

Computer Graphics

Contents

- Computer graphics: what and why
- Many scenes, two renderer and one image
- About course

Computer graphics: what and why

Motivation

"To understand nature, incorporate science and art with technology to create virtual environments that exist or never could have existed."

"Computer graphics is science and art of communicating visually via computer display and its interaction devices" *

"A collaboration between art and technology" **

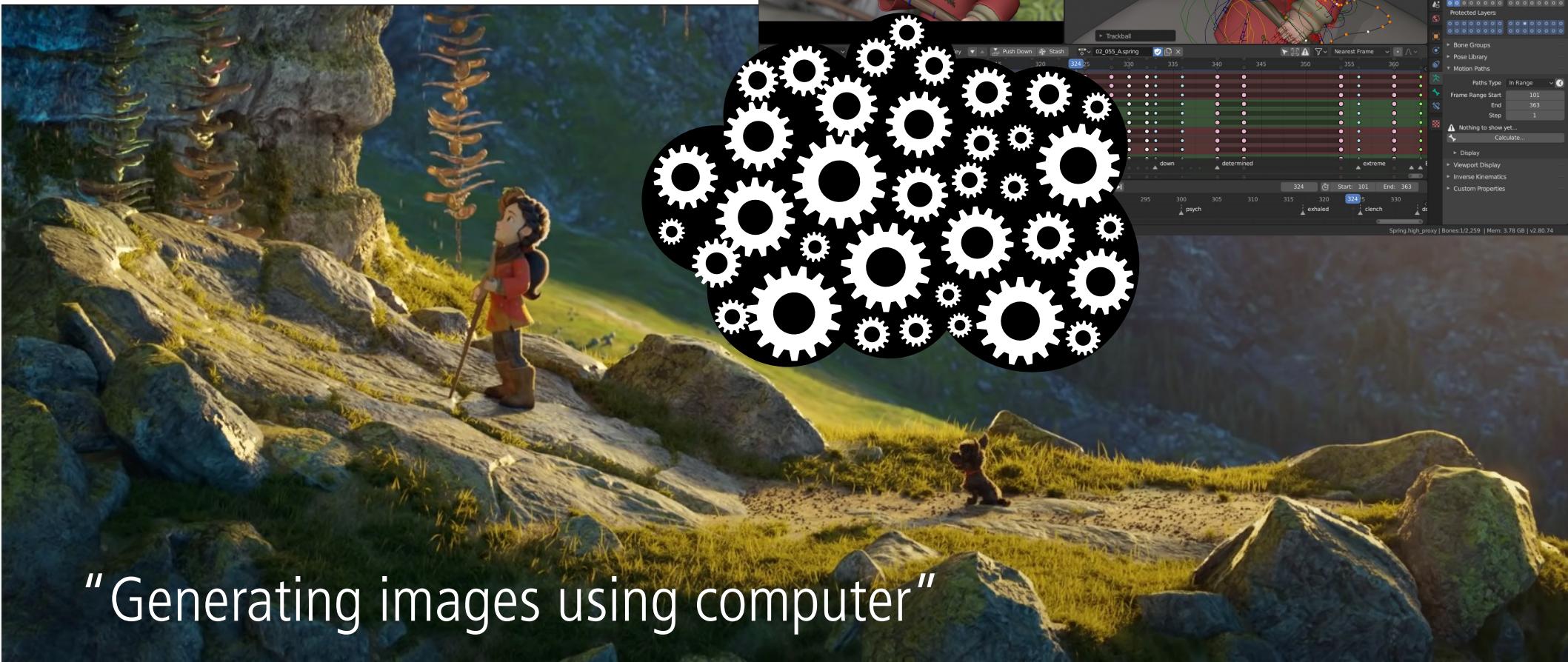
To visualize

To express

* Book: principles and practices

** Pixar

Computer graphics

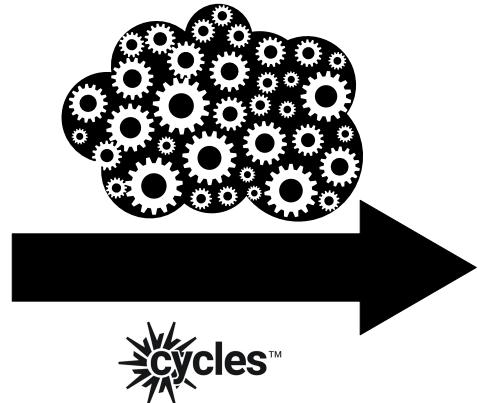
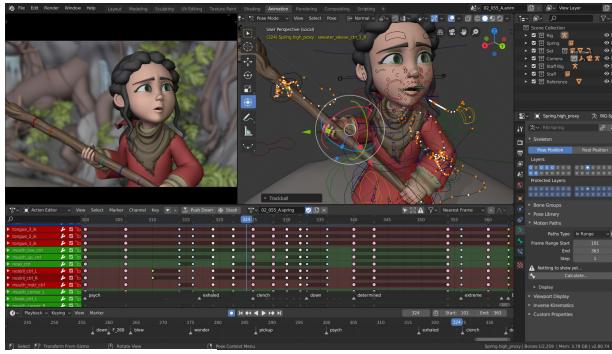


"Generating images using computer"

Computer graphics

Generating images:

- 3D scene – what will be present in image
- Rendering – how image is generated from 3D scene
- Image display – how image is displayed



Computer graphics and you

- You like **physics** and would like to see its practical applications in generating amazing imagery and effects.
- You like **mathematics**: computer graphics is applied mathematics. Enough said.
- You like **programming**: computer graphics is exciting application that employs complex architectures for modeling and rendering and in return gives very gratifying results.
- You like **art and design**: Computer graphics is not only about tools which serve for simulating and rendering 3D scenes - it is also how we use those tools to create something that exists or never existed
- You like **animated films** or **VFX**: yes there is a lot of computer graphics there combined with other disciplines to support stories to remember
- You like **computer games**: amazing application of computer graphics combined with different disciplines
- You like **visualization**: biology? Chemistry? Geology? Astronomy? Computer graphics is there for you!

