



Course 251-0502-00L:
Visual Computing

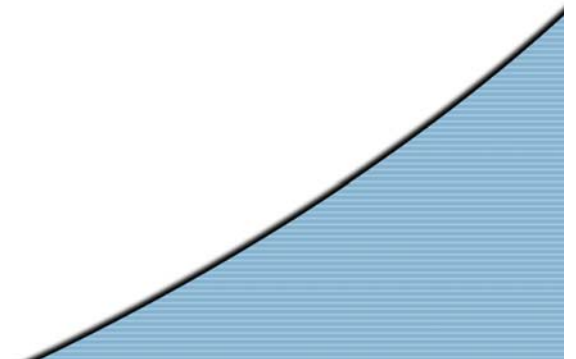
Prof. Dr. Markus Gross

*Computer Graphics Laboratory
Institute of Computational Science
ETH Zürich*

Prof. Dr. Joachim Buhmann

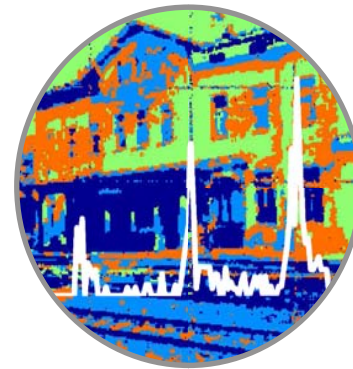
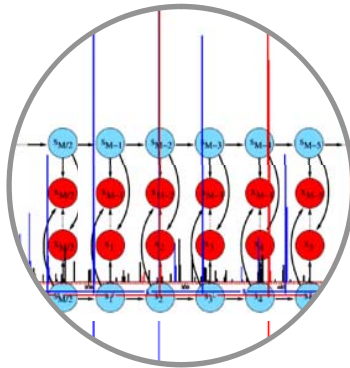
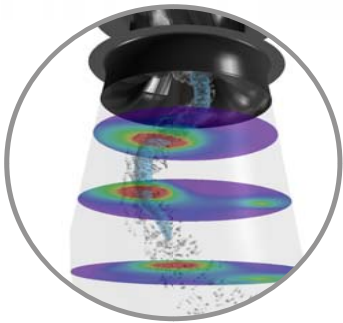
*Machine Learning Group
Institute of Computational Science
ETH Zürich*

