

# Outro

DHBW, Computer Graphics

Lovro Bosnar

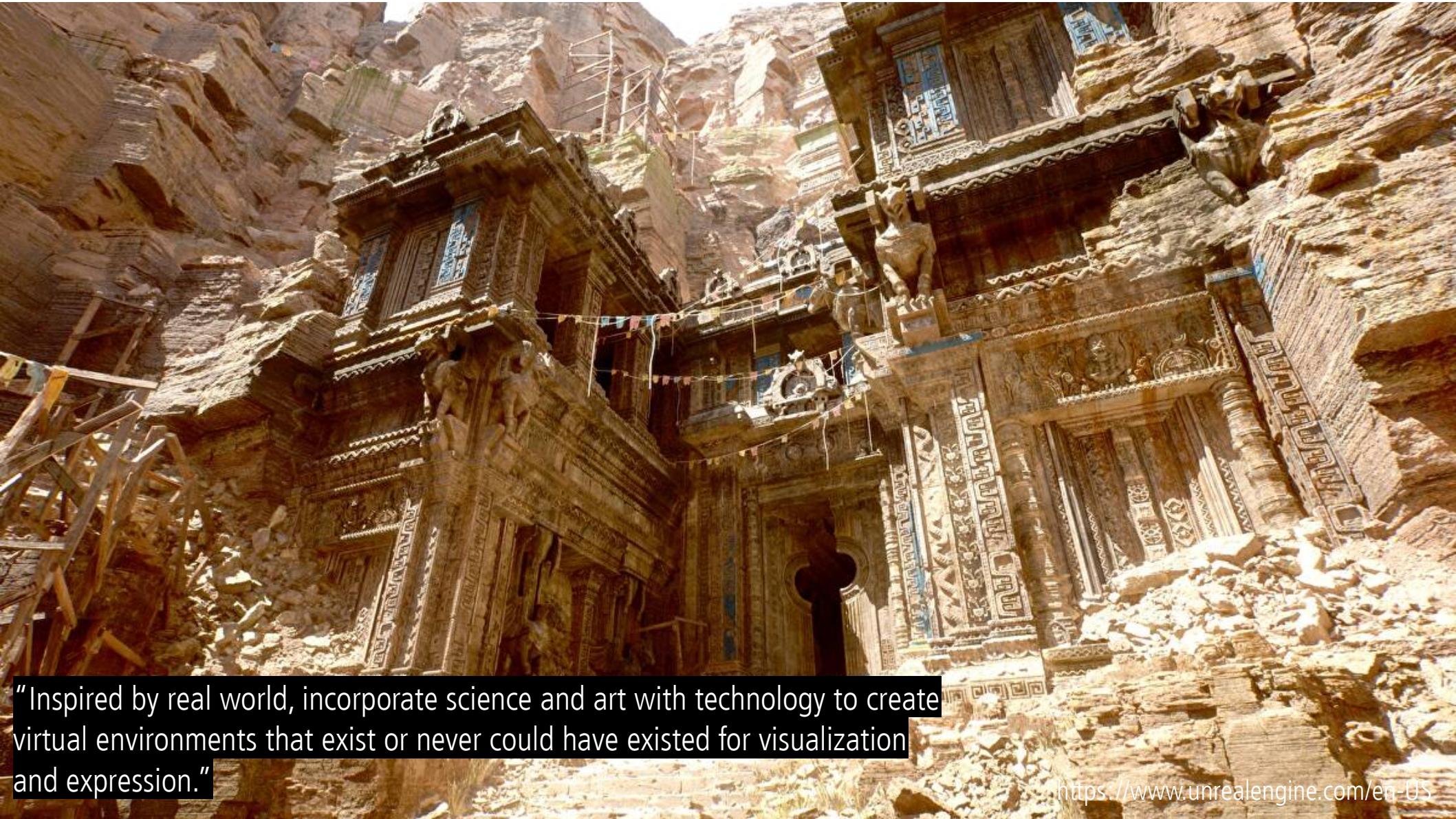
29.3.2023.

# Plan

- Review
- Where to next?

# Review

“Computer graphics is science and art of communicating visually via computer display and its interaction devices”



"Inspired by real world, incorporate science and art with technology to create virtual environments that exist or never could have existed for visualization and expression."

<https://www.unrealengine.com/en-US>



6

"A collaboration between art and technology"

<https://www.pixar.com/>

# Computer graphics



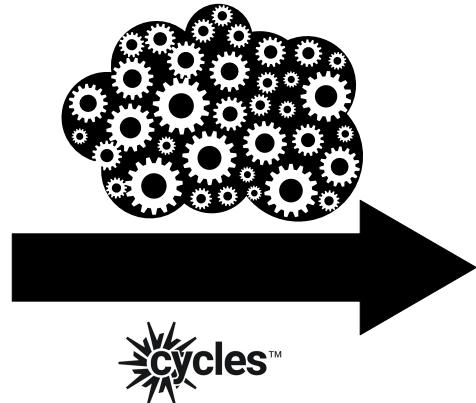
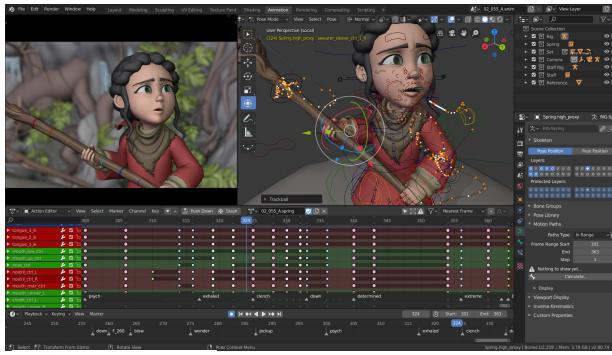
"Generating images using computer"

<https://www.blender.org/>

# Computer graphics

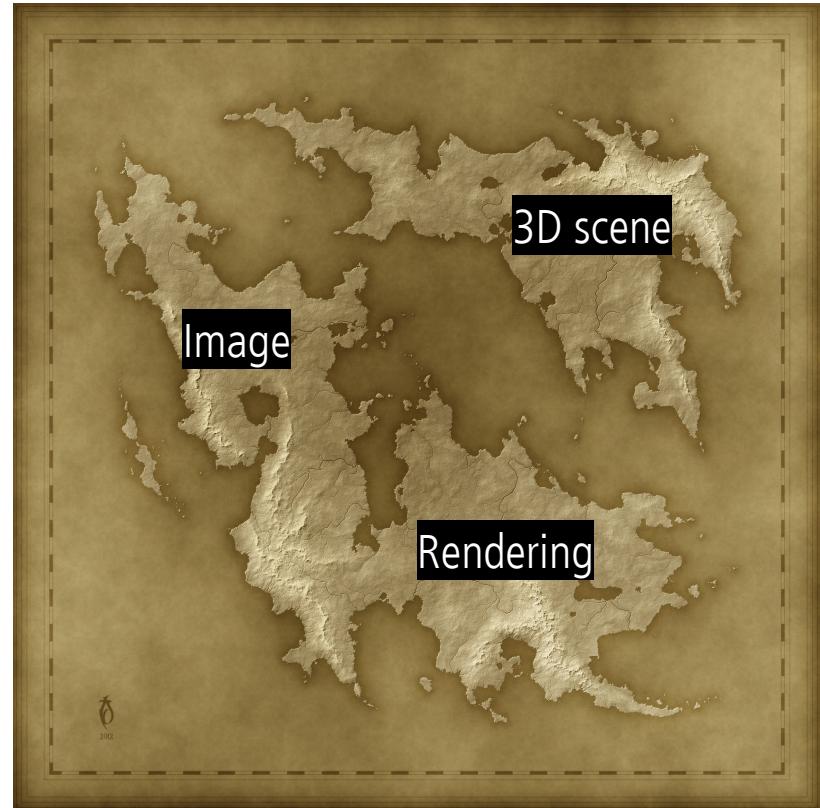
Generating images:

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



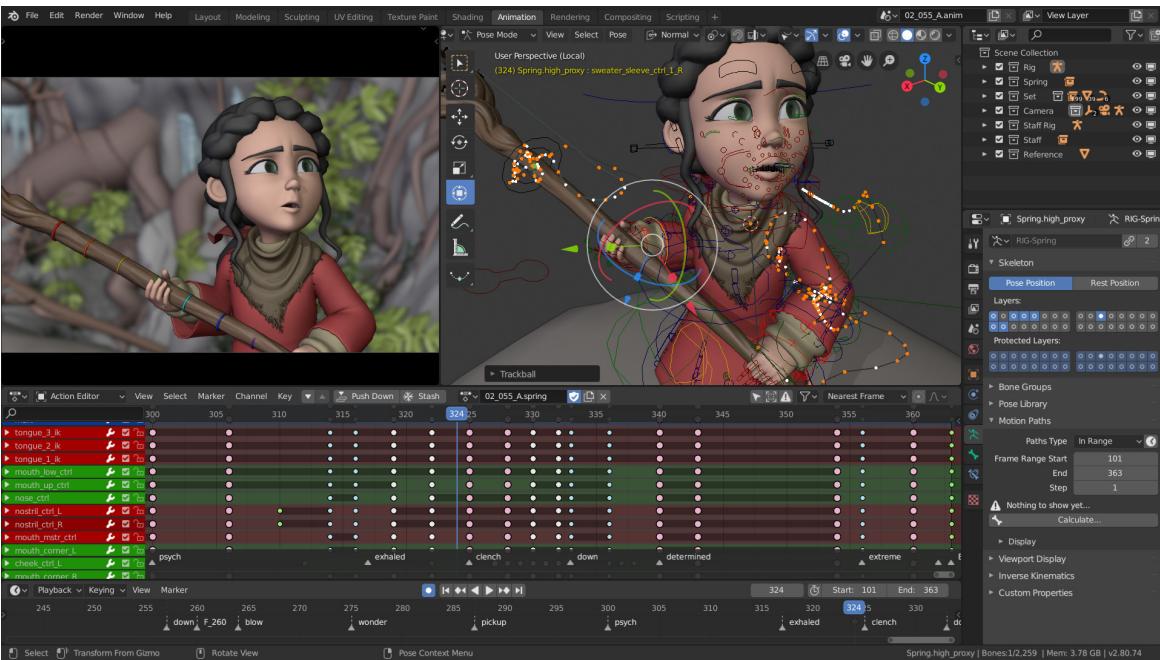
# Map of computer graphics

- You have the map of computer graphics
- You have good foundations of computer graphics (even if you forget all the details!)
- It is up to you now to explore further!



# Special outcomes

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



Where to next?

# Where to next?

- **Practical directions:**
  - Think about where can you **apply computer graphics** methods in your work (master thesis?)
  - Build on your project work or **build rendering/modeling system** from scratch
  - Get familiar with **industry-standard technology**
- **Research directions:**
  - Look into and **investigate topics** which were “out of scope”
  - **Read a complete book** covering computer graphics
  - Follow **conferences and read science papers**