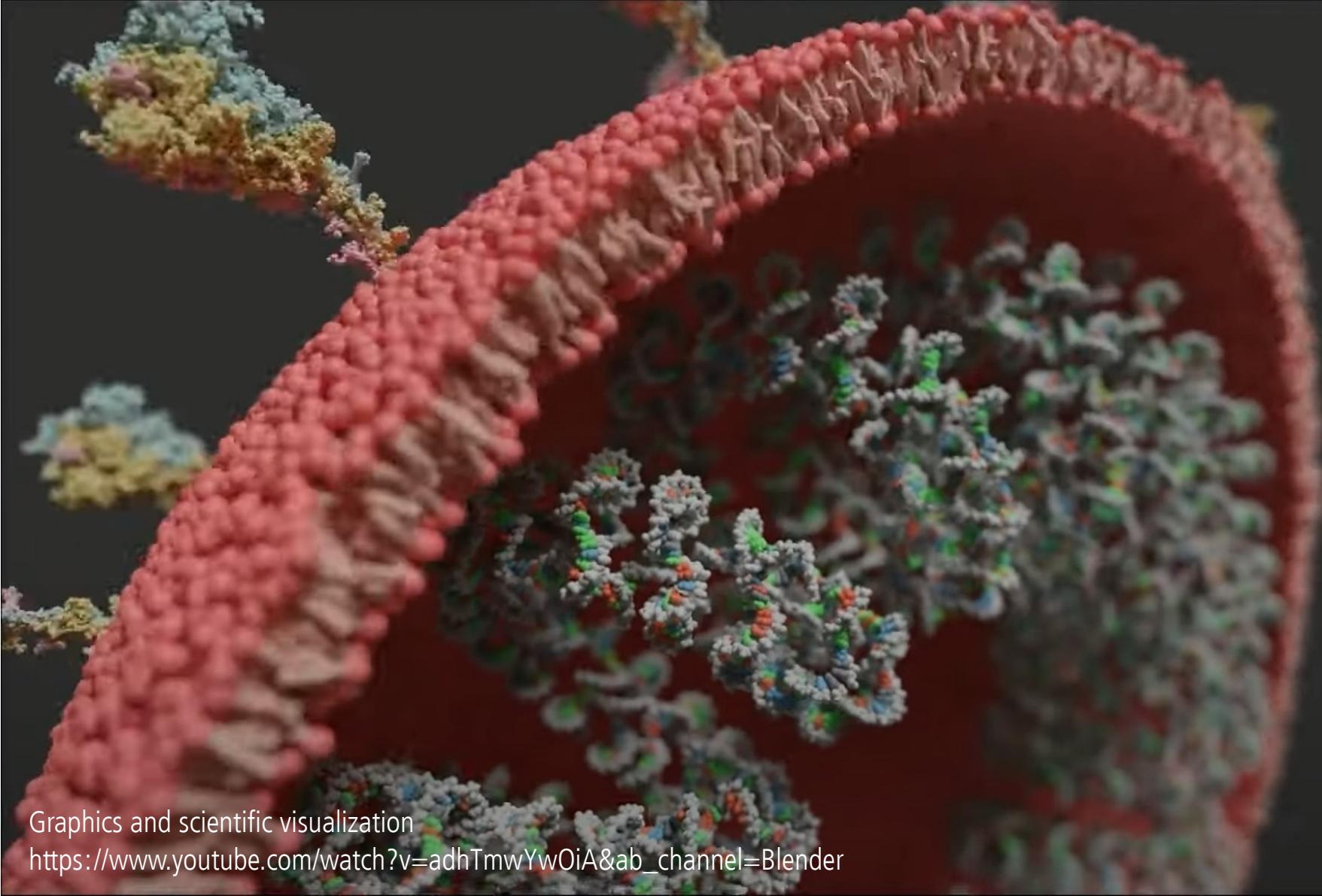


Graphics and computer games

<https://www.rockstargames.com/reddeadredemption2/>

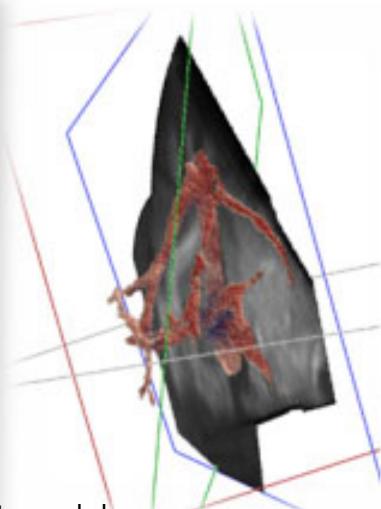