SSo6



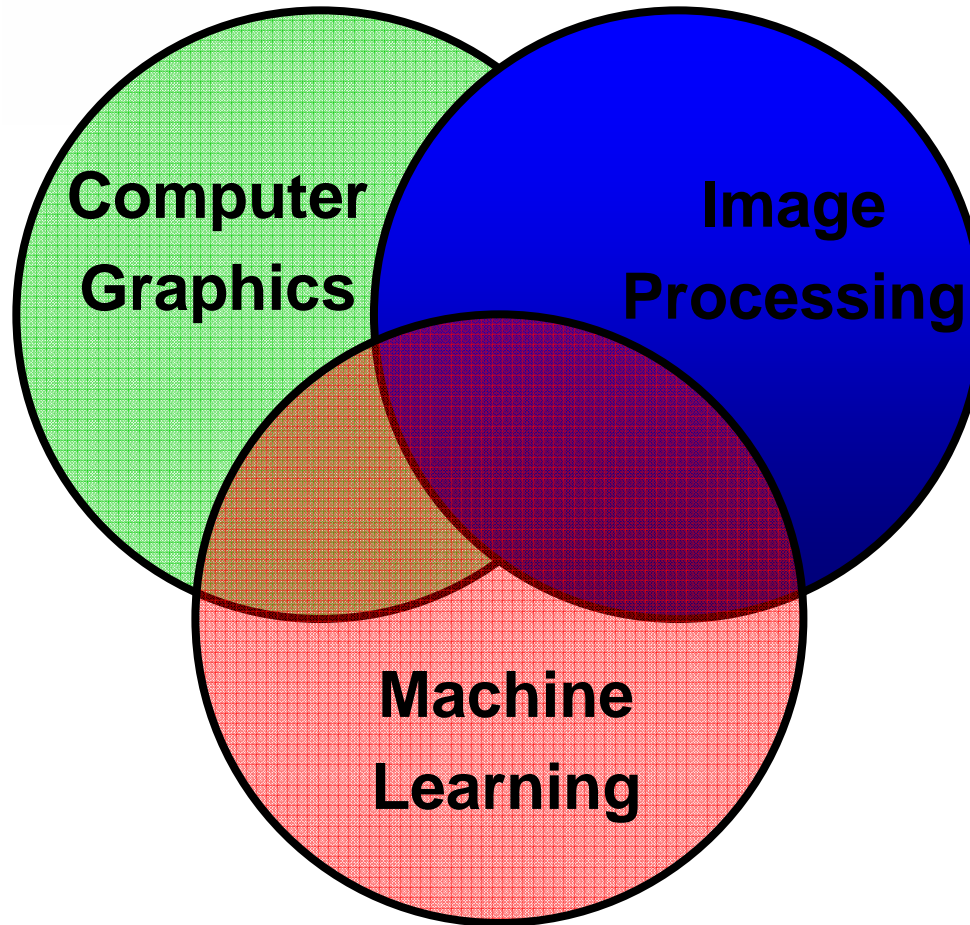


Visual Computing





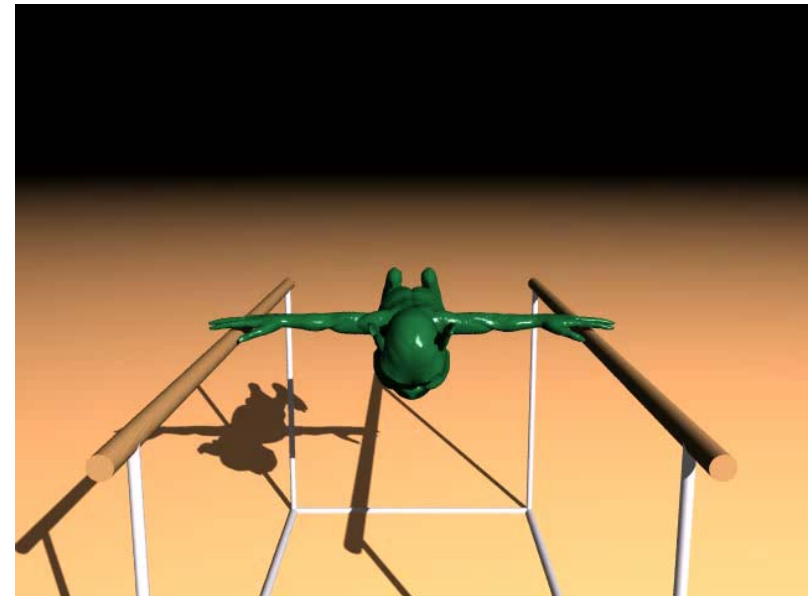
Areas





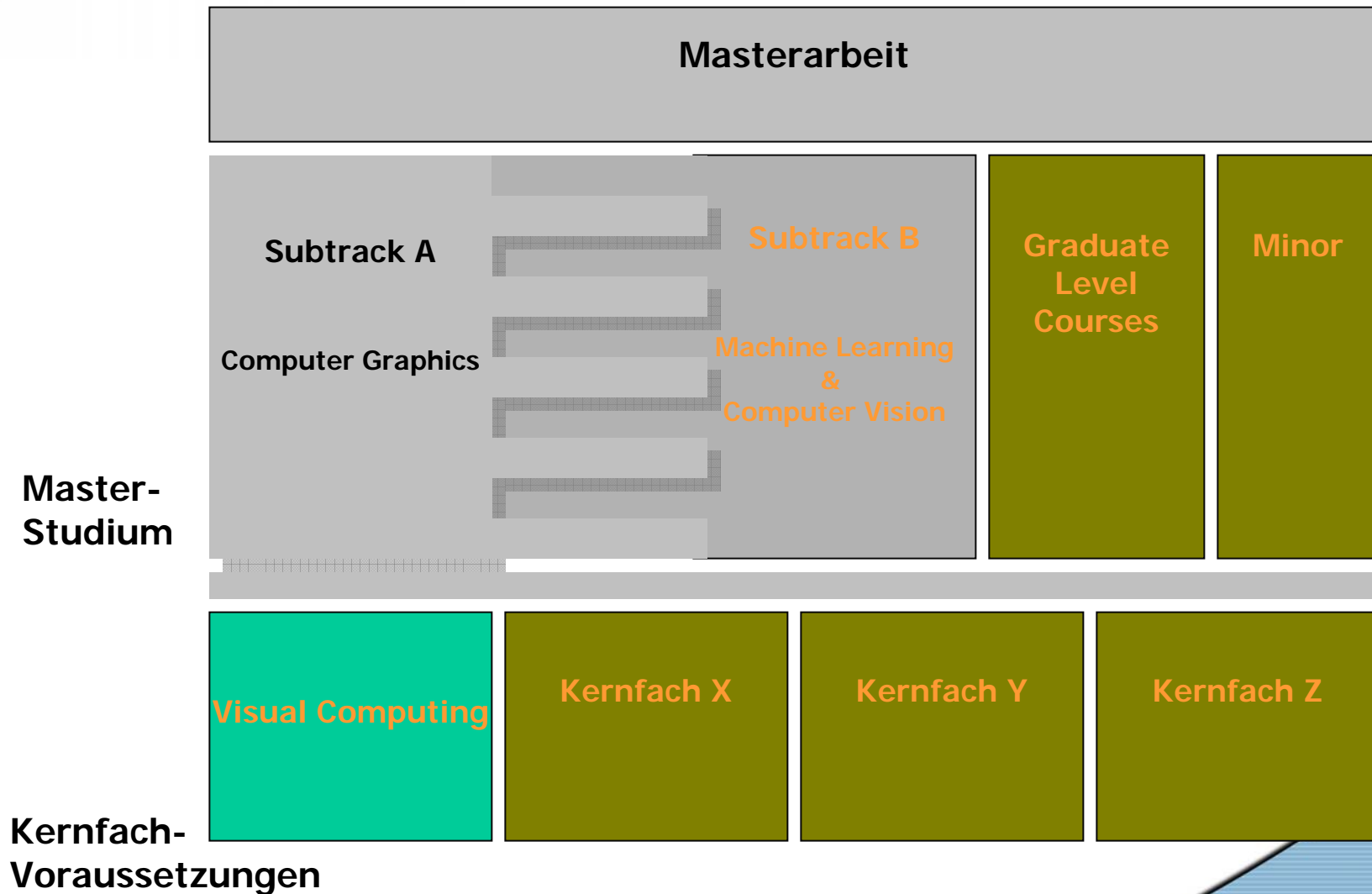
Goals

- In-depth introduction to core concepts in graphics, vision and machine learning
- Basis of the specialization track in visual computing
- Entry point for a variety of specialized courses
- Both theoretical and practical issues





Structure





Advanced Courses (Ex.)

Summer semester 2006:

1. **Advanced Image Synthesis**
 - *Realistic Image Synthesis*
 - *Advanced Rendering Techniques*
2. **Physically-Based Modeling**
 - *Animation, deformation, fracture, flow, collision detection*
3. **Surface Representations and Geometric Modeling**
 - *Geometric Modeling, Splines, Meshes, Processing*
4. **Scientific Visualization**
 - *Volume Rendering, flow visualization*



Course Organization **Overview**

Lecturers	Prof. Dr. Markus Gross Prof. Dr. Joachim Buhmann
Locations	Course: Di. 11-12 CAB G61 Mi. 10-12 IFW A36 Exercises: Di. 14-16 CAB H52, H56 Do 8-10 G52, G56
Credits	3V / 2U



Course Organization *Team*

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Course Organization **Schedule**

Course modules (part 1 - Prof. Gross):

- Introduction – graphics pipeline – API – architecture
- Colors and color models, perception
- Transformations, projections, camera models
- Lighting, reflection, shading models, ray tracing
- Texturing and aliasing, parametrization
- Sampling theorem, Fourier transform, convolution, LTI
- Linear filtering (low pass, high pass, band pass), Laplace pyramids, recursive filtering



Course Organization **Schedule**

Course modules (part 2 - Prof. Buhmann):

- Nonlinear Filtering, edge detection, non-linear diffusion
- Shape from X
- Bayes rules, optimal classifiers
- Linear classifiers, support vector machines
- Dimensionality reduction, PCA, ICA, local linear embedding
- Clustering – K-means, C-means, EM-compression
- MRF models, Bayes nets



Course Organization **Schedule**

Exercises:



- Both practical and theoretical exercises.
- Weekly submissions.
- Electronic registration (during first week).
- Additional details on webpage.
- First exercise handed out on April 11.



Course Organization

Material

- Lecture notes:
 - Covering first part of lecture
 - CHF 20.–
- Slide set in PDF format
- Java applets.
- Course webpage:

[http://graphics.ethz.ch/main.php?Menu=4
&Submenu=5&Course=vc_master&Hornav=1](http://graphics.ethz.ch/main.php?Menu=4&Submenu=5&Course=vc_master&Hornav=1)



Course Organization **Support**

- Forum:
 - <http://forum.vis.ethz.ch/board.php?boardid=116>
 - http://graphics.ethz.ch/teaching/vc_master/tpf/index.php
- Assistants during exercises.
- Assistants using e-Mail.



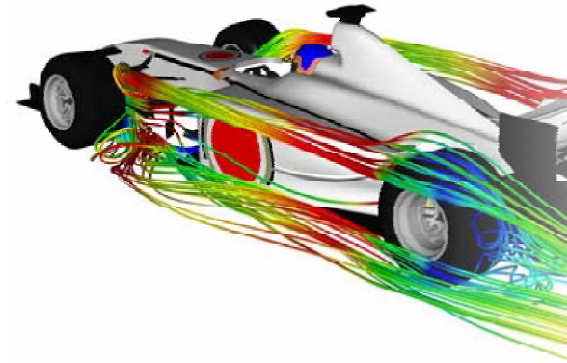
cg_stud mailing list

- We administer a mailing list for students interested in Computer Graphics
 - http://www.lists.inf.ethz.ch/mailman/listinfo/cg_stud
 - Subscribe under: *Subscribing to cg_stud*
 - You will get exclusively cgl-related mails, no spam:
 - Talk invitations
 - Demo invitations
 - Party invitations ;-)
 - And more...