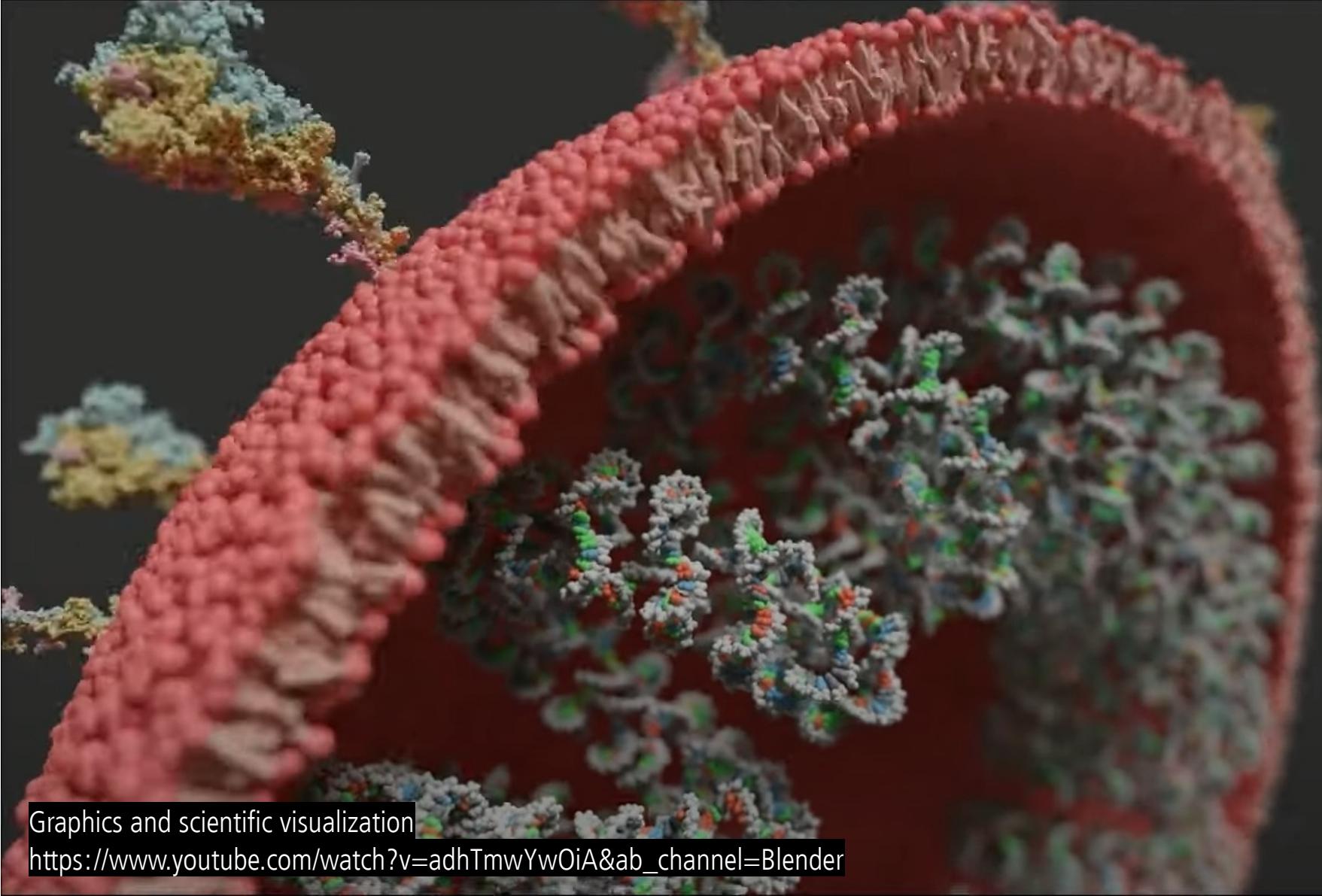


Graphics and computer games

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

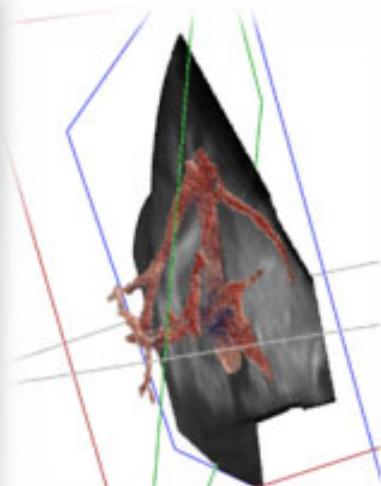
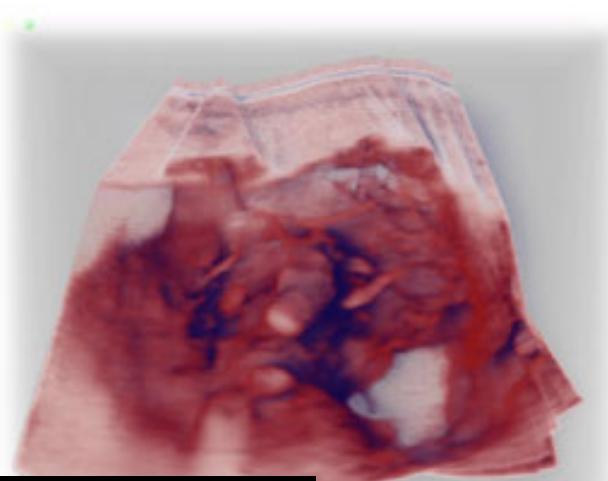
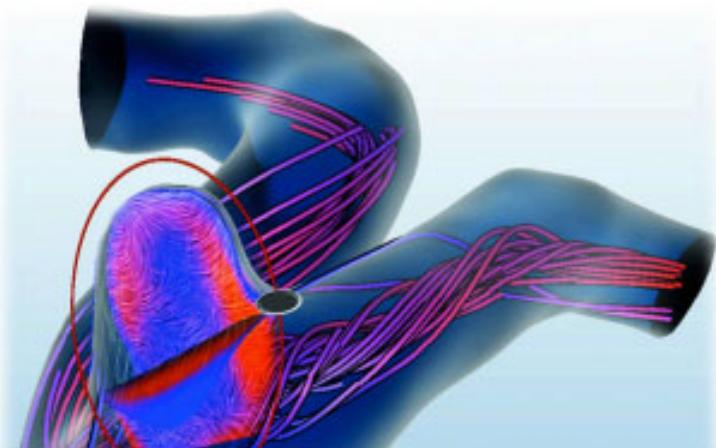
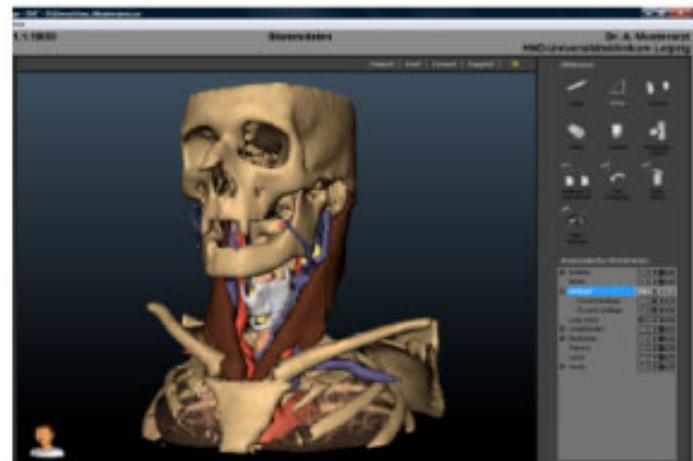
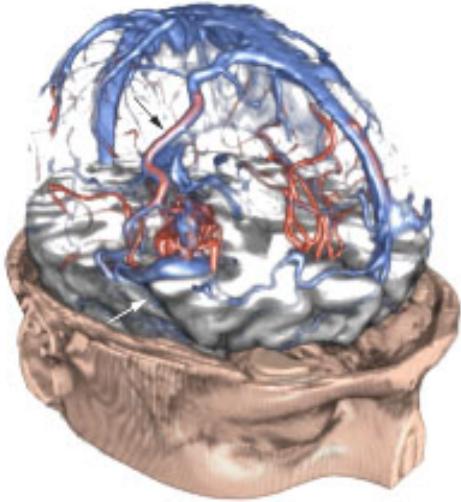


Graphics and animated film  
<https://www.pixar.com/soul>



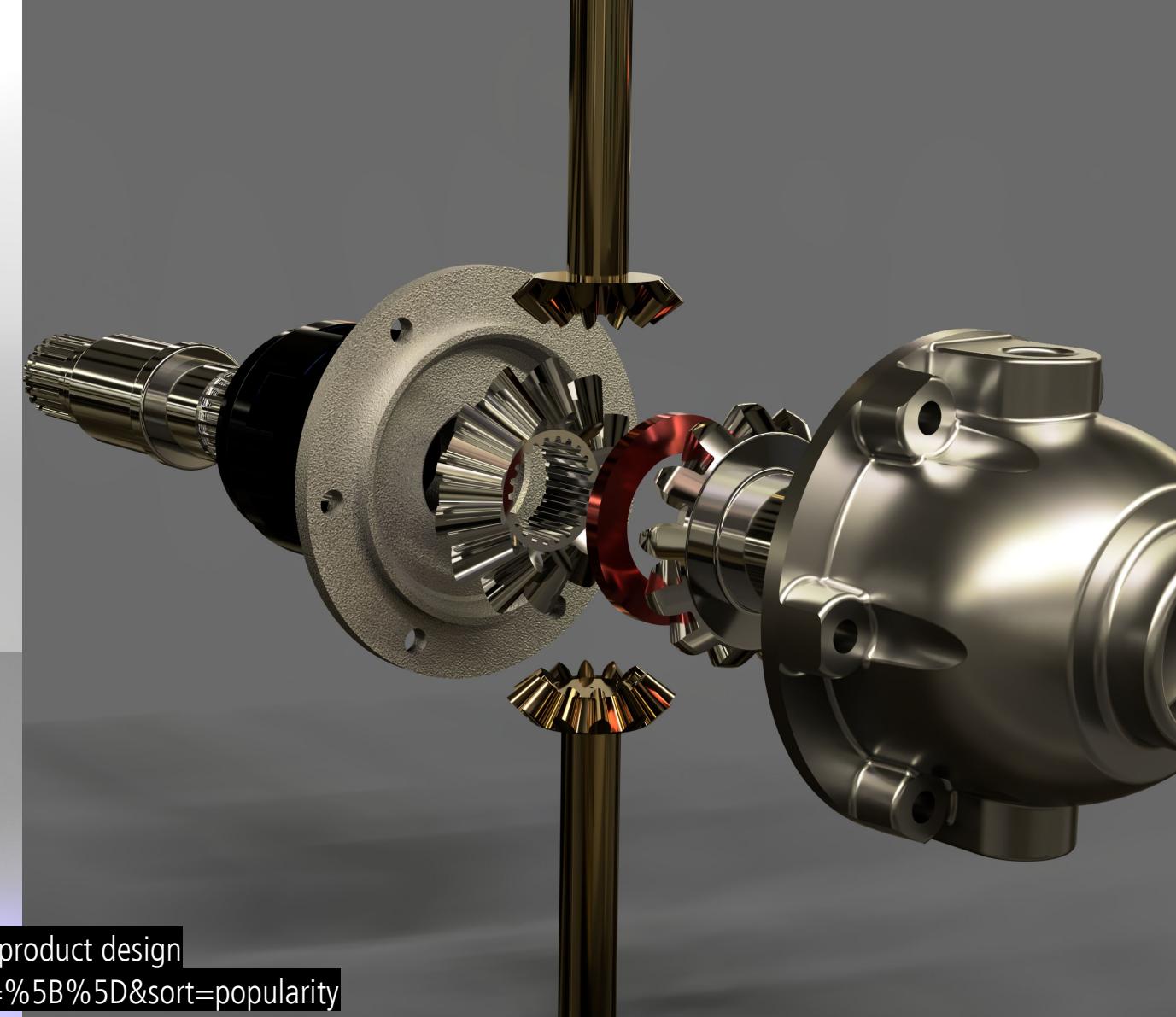
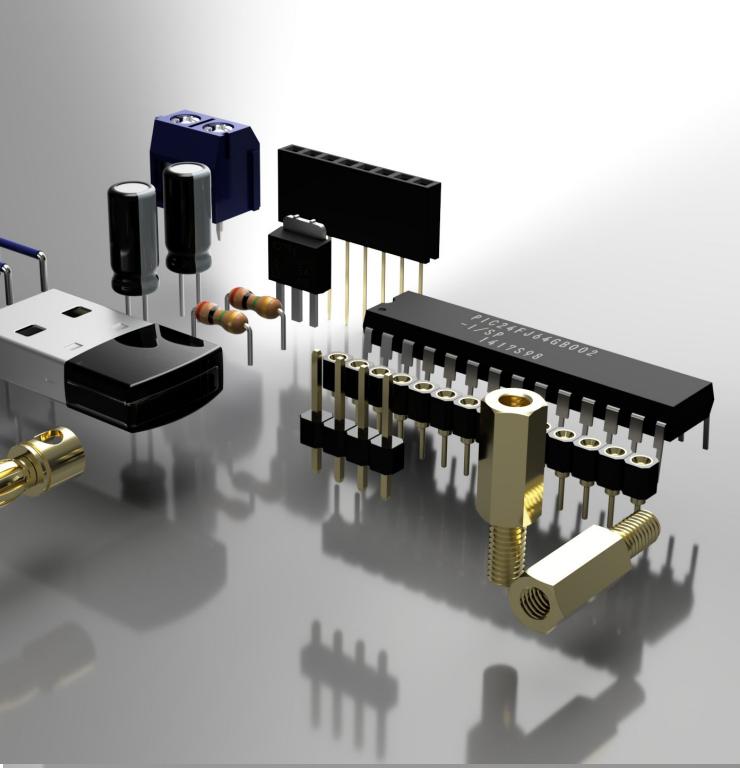
Graphics and scientific visualization