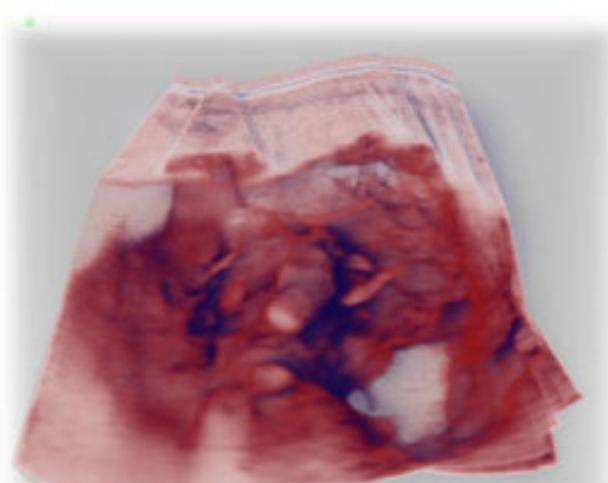
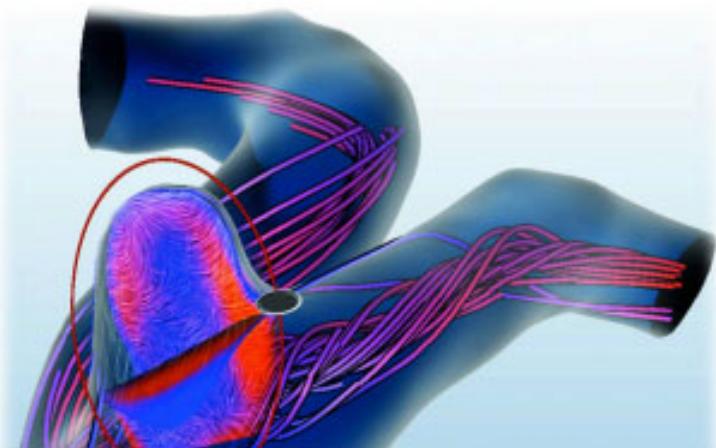
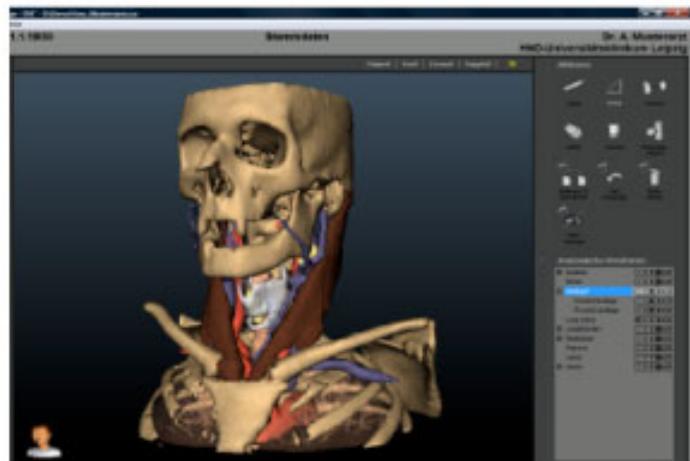
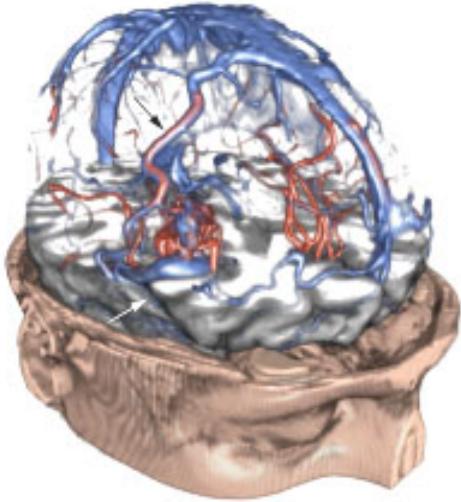