Part I: Graphics

```
02ea5410: 9b 71 05 e8 0c 45 3a ef b7 a4 24 ea 19 54 82 cc
02ea5420: be 59 e8 b8 4e d4 f9 22 a7 0d 77 13 73 ad 45 44
02ea5430: 9e a1 e6 99 a6 59 dc 61 5b e0 83 53 c7 5b aa 9f
02ea5440: 5f aa 4d fa 29 42 1f 85 c5 b7 ac 84 b2 d3 59 37
02ea5450: b1 93 39 aa 97 b5 c6 8a a9 66 8a c3 08 aa 44 f4
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02ea54f0: 91 a7 3a ec 79 0e 59 54 e1 65 ca c7 fa 82 aa f9
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*«The purpose of computing is insight,
not numbers!» - Richard Hamming*

..or

«A picture is worth a thousand numbers!»





Goals

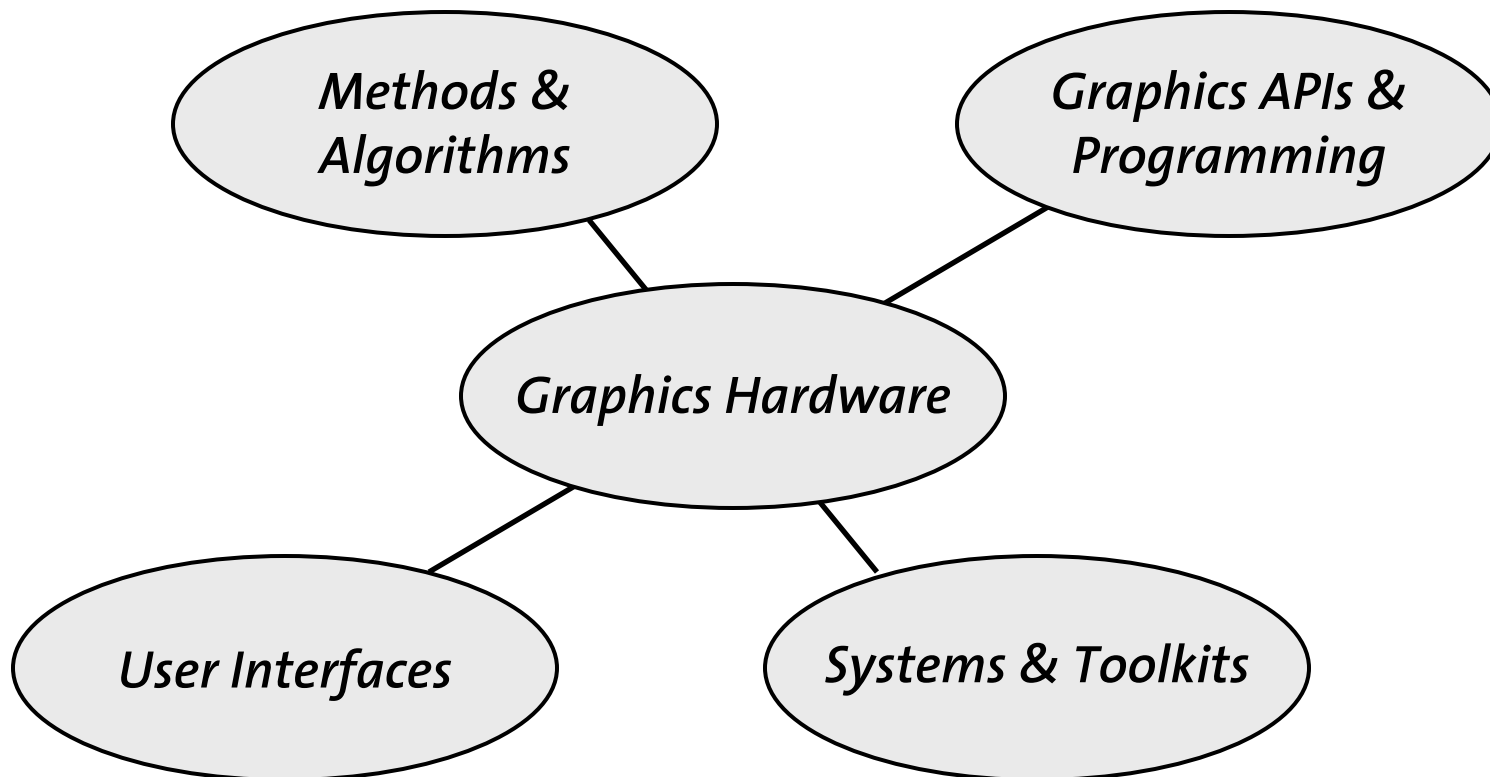
- Introduction to the **fundamentals of 3D Computer Graphics** and image generation
- A trip down the **Graphics Pipeline**
- Introduction to the **OpenGL** graphics API



Computer Graphics covers

Lecture

Exercises