[https://www.youtube.com/watch?v=adhTmwYwOjA&ab\\_channel=Blender](https://www.youtube.com/watch?v=adhTmwYwOjA&ab_channel=Blender)



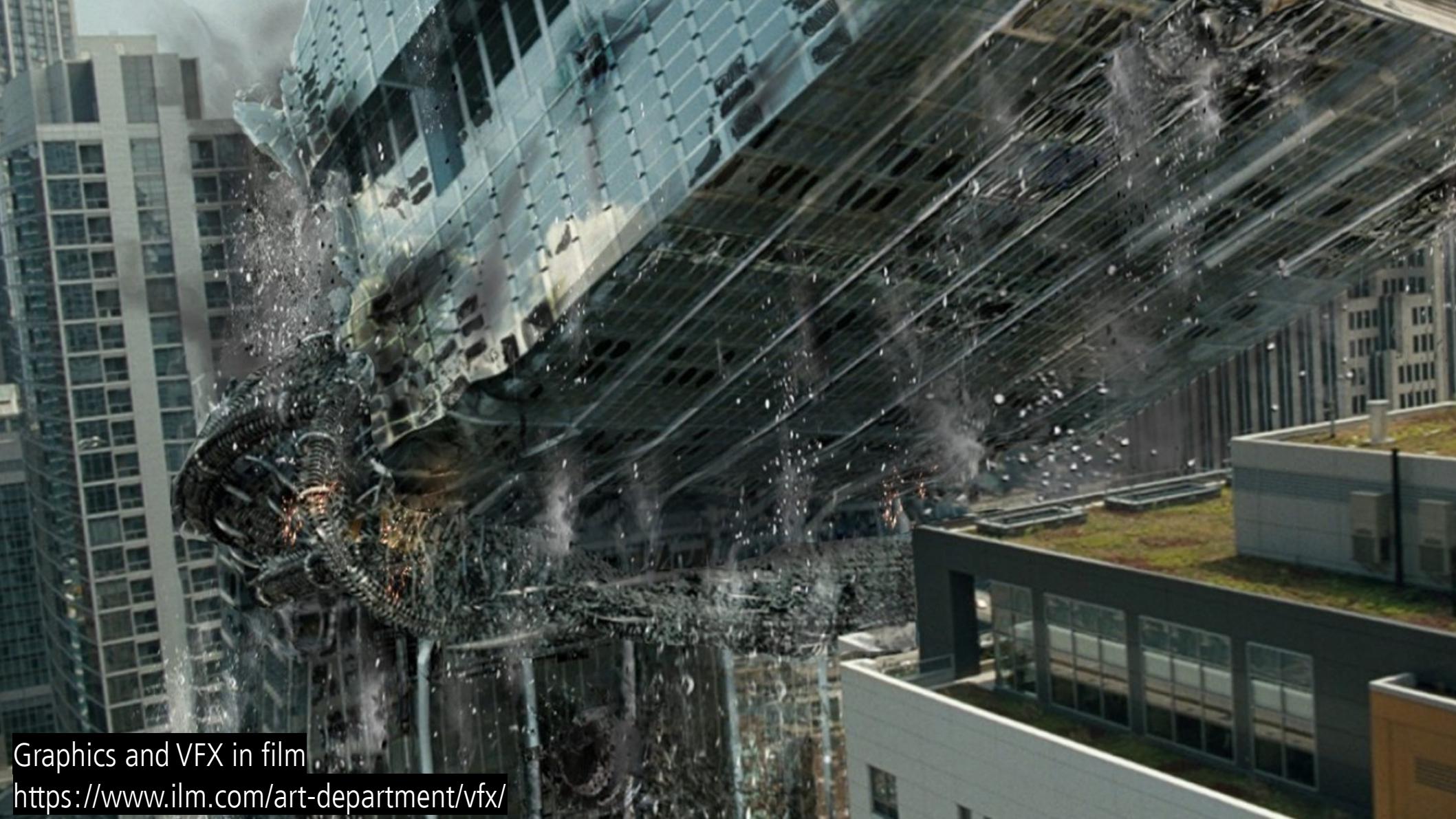
Graphics and medicine

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



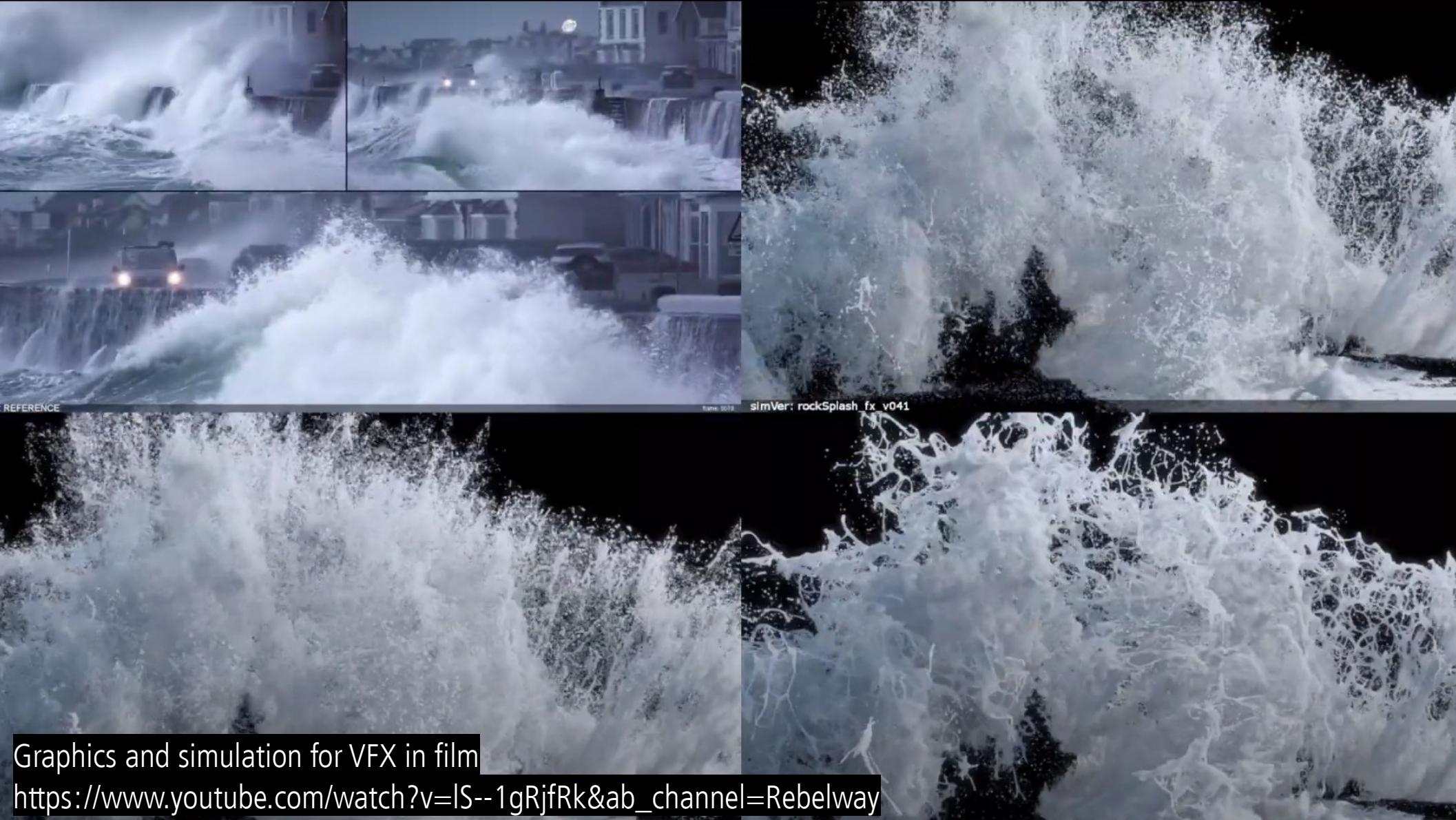
Graphics and CAD, manufacturing, engineering, product design