Graphics and animated film
<https://www.pixar.com/soul>



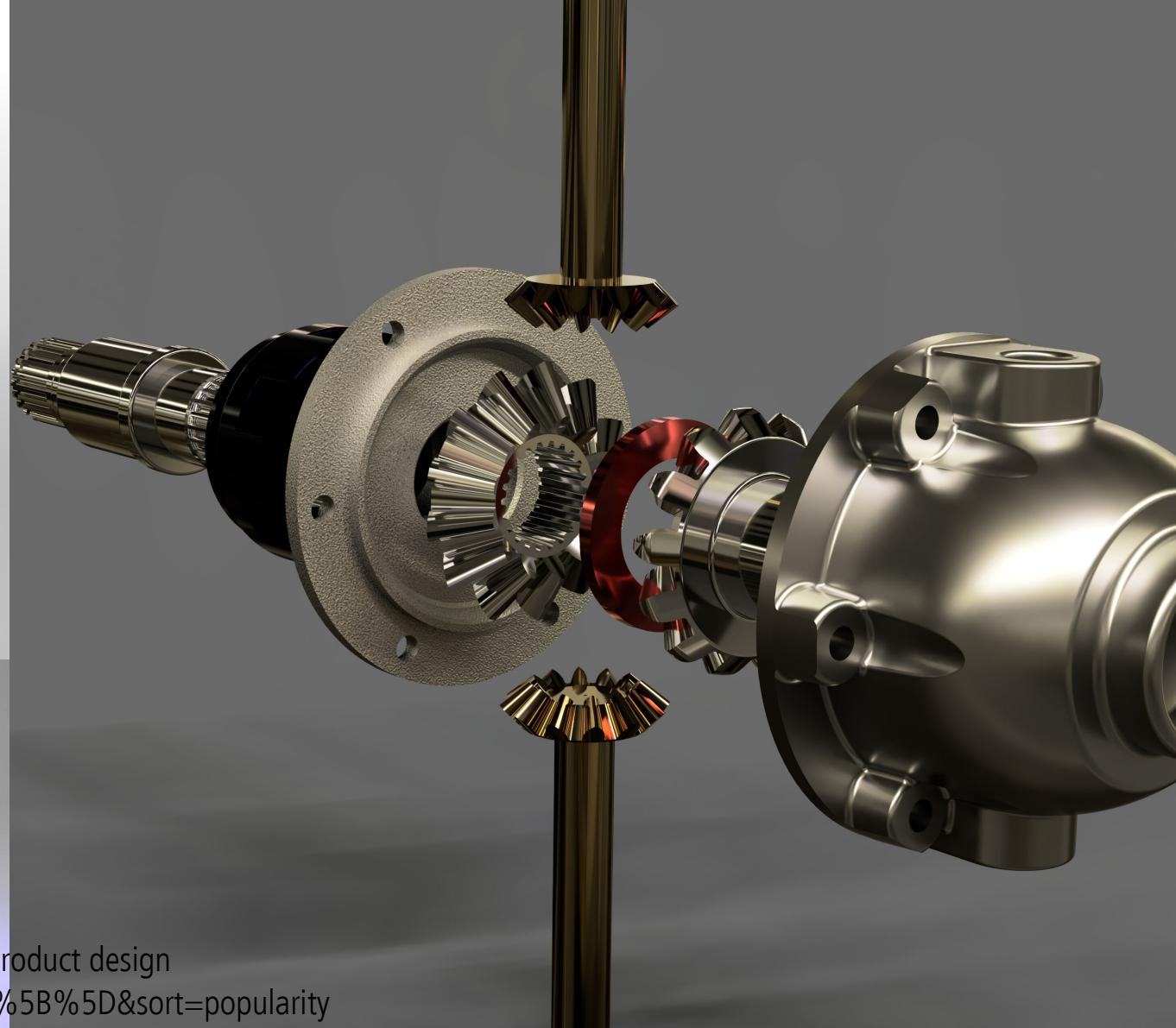
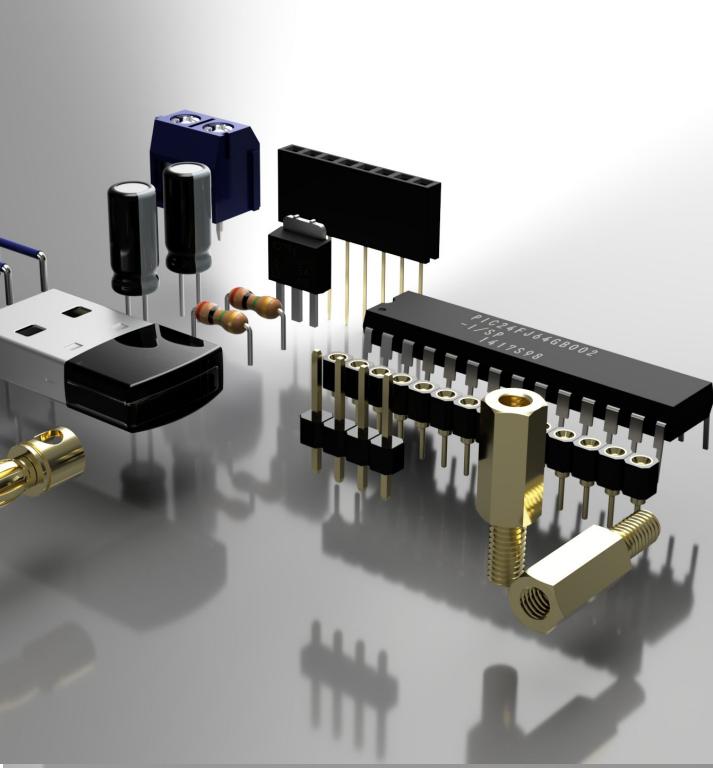
Graphics and scientific visualization