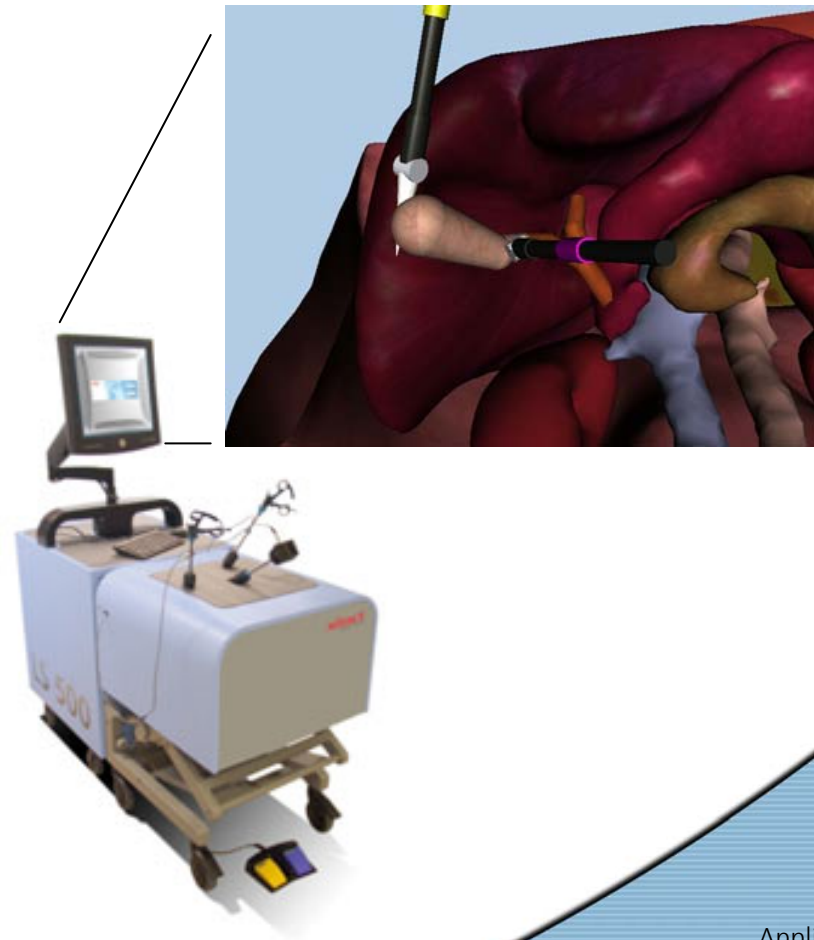
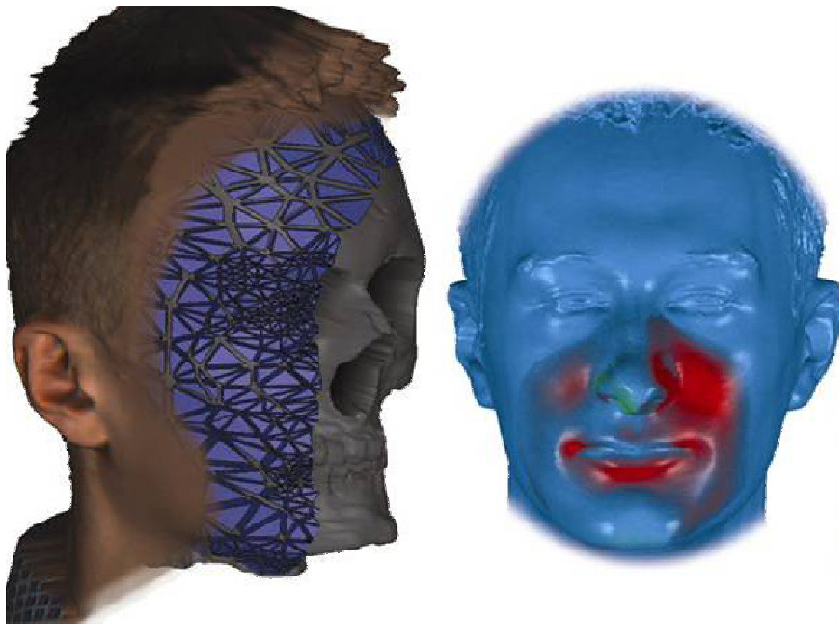
Applications
**Modeling &
Image Generation**





Applications

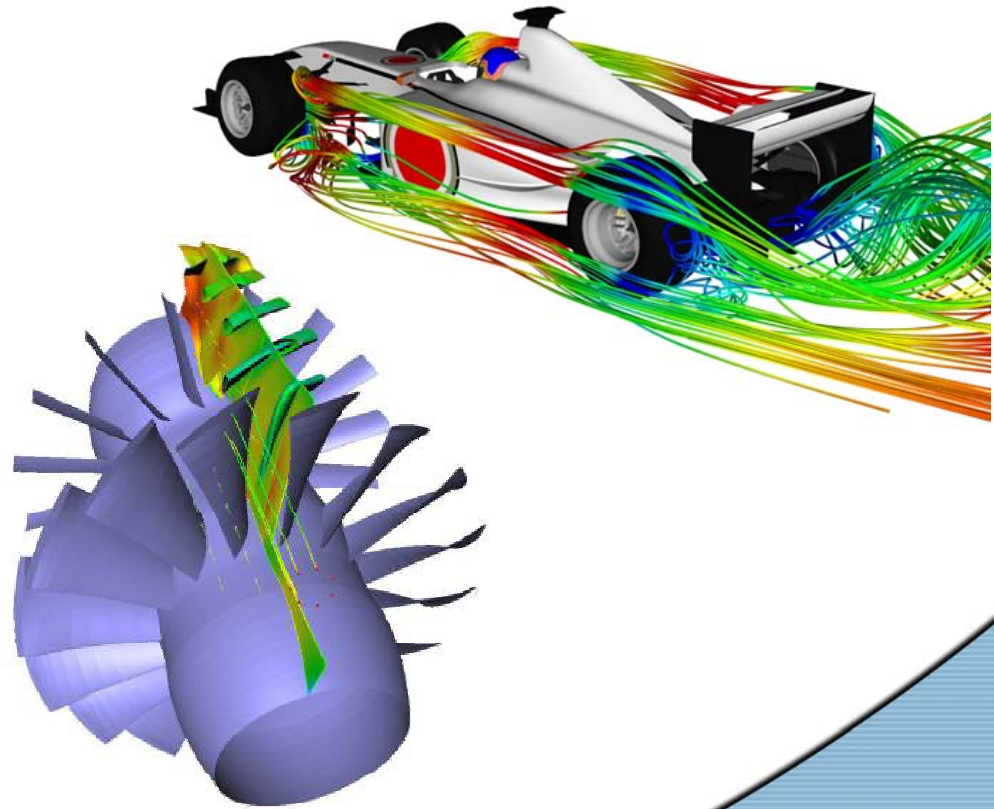
Medical Simulations





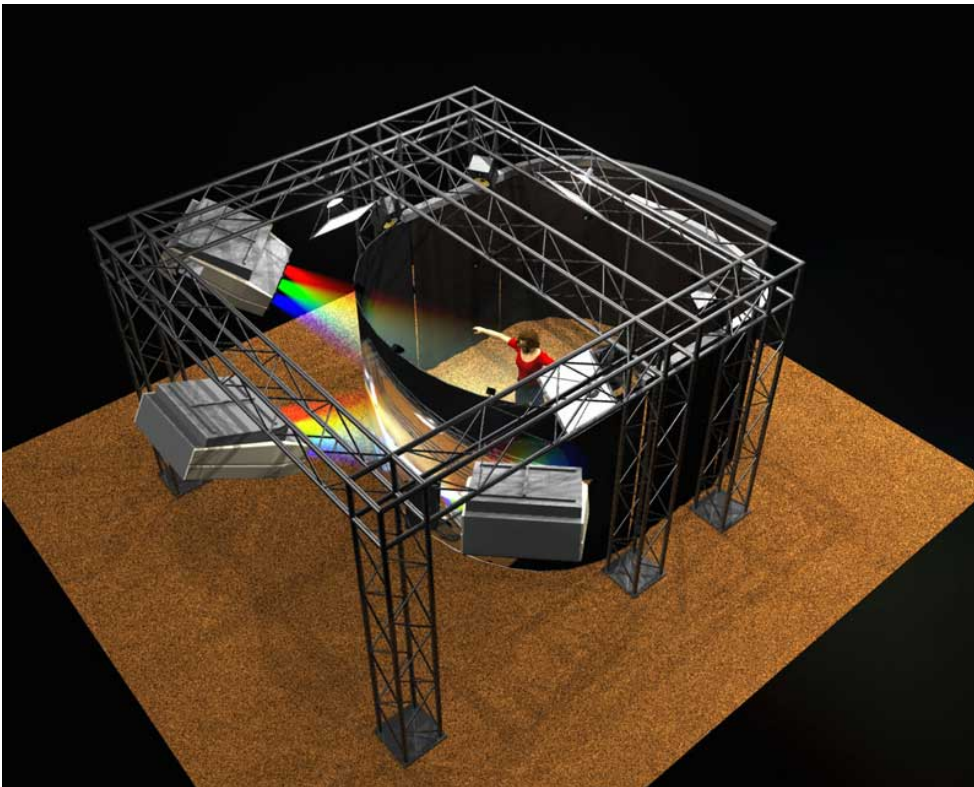
Applications

Scientific Visualization





Applications **Collaborative VE**



The Blue-C



Markets

Feature Films





Markets Games





Course Organization

Further Readings

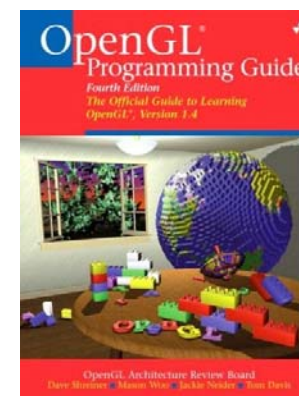
- D. F. Rogers:
Procedural Elements of Computer Graphics
2nd edition, McGraw-Hill, 1997.
- A. Watt:
3D Computer Graphics
3rd edition, Addison-Wesley, 1999.
- J. Foley, A. van Dam, S. Feiner, J. Hughes:
Computer Graphics – Principles and Practice
Addison-Wesley, 1990.
- J. Encarnacao, W. Strasser, R. Klein:
Graphische Datenverarbeitung
4th edition, Oldenburg, 1996.



Course Organization

Further Readings

