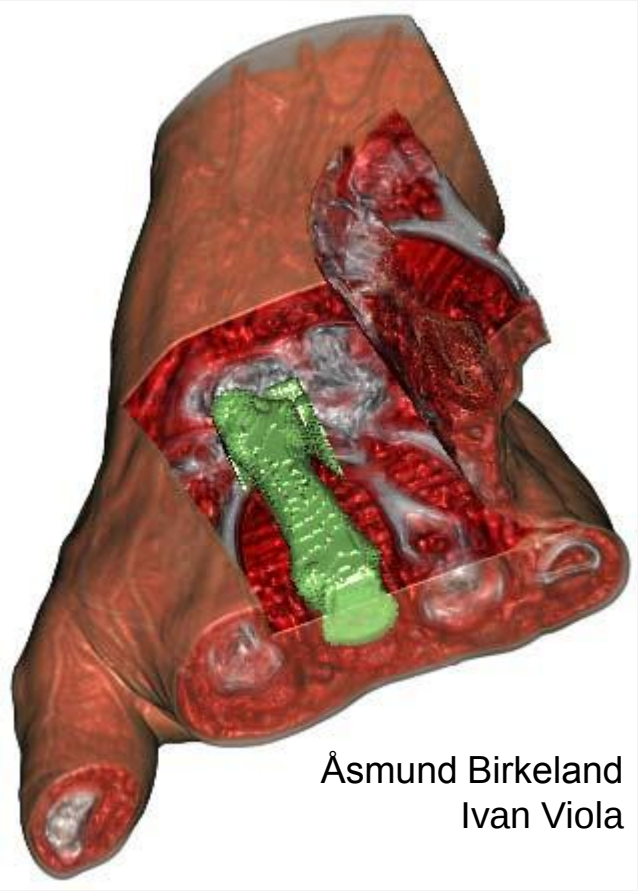
GSVM course outline: Visualization

For visions: observe movies

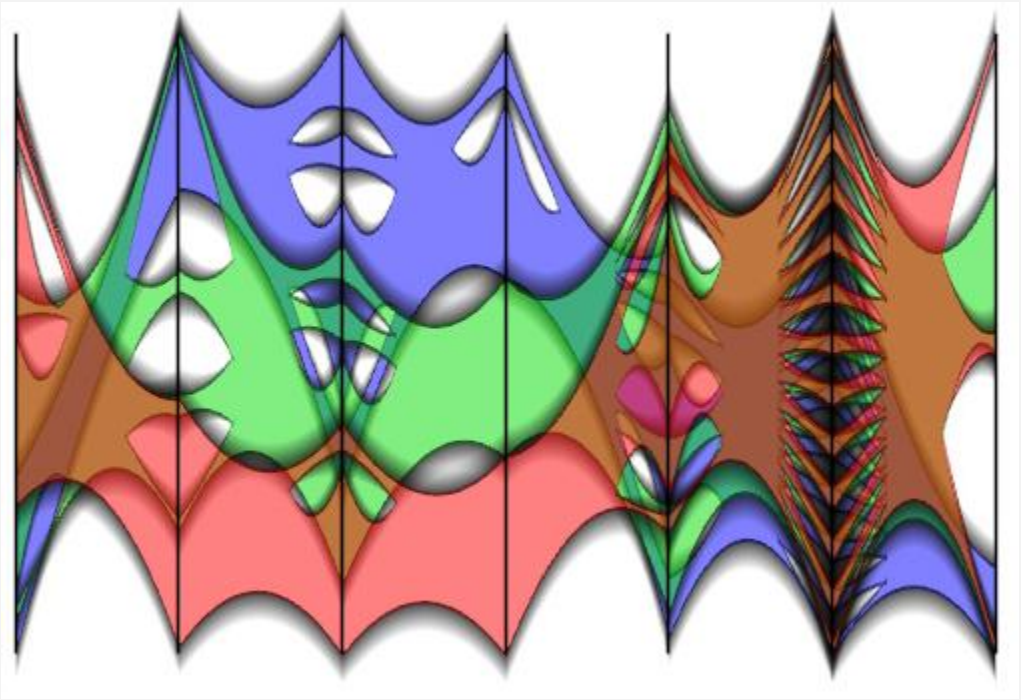


Visualization

- Medical visualization
- Scientific visualization
- Information visualization



Åsmund Birkeland
Ivan Viola



Kevin McDonnell

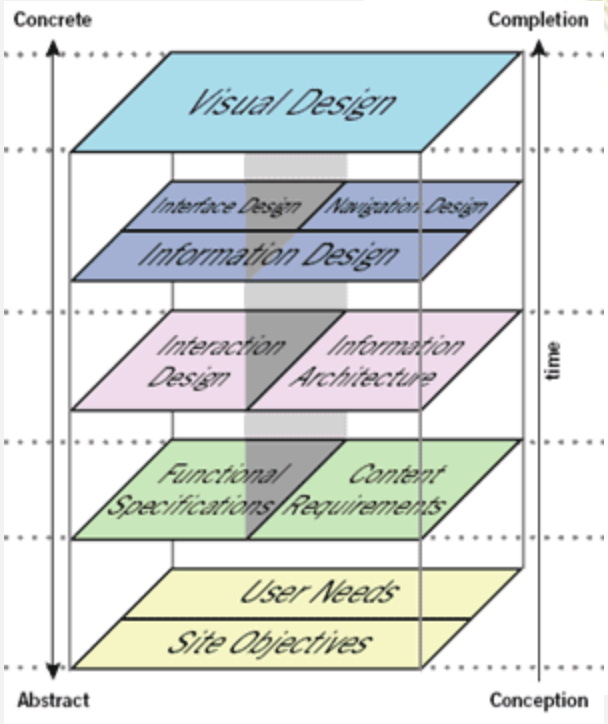
GSVM course outline: Multimedia

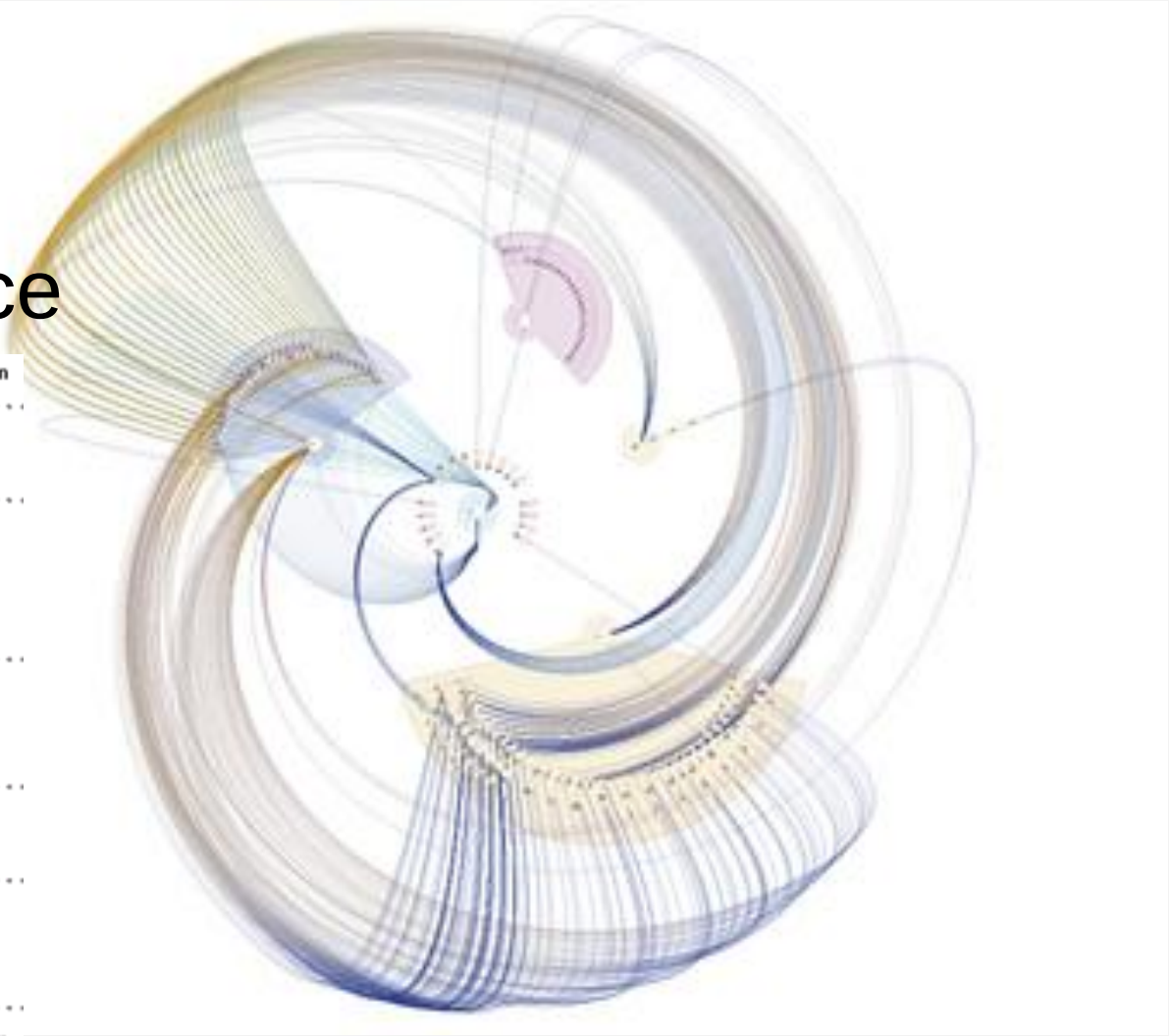
Creating and storing media

- 2d formats, 3d formats
- Audio/video/animation formats
- Vector graphics / bitmap graphics
- Compression, streaming
- Data manipulation

Organizing multimedia

- Web design
- Navigation
- User experience





New and emerging media

- Virtual spaces (WoW, Second life, Wii) and virtual cities, CAVE
- Force feedback, haptic inferfaces
- Real virtuality

GSVM rules

Course requirements

- Basic experience in computer graphics
  - Gaming is enough ☺
- Programming
  - No specific language
- Mathematics
  - Linear algebra, vector calculus

Evaluation

- Test 50 points
  - 25 < required to pass
- Labs / Project 50 points
  - 25 < required to pass

Questions and requests

- Tell me what you wish to know more about
- Write to: mnovotny@sccg.sk
- Subject: GSVM ...
- More questions?

Readings

- Ružický, Ferko – Počítačová grafika a spracovanie obrazu

- Žára a kol. – Moderní počítačová grafika

- http://pg.netgraphics.sk/