<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](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>



Engineered with



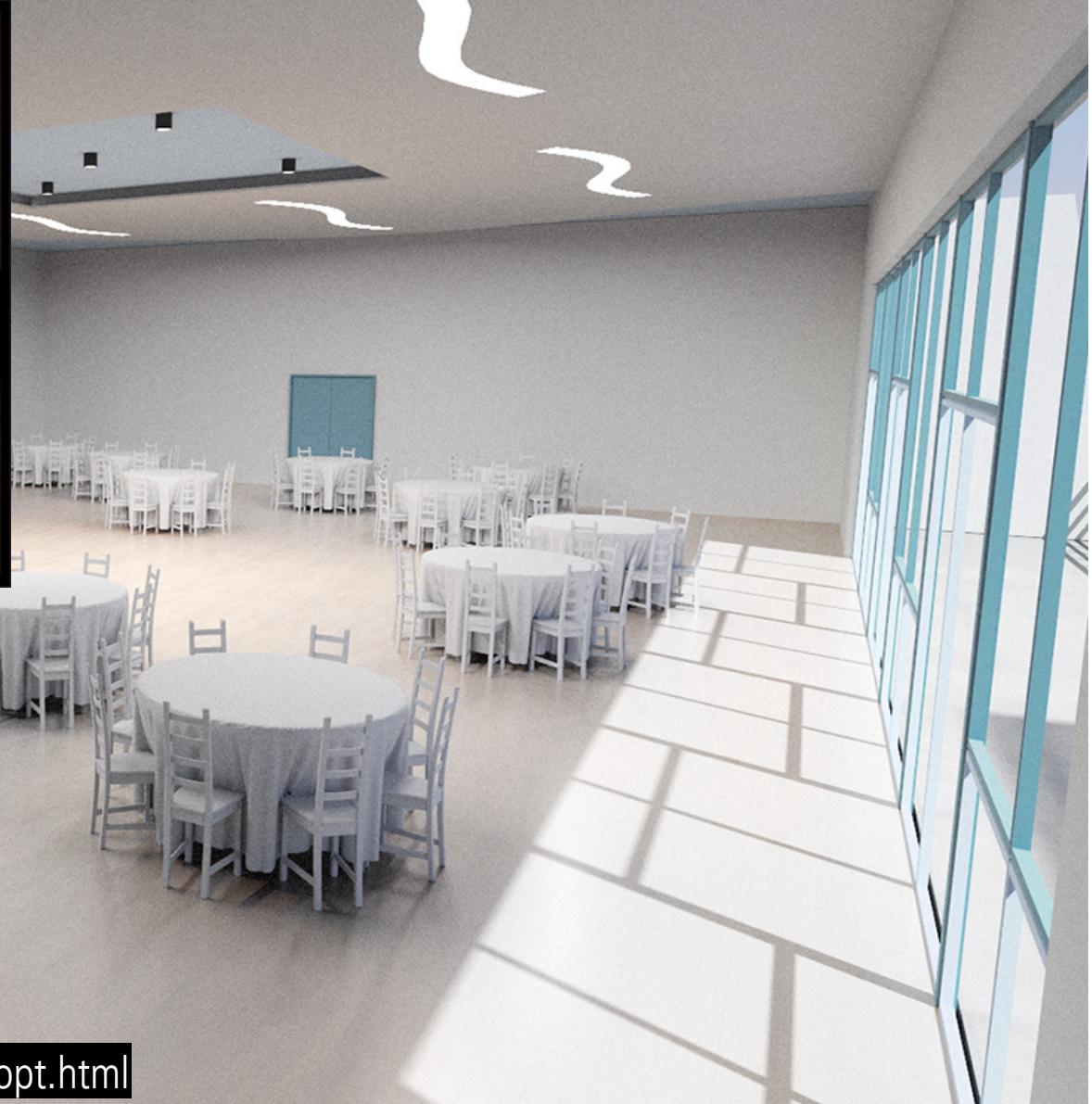
Graphics and product design; product visualization

[https://www.youtube.com/watch?v=-BscQpkhpJw&ab\\_channel=Houdini](https://www.youtube.com/watch?v=-BscQpkhpJw&ab_channel=Houdini)



Graphics and interior design; ergonomic design

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

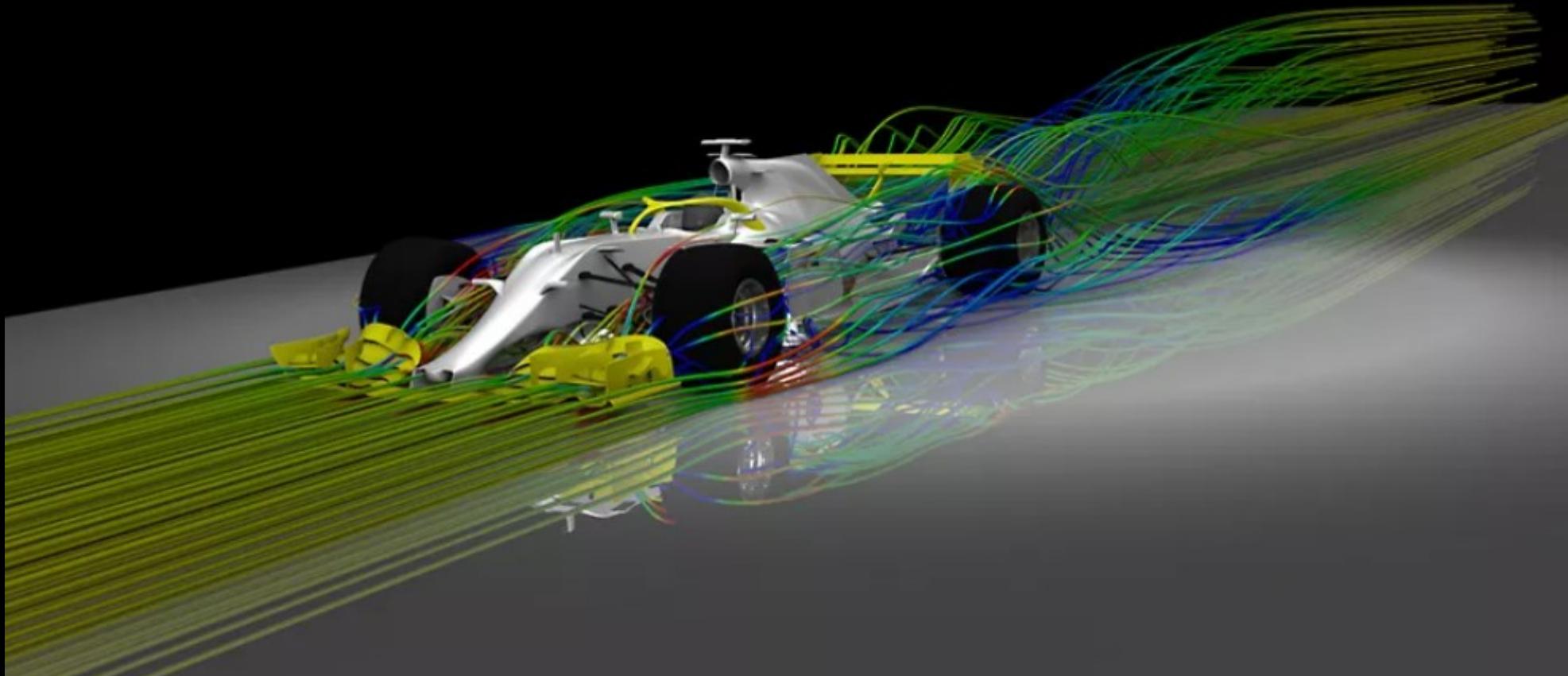


Graphics and illumination planning

[http://graphics.cs.aueb.gr/graphics/research\\_lightingopt.html](http://graphics.cs.aueb.gr/graphics/research_lightingopt.html)