- T. Akenine-Möller, E. Haines:
Real-time Rendering
2nd edition, A. K. Peters Ltd, 2002.
<http://www.realtimerendering.com>
- M. Woo, J. Neider, T. Davis:
OpenGL Programming Guide
4th edition, Addison Wesley,
OpenGL Version 1.4





A Brief History of Computer Graphics

A Summary of
Wayne Carlson's

A Critical History of Computer Graphics
accad.osu.edu/~waynec/history/lessons.html



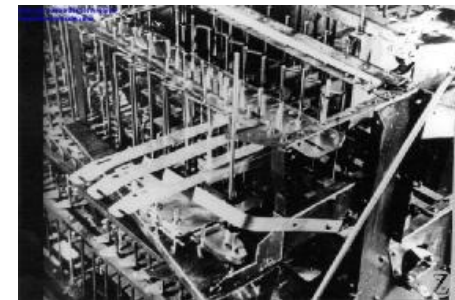
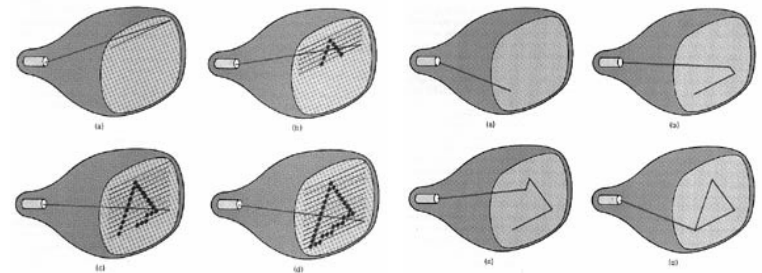
*The discipline is so recent in its early
developments
and so rapidly changing
that we are in fact living it,
and it evolves as we speak.*

Wayne Carlson



Beginnings

- 1885 Invention of **CRT** (Cathode Ray Tube)
- 1927 First 60 line raster scanned image by Philo Farnsworth
- 1938 First mechanical computer **Z1** by Konrad Zuse
- 1946 **ENIAC: Electronic Numerical Integrator And Computer** based on vacuum tubes