https://www.youtube.com/watch?v=adhTmwYwOjA&ab_channel=Blender

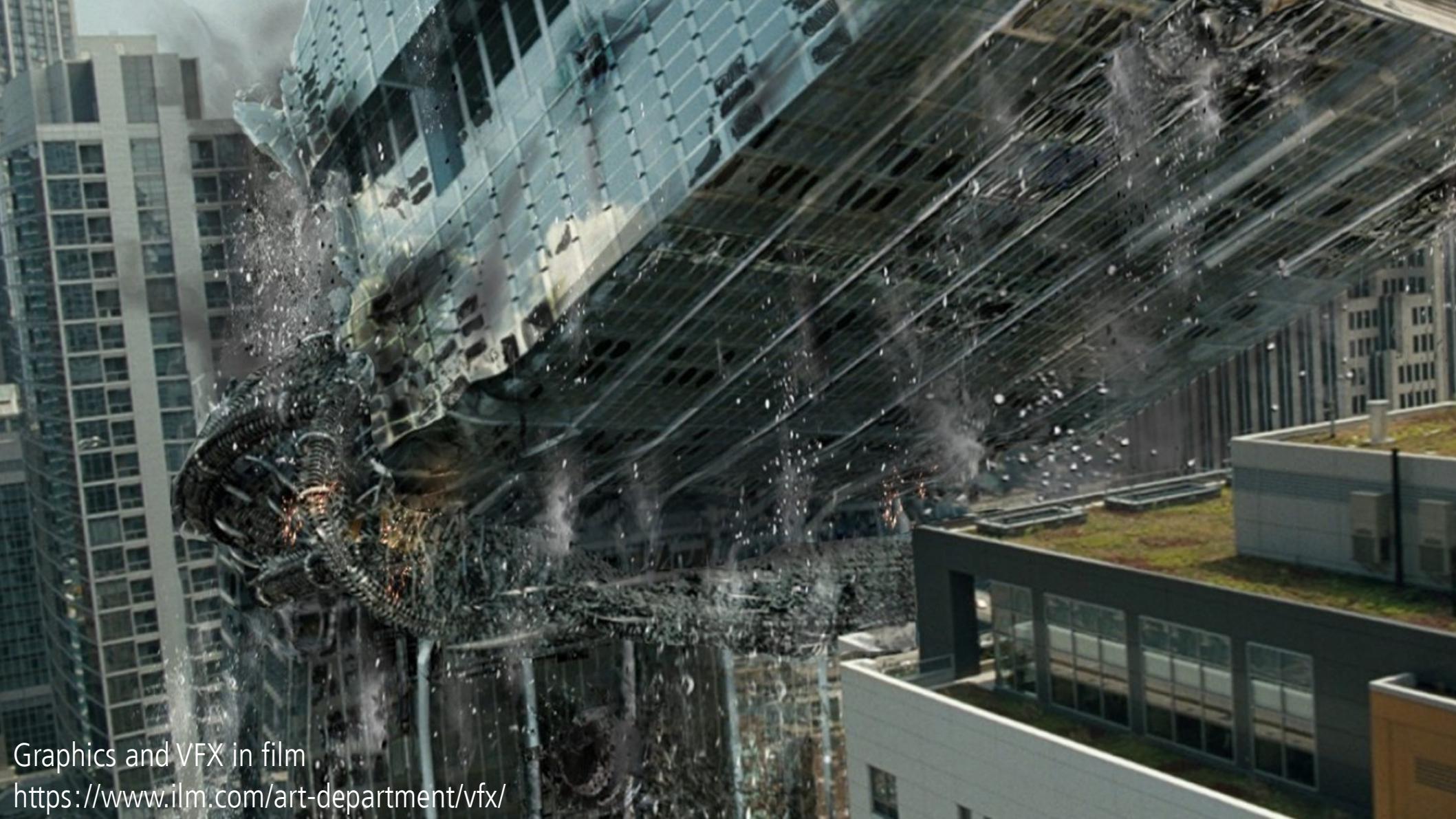


Graphics and medicine

<https://www.siggraph.org/news/eurographics-celebrates-computer-graphics-in-medicine/>



Graphics and CAD, manufacturing, engineering, product design
<https://gallery.autodesk.com/projects/all#filters=%5B%5D&sort=popularity>



Graphics and VFX in film

<https://www.ilm.com/art-department/vfx/>



Graphics and simulation for VFX in film

https://www.youtube.com/watch?v=lS--1gRjfRk&ab_channel=Rebelway



Graphics and motion capture for VFX in film

<https://www.fxguide.com/fxfeatured/weta-digital-s-remarkable-face-pipeline-alita-battle-angel/>



Graphics and arhitecture

<https://www.blenderguru.com/articles/20-jaw-dropping-architectural-renders>



Graphics and interior design; ergonomic design
<https://www.blenderguru.com/articles/20-jaw-dropping-architectural-renders>

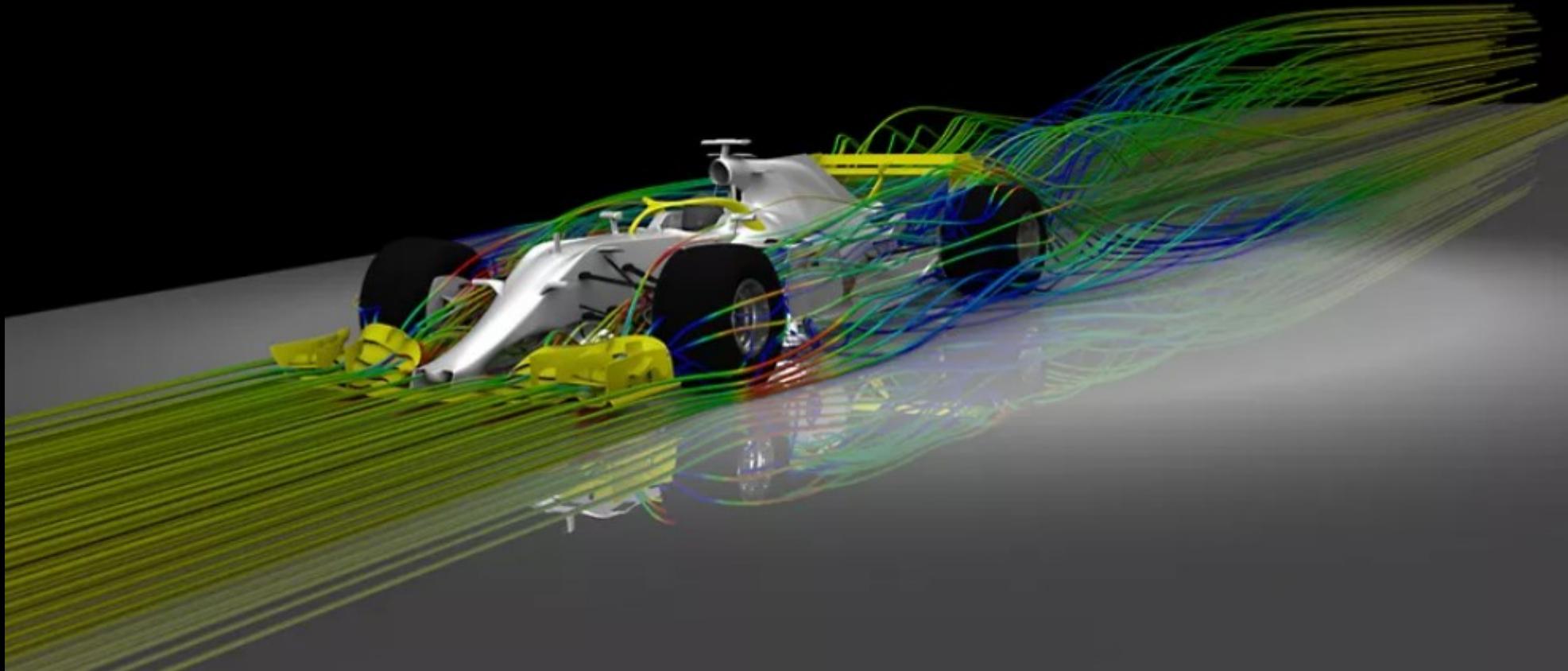


graphics and illumination planning
http://graphics.cs.aueb.gr/graphics/research_lightingopt.html



