


Course 251-0502-00L:  
**Visual Computing**

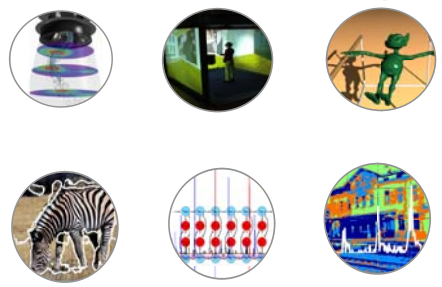
**Prof. Dr. Markus Gross**  
Computer Graphics Laboratory  
Institute of Computational Science  
ETH Zürich

**Prof. Dr. Joachim Buhmann**  
Machine Learning Group  
Institute of Computational Science  
ETH Zürich


SSo6



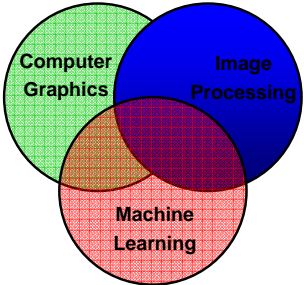
## Visual Computing




2  
Course Organization



## Areas




3  
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## Goals

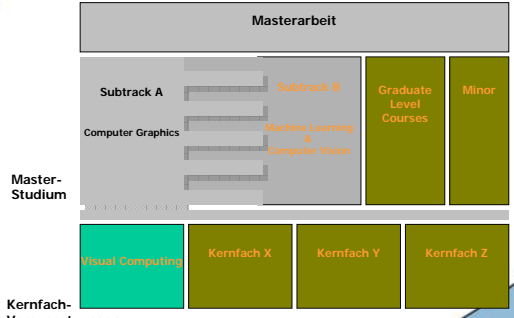
- In-depth introduction to core concepts in graphics, vision and machine learning
- Basis of the specialization track in visual computing
- Entry point for a variety of specialized courses
- Both theoretical and practical issues




4  
Course Organization



## Structure



5  
Course Organization



## 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

6  
Course Organization

**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

7  
Course Organization

**Course Organization Team**

<b>Markus Gross</b>	<b>Dozent</b>	grossm@inf.ethz.ch
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8  
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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

9  
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**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

10  
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**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.

11  
Course Organization

**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)

12  
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**Course Organization Support**

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

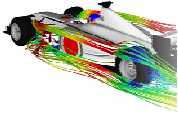
13  
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**cg\_stud mailing list**


- We administer a mailing list for students interested in Computer Graphics
  - [http://www.lists.inf.ethz.ch/mailman/listinfo/cg\\_stud](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...

14  
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**Part I: Graphics**



«The purpose of computing is insight, not numbers!» - Richard Hamming  
..or  
«A picture is worth a thousand numbers!»



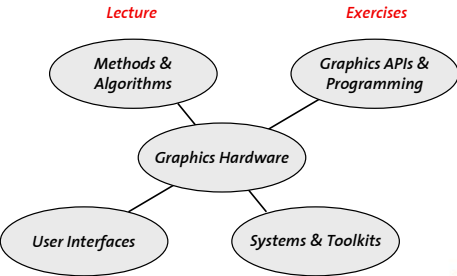
15  
Motivation

**Goals**

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


16  
Goals

**Computer Graphics covers**



17  
Applications

**Applications Modeling & Image Generation**



18  
Applications

Applications

## Medical Simulations

19 Applications

Applications

## Scientific Visualization

20 Applications

Applications

## Collaborative VE

The Blue-C

21 Applications

Markets

## Feature Films

22 Applications

Markets

## Games

23 Applications

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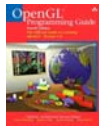
## Further Readings

- D. F. Rogers:  
*Procedural Elements of Computer Graphics*  
2<sup>nd</sup> edition, McGraw-Hill, 1997.
- A. Watt:  
*3D Computer Graphics*  
3<sup>rd</sup> 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*  
4<sup>th</sup> edition, Oldenburg, 1996.

24 Course Organization

**Course Organization**  
**Further Readings**

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

25  
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**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](http://accad.osu.edu/~waynec/history/lessons.html)

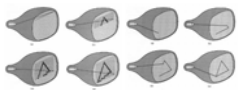


*The discipline is so recent in its early developments and so rapidly changing that we are in fact living it, and it evolves as we speak.*

Wayne Carlson

27  
History

**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

28  
History

**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



29  
History

**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)

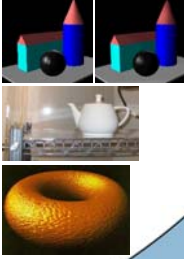




30  
History

**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



31 History

**1980's**

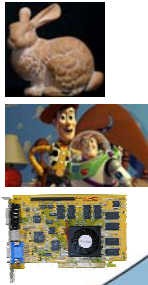
- 1980 Turner Whitted: Ray tracing
- 1982 Silicon Graphics (SGI) founded
- 1982 TRON (Disney) 15 minutes of computer generated images
- 1983 Apple Lisa: First PC with GUI
- 1984 Goral et. al: Radiosity
- 1985 Microsoft Windows 1.01
- 1986 MIT: X-Window System



32 History

**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



33 History


**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



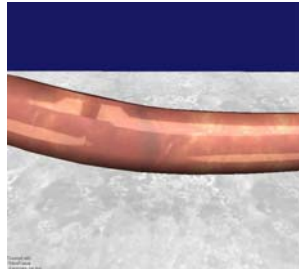
34 History

**Example Demo Realtime FEM**




36 History

**Vessel Rupture**




36 Course Organization







### Heat Transfer and Melting




37  
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### Boiling



38  
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### Lava




39  
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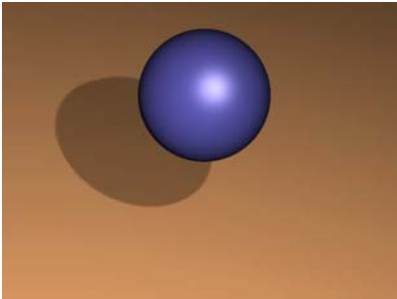
### Brittle




40  
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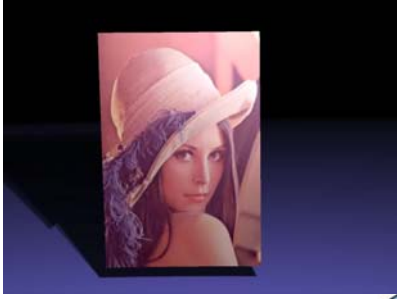
### Shell Physics- Balloon



41  
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### Shell Physics- Baloon



42  
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