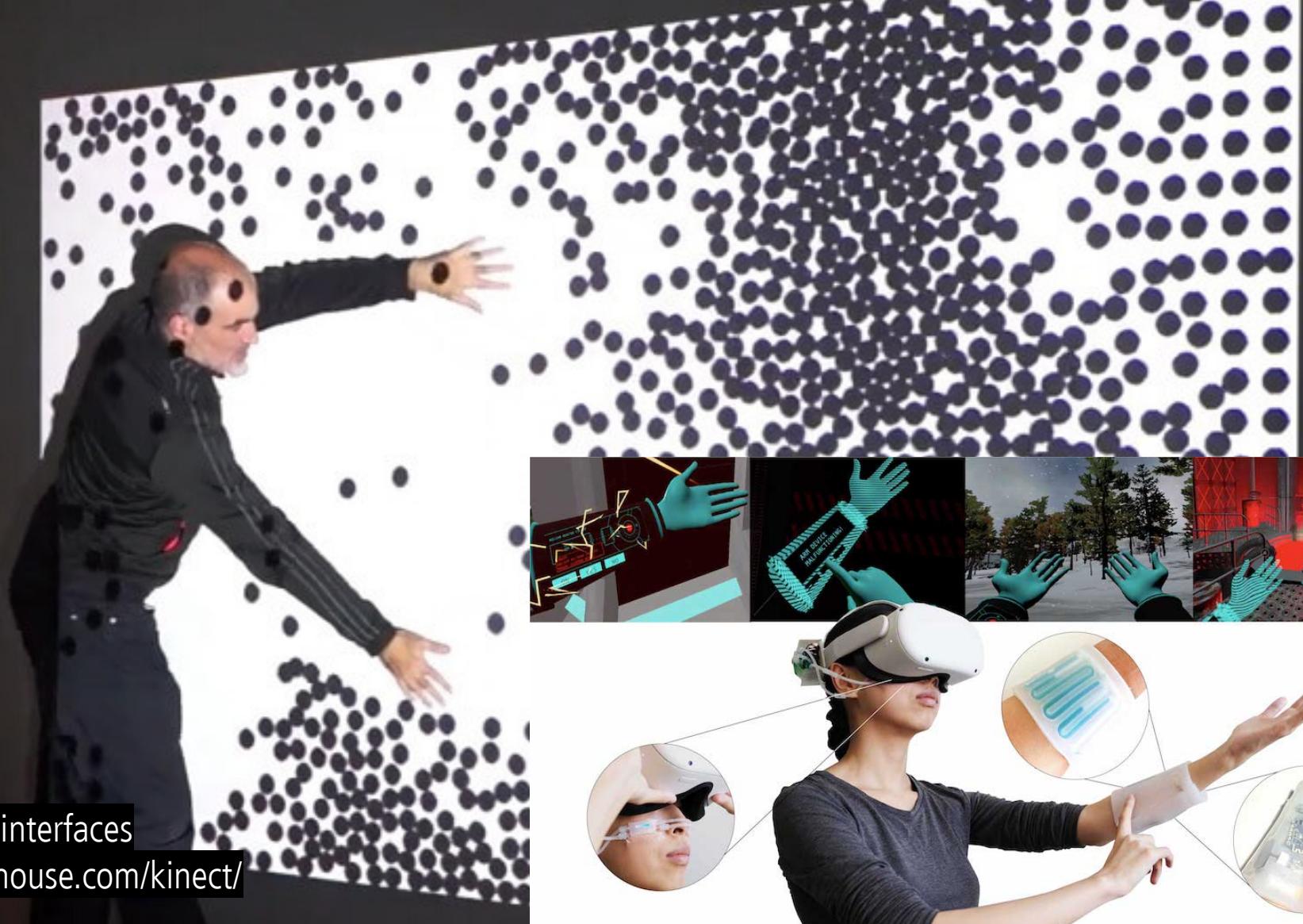


Graphics and new media art  
<https://refikanadol.com/>



Graphics and predictive simulations

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



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

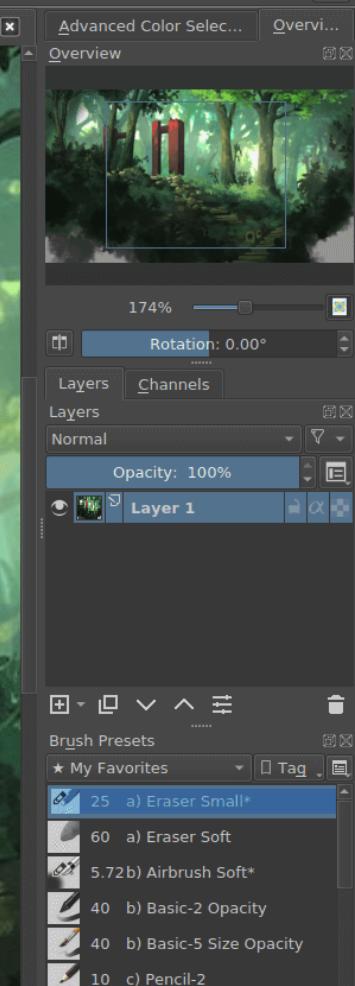
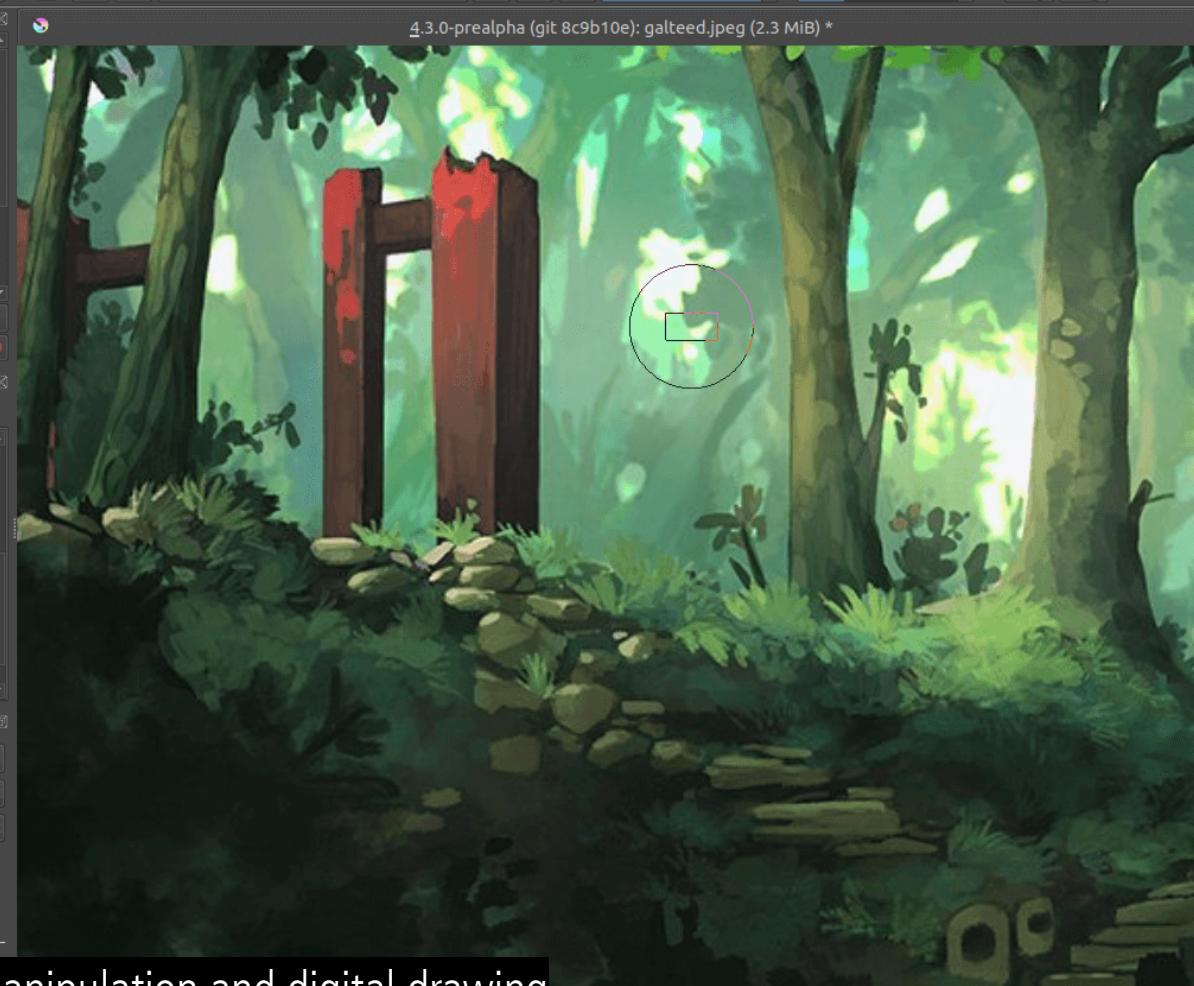
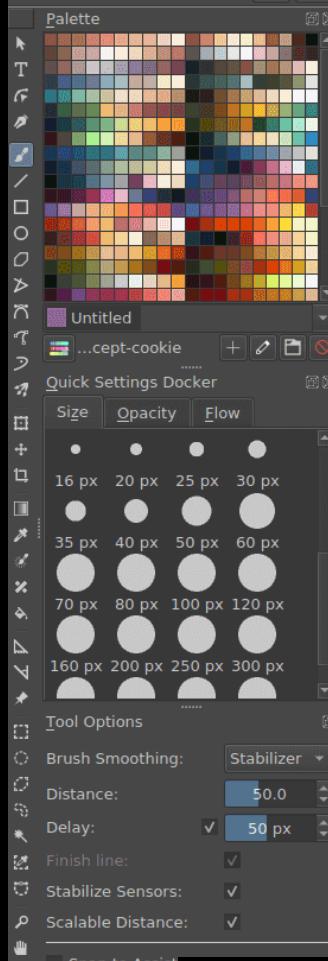
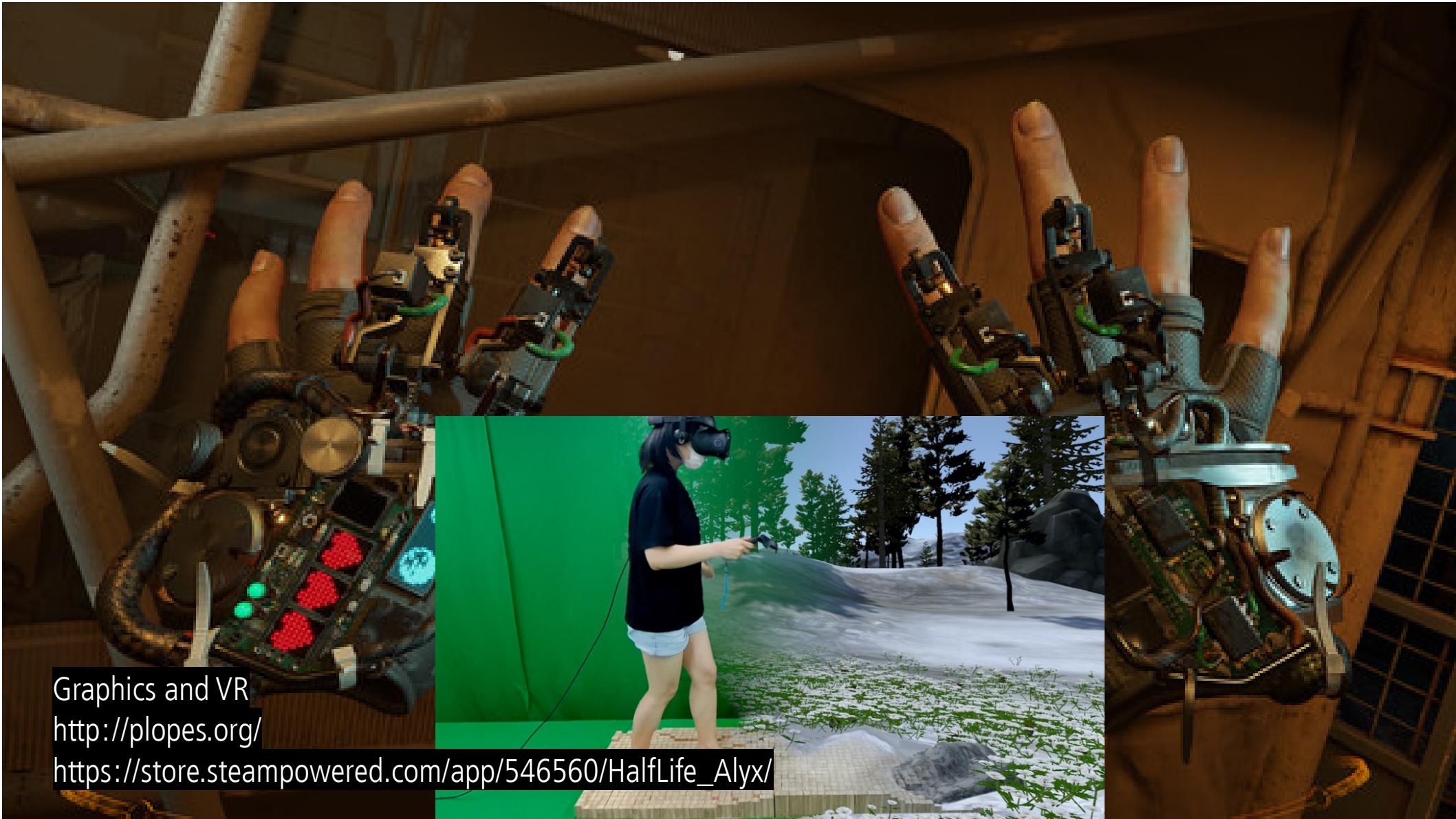


Image manipulation and digital drawing  
<https://krita.org/en/features/highlights/>



Graphics and VR  
<http://plopes.org/>  
[https://store.steampowered.com/app/546560/HalfLife\\_Alyx/](https://store.steampowered.com/app/546560/HalfLife_Alyx/)



# Computer graphics today



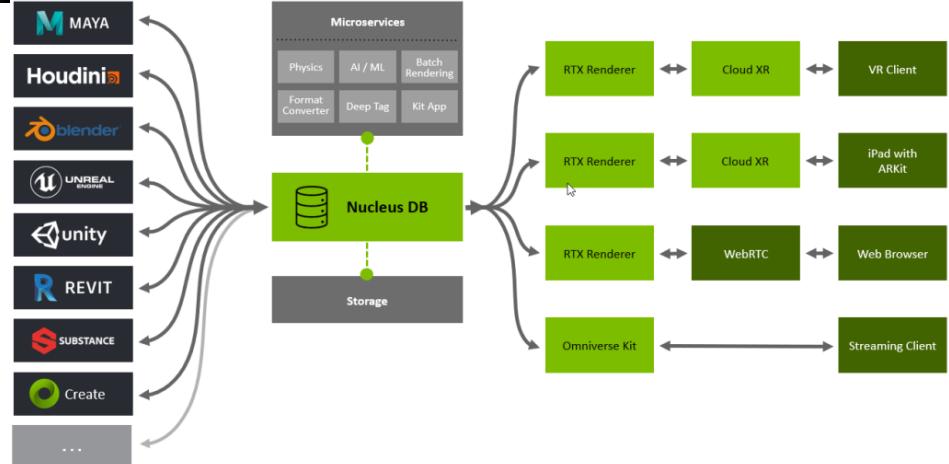
<https://www.siggraph.org/>



[https://www.research.autodesk.com/bloa/inside-autodesk-research-explo  
ring-our-research-teams/#industry-futures](https://www.research.autodesk.com/bloa/inside-autodesk-research-explo-ring-our-research-teams/#industry-futures)



<https://research.nvidia.com/research-area/real-time-rendering>



<https://www.nvidia.com/en-us/omniverse/>

# 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 vision** or image processing: graphics is about creating and manipulating images
- You like **human-computer interaction**: computer graphics enables visual interfaces and interaction
- 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!