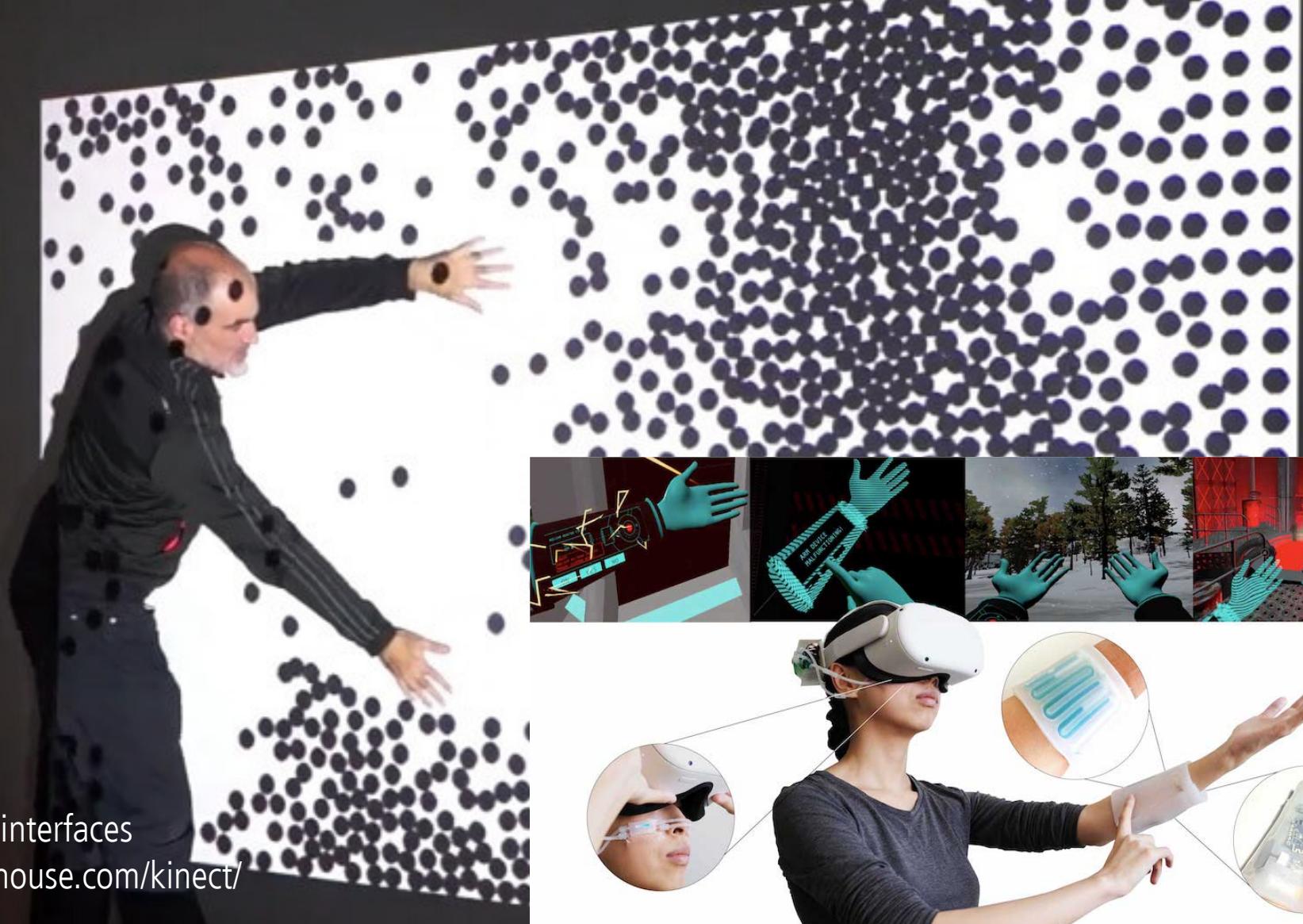


Graphics and new media art
<https://refikanadol.com/>



Graphics and predictive simulations

<https://www.ansys.com/company-information/the-ansys-story>



Graphics and user interfaces
<https://parametrichouse.com/kinect/>
<http://plopes.org/>