Beginnings

- 1946 MIT: Whirlwind computer, first computer with real-time display airplanes on **vector CRT**, **interaction** with light pen
- 1947 Invention of **transistor** (transfer resistor)
- 1959 TX-2 developed at MIT first **transistor-based** computer with 9 inch CRT + light pen





1960's

1961 [Spacewar](#) first computer game at MIT

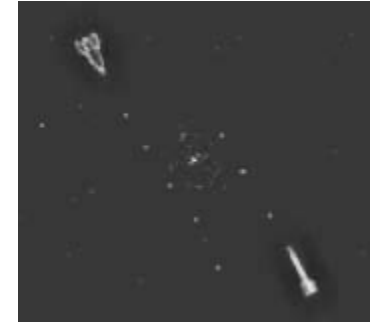
1963 Sketchpad on TX-2 by [Ivan Sutherland](#) “grandfather” of interactive computer graphics

1968 Douglas Engelbart invents computer [mouse](#)

1969 ACM [Siggraph](#) founded

1969 First [frame buffer](#) at Bell Labs

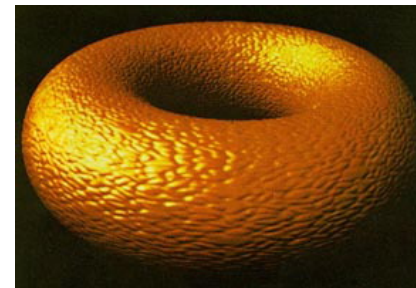
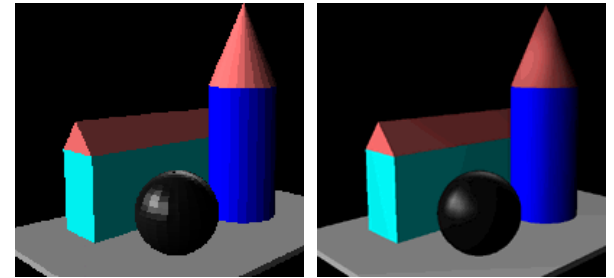
1969 First [GUI](#) by Alan Kay (Xerox)





1970's

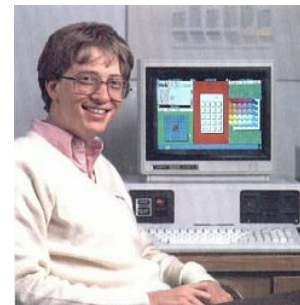
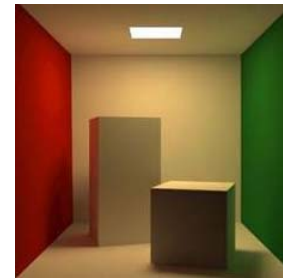
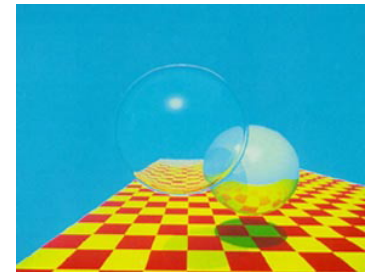