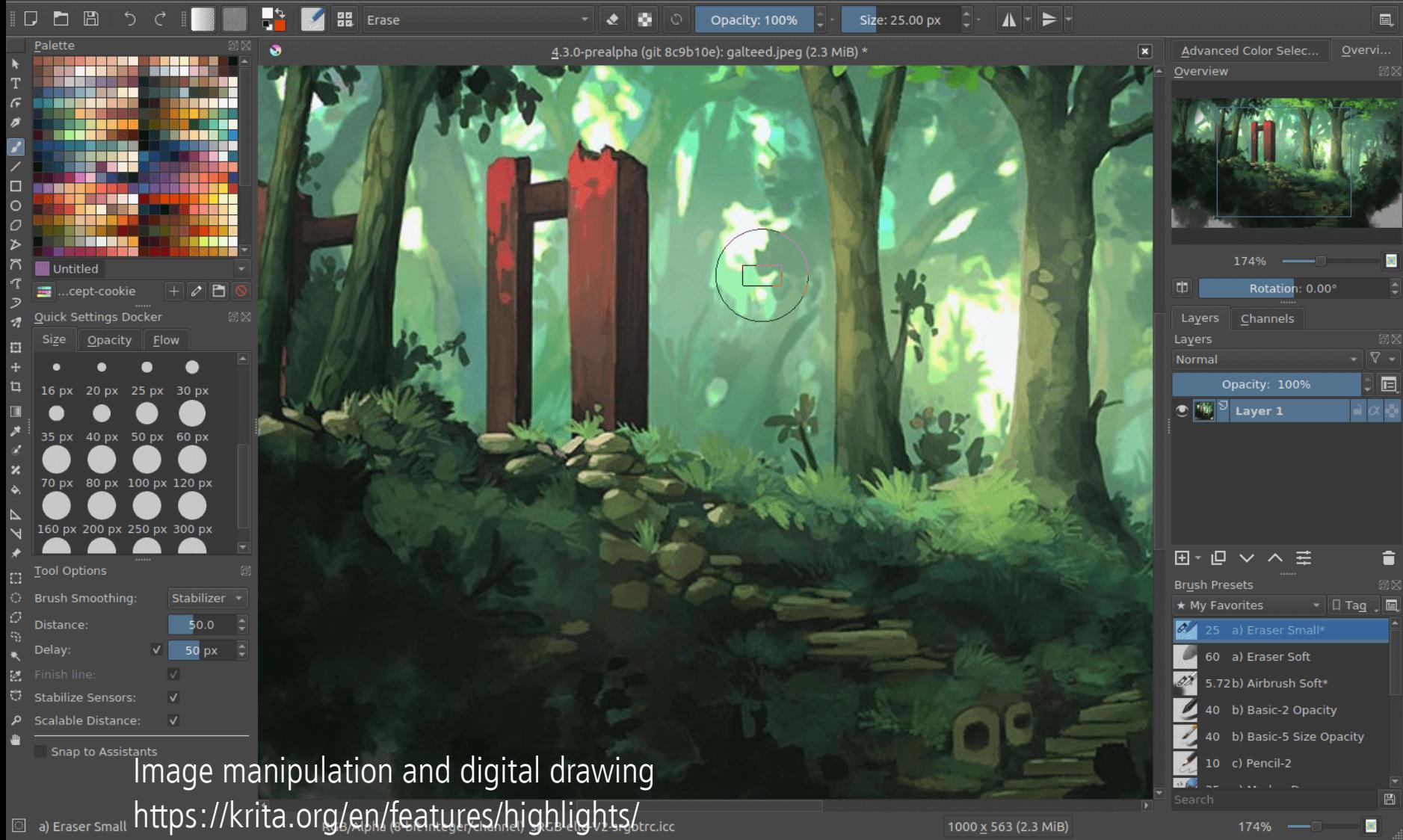
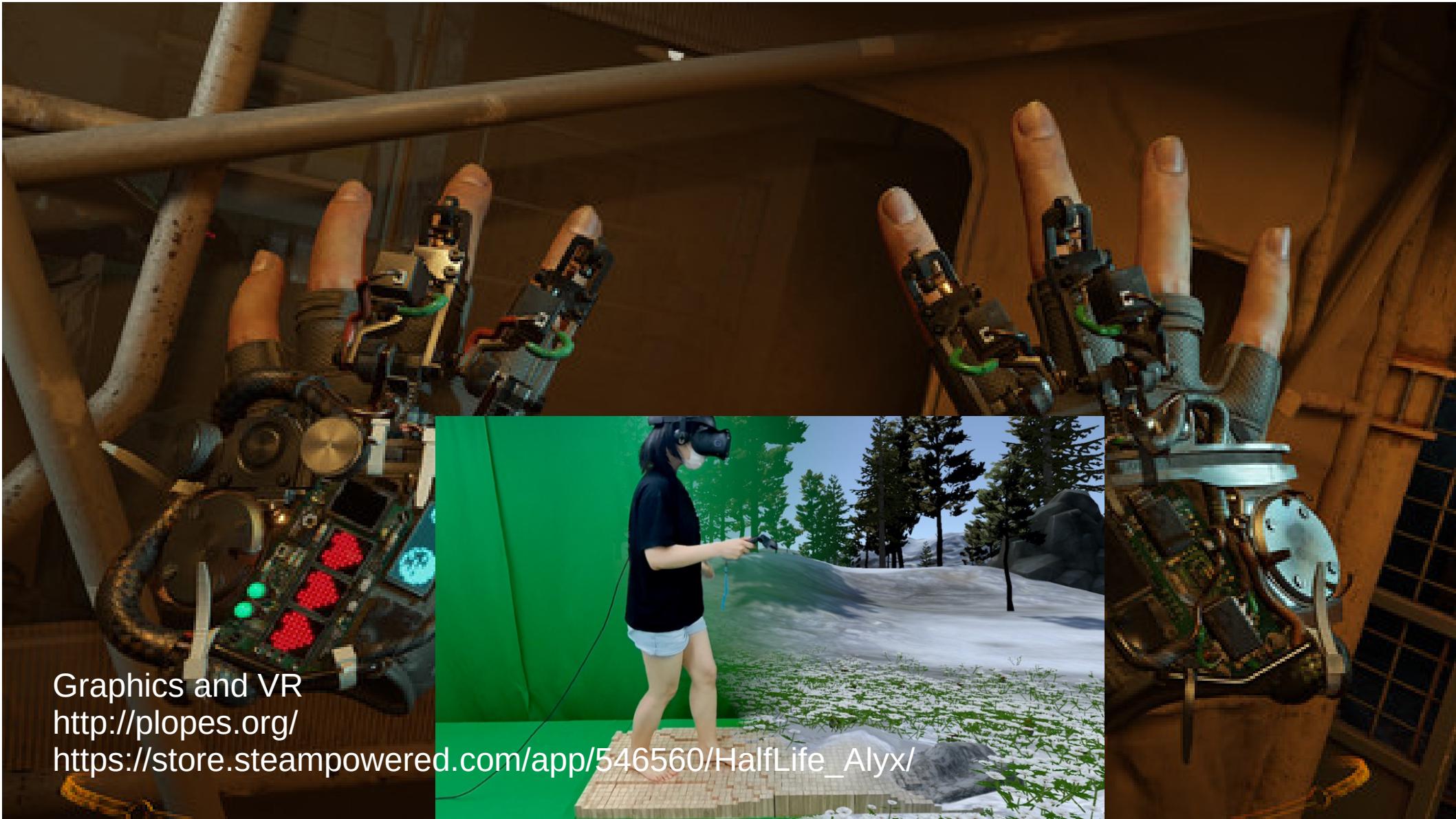


Image manipulation and digital drawing

<https://krita.org/en/features/highlights/>

1000 x 563 (2.3 MiB)

174%



Graphics and VR
<http://plopes.org/>
https://store.steampowered.com/app/546560/HalfLife_Alyx/

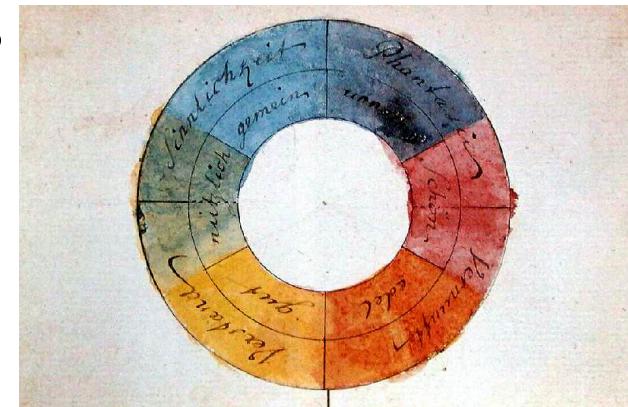
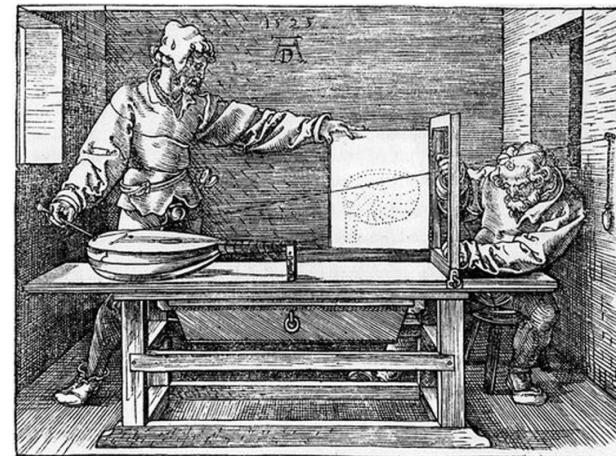


Computer graphics and AR

<https://deltareality.com/portfolio/vaillant-ar-facility-tour/>

Bit of history

- Development of perspective projection in drawing:
perspective machine (Albrecht Dürer)
- Johann Wolfgang von Goethe and Theory of Colours
- Optics (physics)
- Geometry, linear algebra, statistics
- Computer science



Computer graphics today

Many scenes, two renderers and one image

Glimpse into image generation

- Analogy: taking a photograph
 - World → 3D scene
 - Image formation → rendering
 - Image

3D scene modeling

- Interactive modeling: artists
- Acquisition from real world

Rendering

- Rasterization-based rendering
- Ray-tracing based rendering

Image

About course

About course

- This course is not about art, design, game-development, film, visualization in engineering and science domains...
- ...but it gives foundations for making those with right domain knowledge.
- Computer graphics is a tool to create beautiful imagery but tool alone is not enough to create those images! Therefore, if you are interested in applying graphics to specific domain area (game, film, sci-vis, etc.) I encourage you to obtain the required domain knowledge as well!

About lecturer

- My background
- My interests
- My experiences

About you

- What is computer graphics for you?

About course

- During lectures we will cover wide range of methods and ideas conceptually
- During project work, you will have time to dive deeper into technical aspects and implementations of what is the most interesting to you.

Course outcomes

- Understand fundamental concepts and theory: those are immortal
- Typically mathematics, algorithms and methods used in computer graphics
- Understanding how foundations are supporting technology and which technology exists for you to create
- Map of the computer graphics

Map of computer graphics

- Point of lectures is to give structure and it is up to you to fill it.

Special outcomes

- “Seeing world with different eyes”
- Foundations for expression and visualization

Course content

- 10 lectures, 3h each
- Project: through all lectures
- Exam: end of lectures, 30min, Moodle questions

Lectures syllabus

- Lecture 1: introduction (this) and rendering overview
- Lecture 2: 3D scene - shapes and materials
- Lecture 3: 3D scene - lights and cameras
- Lecture 4: Rendering - rendering introduction and raytracing
- Lecture 5: Rendering - rasterization
- Lecture 6: Images - images + project
- Lecture 7: More on 3D scene + project
- Lecture 8: More on 3D scene + project
- Lecture 9: More on rendering + project
- Lecture 10: More on image + project
- <https://github.com/lorentzo/IntroductionToComputerGraphics/wiki/Syllabus>

Lectures

- The point of lectures is to give the big picture and give highlights on foundations
 - They are starting point, a map, which is for you to explore.
 - Consultations are always possible!
- During lectures write down important points ask if anything is unclear
 - Feel free to interrupt! If something is not clear for you it is a high possibility it is also not clear for someone else – it is good to repeat!

Note for slides

- Note for slides
 - Slides were intended for both lectures and as reading material. Therefore, some slides contain a lot of text which is intended for student to read at home. Those slides will have special icon.
 - Important elements will be highlighted and noted that they should be written down by hand
 - Your interaction is crucial for best learning experience

Questions

Reading material

Write it down

Learning material

- These presentations and your notes
- <https://github.com/lorentzo/IntroductionToComputerGraphics>
- All materials are available in advance
 - TIP: read materials before lecture – it helps for following the lecture

Additional learning material

- Books
- Useful sites

Projects

- TODO: shortly describe projects + add images of what results might look like
 - Low level of abstraction: coding and focus on rendering
 - High level of abstraction: modeling, animation and interaction in DCC or game engine
- <https://github.com/lorentzo/IntroductionToComputerGraphics/wiki/Projects>
- Projects: a time dedicated to experience real-life development (and research).
 - Projects can be started even after this lecture: decide on topic and start investigating!.
 - Projects should be time for you to research and work on your own - consultations are always possible!
 - Projects are made to be fun and engaging: choose what you like!

Course grading

- Project
 - Based on solved steps
- Exam
 - 30min, online, Moodle