- 1971 Henri Gouraud: Interpolated shading
- 1974 Ed Catmull: Texture mapping, Z-buffer
- 1974 Sutherland: Polygon clipping
- 1975 Bui-Tuong Phong: Normal interpolation shading
- 1975 Martin Newell: Utah Teapot
- 1976 Jim Blinn: Environment mapping
- 1977 Jack Bresenham: Scan conversion algorithms
- 1978 Blinn: Bump mapping





1980's

- 1980 Turner Whitted: Ray tracing
- 1982 Silicon Graphics (SGI) founded
- 1982 TRON (Disney) 15 minutes of computer generated images
- 1983 Apple Lisa: First PC with GUI
- 1984 Goral et. al: Radiosity
- 1985 Microsoft Windows 1.01
- 1986 MIT: X-Window System





1990's

- 1992 OpenGL released by SGI
- 1994 Greg Turk scans Stanford Bunny
- 1995 Toy Story: First full-length computer animated film
- 1996 3Dfx Voodoo: First 3D accelerator for PCs, textured triangles
- 1999 GeForce256: Transformation & Lighting (T&L)
- 1999 PC graphics outperform SGI graphics workstations





2000 - present

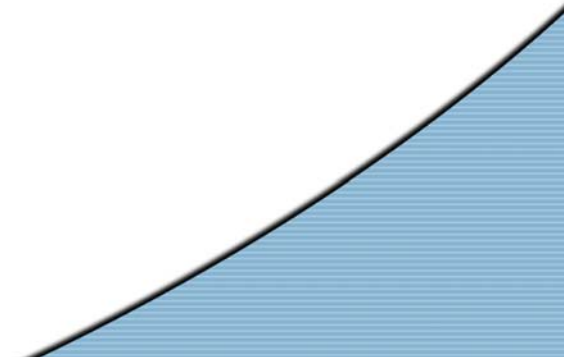
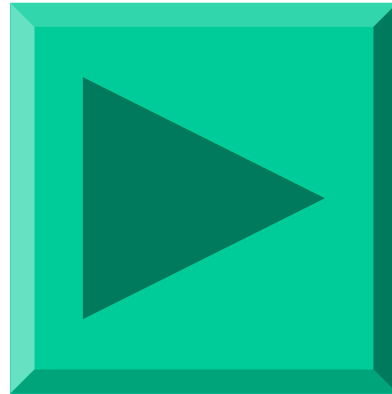
- 2001 GeForce3: Programmable T&L
- 2001 Final Fantasy: Human actors replaced by CG models
- 2004 GeForce FX, ATI Radeon 9800XT
ca. 4 billion texels/s,
ca. 400 million vertices/s
- 2005 Sony PS3 + cell chip, 2 TFlops



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Design and specifications are subject to change without notice.

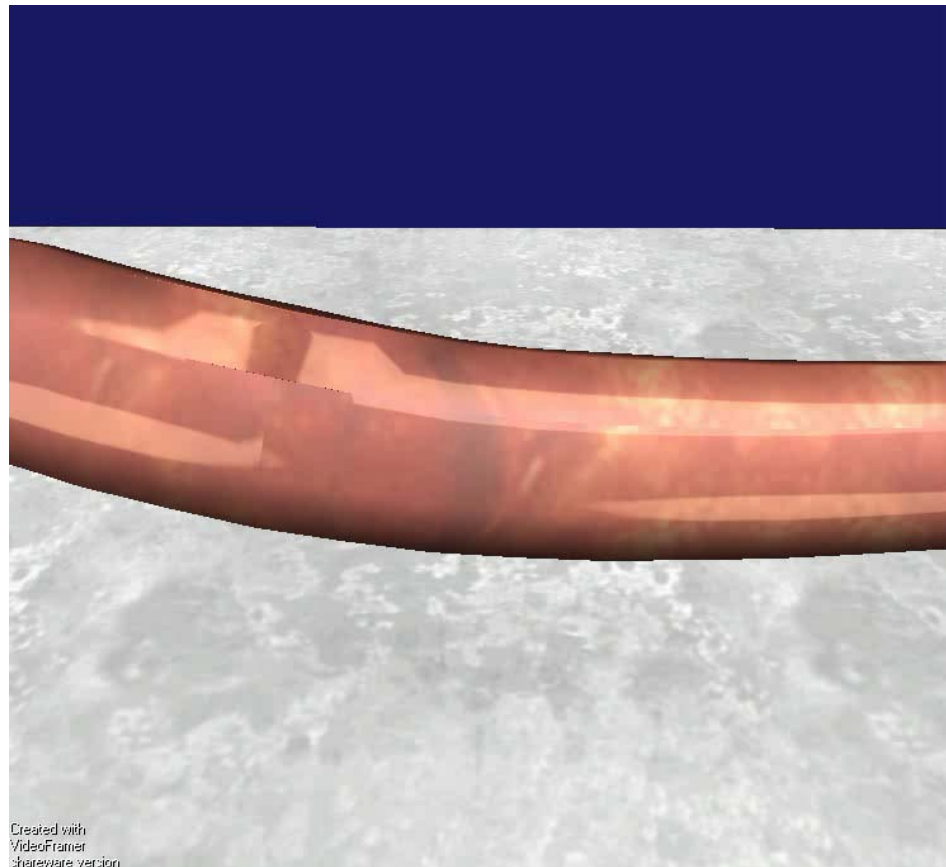


Example Demo Realtime FEM





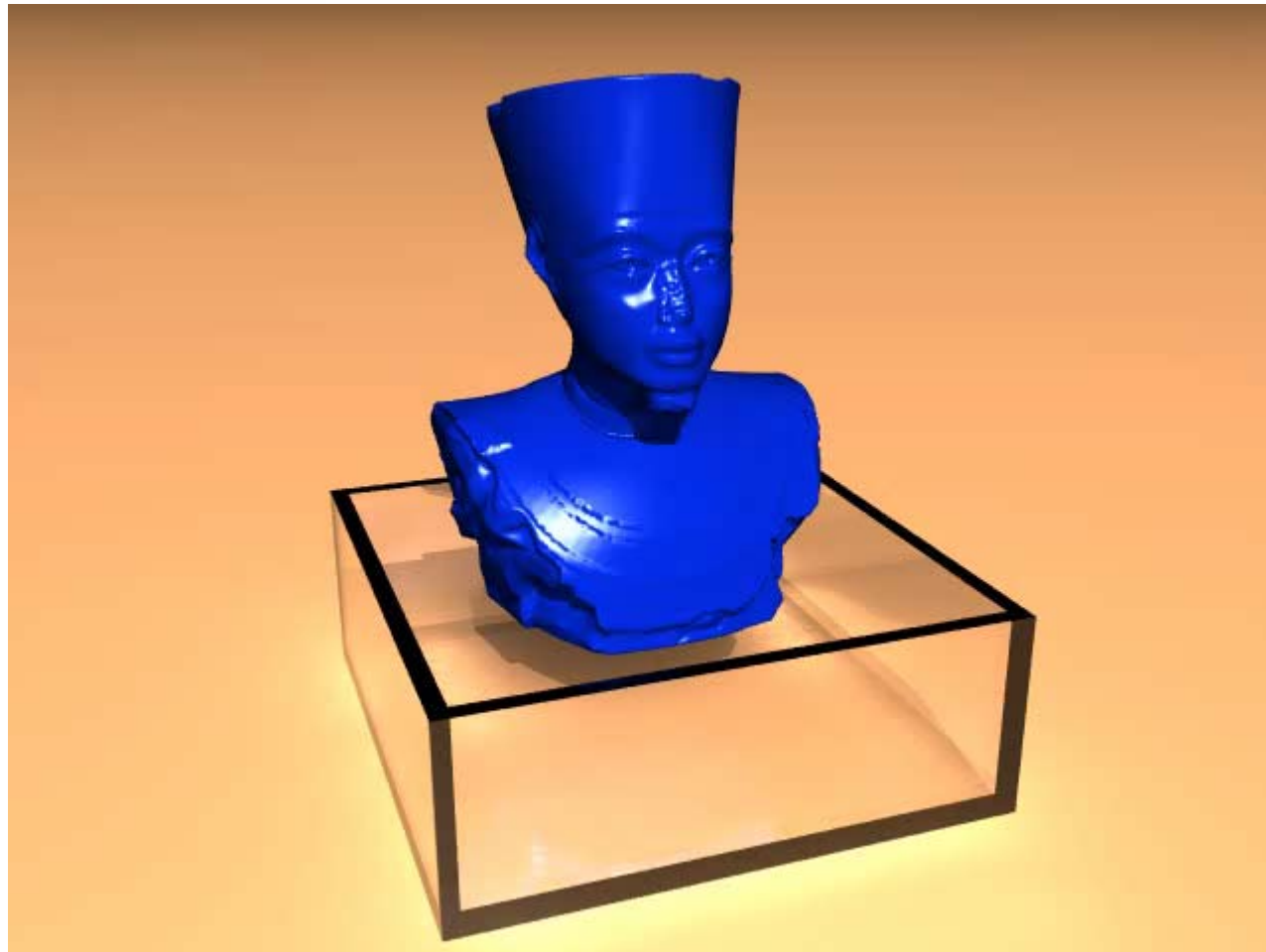
Vessel Rupture



Created with
VideoFraser
shareware version

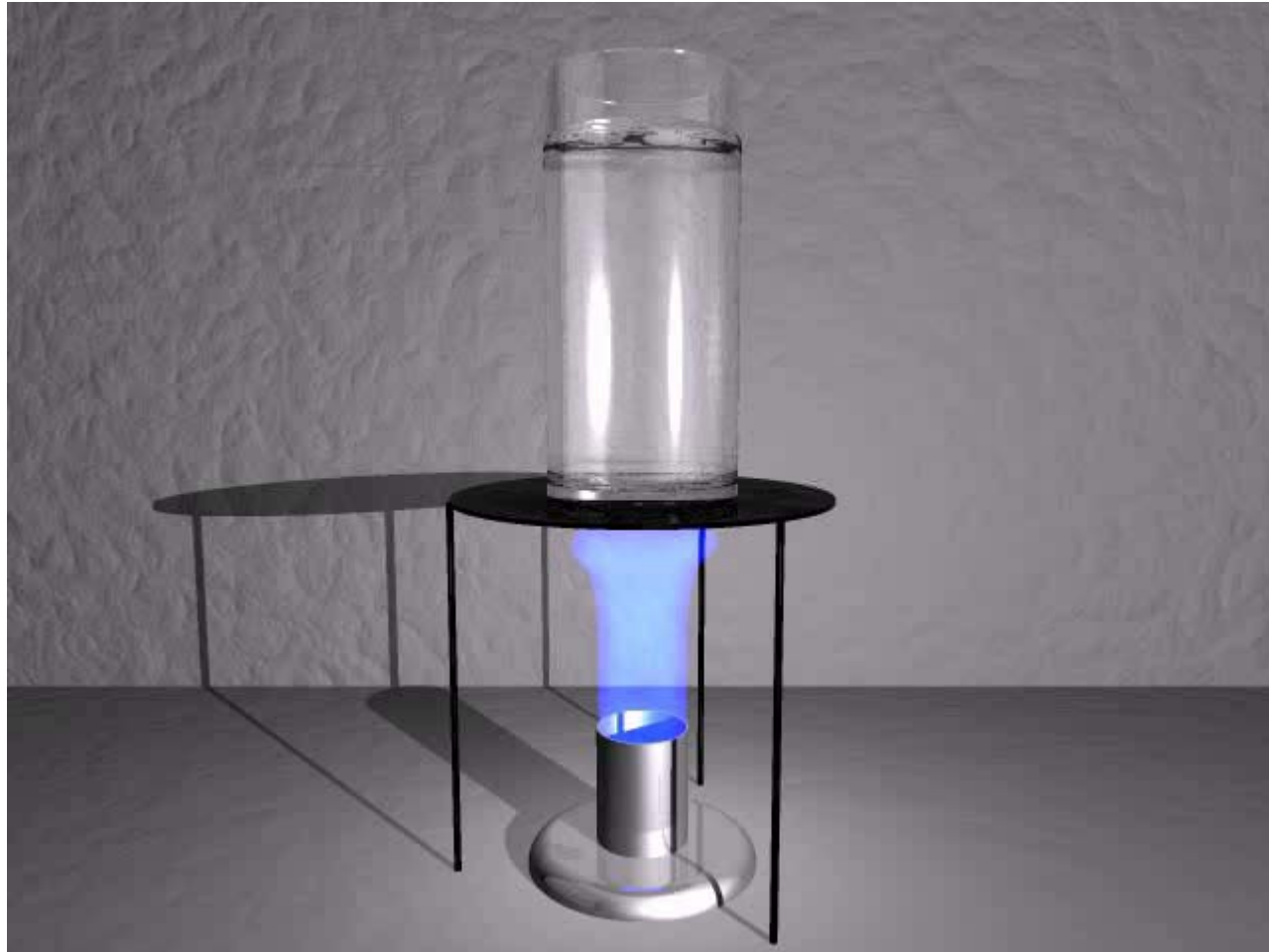


Heat Transfer and Melting



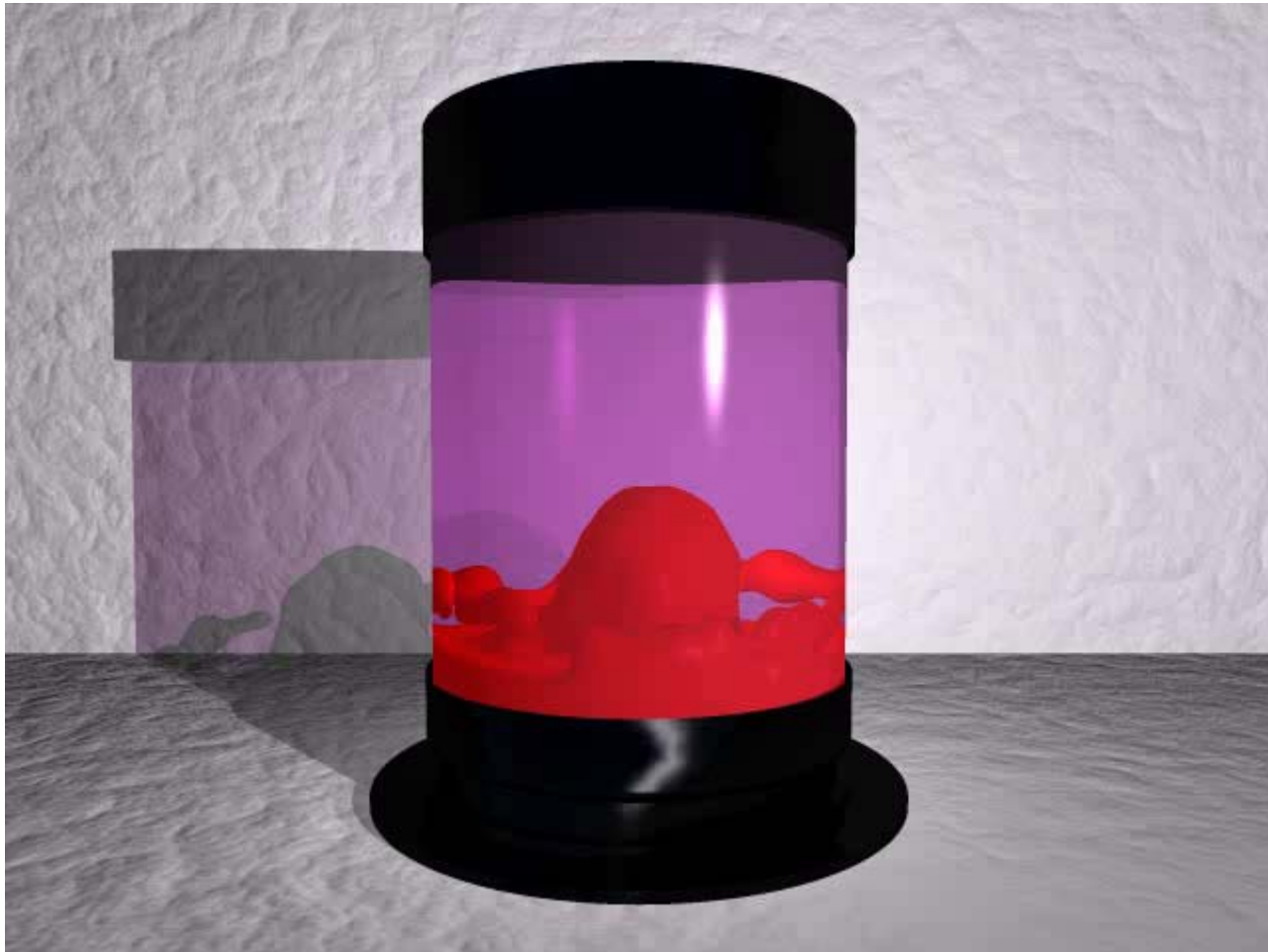


Boiling





Lava



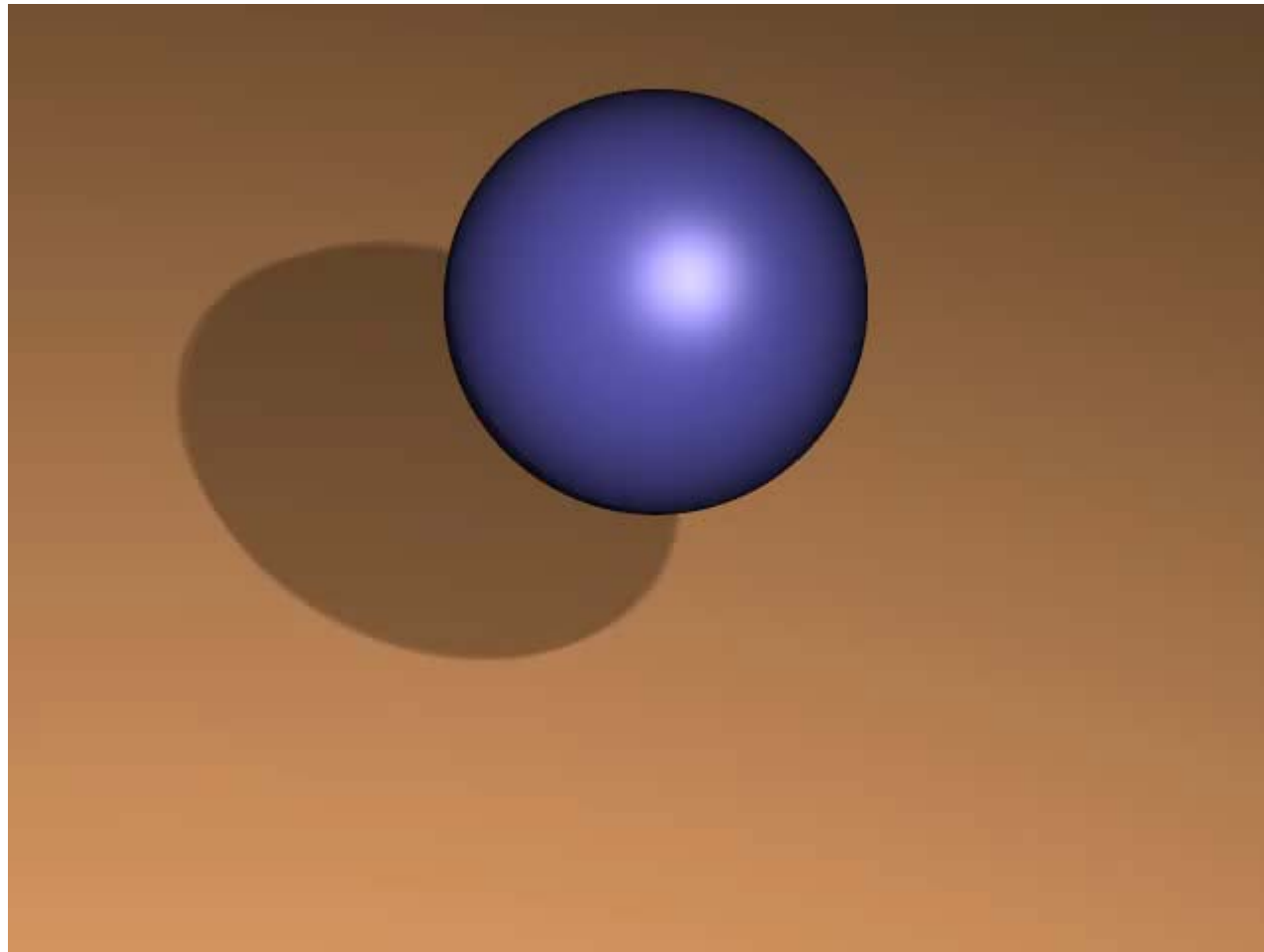


Brittle





Shell Physics- Balloon





Shell Physics- Balloon