# Landscape of computer graphics

- <https://www.realtimerendering.com/portal.html>



## Real-Time Rendering Portal

Last changed: September 28, 2022

This page is devoted to sites and tools we use on a continuing basis. They're personal picks, and reflect our own biases.

1. [Ke-Sen Huang's conference pages](#) has links for papers from all the major computer graphics conferences and workshops. The pages by Tim Rowley are not available directly, but [this archive](#) contains them.
2. [Advances in Real-Time Rendering in 3D Graphics and Games](#), [Introduction to Real-Time Ray Tracing](#), [Open Problems in Real-Time Rendering](#), [An Overview of Next-Generation Graphics APIs](#), and [Stylized Rendering in Games](#) SIGGRAPH course materials are hosted on our site.
3. [SIGGRAPH 2021 links](#), compiled by Stephen Hill. Also see link pages for [SIGGRAPH 2020 links](#) [SIGGRAPH 2019 links](#) (and [SIGGRAPH 2019 ray tracing links](#)), [SIGGRAPH 2018](#), [SIGGRAPH 2017](#), [SIGGRAPH 2016](#), [SIGGRAPH 2015](#), [SIGGRAPH 2014](#), [SIGGRAPH 2013](#), [SIGGRAPH 2012](#) and [SIGGRAPH 2011](#).
4. [Game Developers Conference 2019 links](#), also [2018](#), [2017](#), [2016](#). There's none for 2015, but before then Javier "Jare" Arevalo collected [GDC 2014](#), [2013](#), and [2012](#) presentations. Also see the [GDC Vault](#).
5. [Graphics Programming weekly](#) - Jendrik Illner summarizes graphics blog articles. Think of it as your one-stop blog. He also has a nice [searchable collection](#).
6. [NVIDIA](#) (and [NVIDIA Research](#)), and [AMD](#) (plus [GPUOpen](#)) graphics developer sites - demos, code samples, white papers, etc. Other worthwhile code samples at [Humus-3D](#).
7. Min Chen's list of [Computer Graphics Forum](#) State-of-the-Art (STAR), survey, and review papers since 2010.
8. [The Journal of Computer Graphics Techniques](#) - open access (free to all) and many articles include code samples.
9. [Journal of Graphics Tools](#) (JGT) code repository.
10. [Graphics Gems Repository](#) - contains the source code for many graphics algorithms. Search the contents by [category](#), by [author](#), or by [book](#).
11. [Developer sites and mailing lists](#): [GameDev.net](#) is active, as is [OpenGL.org](#), [Ogre Forums](#), [GD Algorithms](#) archives dying out but searchable ([subscribe](#)), and [FlipCode](#) (old, closed, but some good things in the archives).
12. [Game company publication pages](#): alphabetically, and a few quite dated, but here goes. [Frostbite](#), [Guerrilla Games](#), [Unreal Engine](#), [Unity](#), [Ready At Dawn](#), [Tri-Ace](#), and [Activision](#).
13. [Film company publication pages](#): [Disney](#) ([Hyperion renderer specific](#)) and [Pixar](#).
14. [Commercial research lab pages](#): [Microsoft Research Asia](#), [Microsoft Research U.S.](#), and [Cesium](#) (GIS).
15. The [Level Up Report](#) by Mark DeLoura is a free weekly that provides pointers to all sorts of developments and resources for learning through games, coding, and making.
16. [Level 80](#) has a constant stream of information for game artists and content creators.
17. [Free \(and good\) books online](#)

# Books

- Scratchapixel: <https://www.scratchapixel.com/>
- PBRT: <https://pbrt.org/>
- Real-Time-Rendering Book:  
<https://www.realtimerendering.com/>
- More books: <https://www.realtimerendering.com/books.html>

# Conferences and research:

- SIGGRAPH: <https://www.siggraph.org/>
- Eurographics: <https://www.eg.org/wp/>
- IEEE computer graphics: <https://www.computer.org/csdl/magazine/cg>
- GDC: <https://gdconf.com/>
- NVIDIA GTC: <https://developer.nvidia.com/>
- List of conferences: <https://kesen.realtimerendering.com/>

# Workshops and talks

- List: <https://www.sidefx.com/learn/talks/>, <https://www.autodesk.com/events>
  - Game Jam
  - HIVE
  - HEX
  - OFFF
  - FMX
  - Blender conference
  - Unity
  - Epic/Unreal
  - Autodesk
  - Etc.

# Practical considerations

- Building more complex renderer with advanced features:

- <https://pbrt.org/>
- <https://github.com/mmp/pbrt-v3>
- <https://github.com/mitsuba-renderer/mitsuba2>

- Investigating and contributing to production rendering engines:

- <https://github.com/appleseedhq/appleseed>
- <https://www.cycles-renderer.org/>
- <https://luxcorerender.org/>



<https://www.cycles-renderer.org/>



<https://github.com/mmp/pbrt-v3>

# Practical considerations

- Building advanced web-based 3D graphics:
  - <https://threejs.org/>
- Diving deeper into real-time, interactive rendering APIs:
  - WebGL: <http://learnwebgl.brown37.net/>
  - OpenGL: <https://learnopengl.com/>
  - Vulkan: <https://vulkan-tutorial.com/>
- Game engines for advanced interactive graphics:
  - <https://www.unrealengine.com/en-US>
  - <https://unity.com/>
  - <https://godotengine.org/>

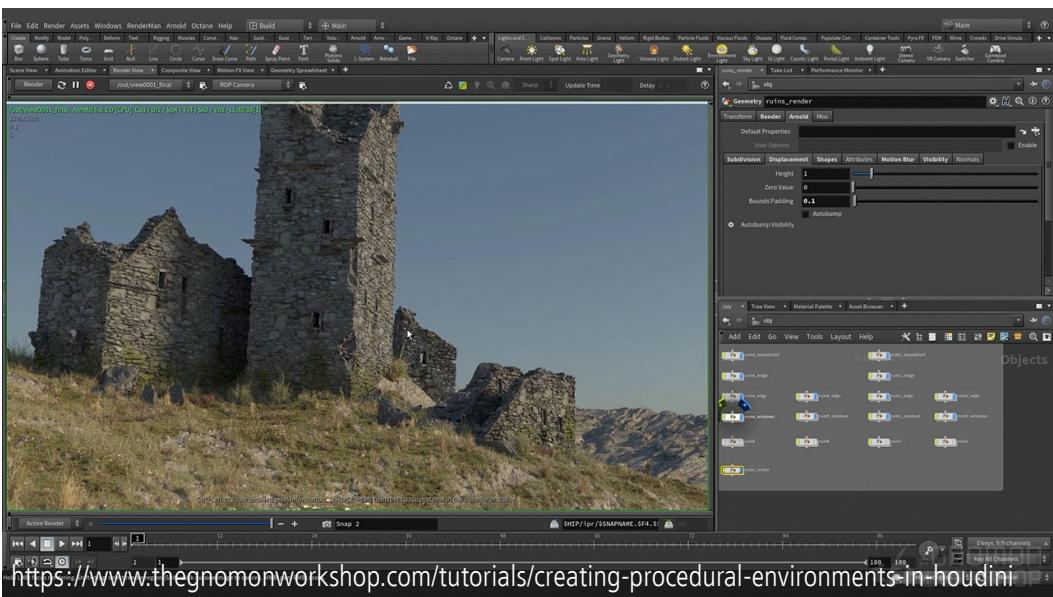


# Practical considerations

- Advanced 3D modeling, sculpting, lighting, material modeling, rendering and compositing in Blender and other content creation tools:
  - <https://www.blender.org/features/>
  - <https://www.maxon.net/en/zbrush>
  - <https://www.adobe.com/products/substance3d-painter.html>
  - <https://renderman.pixar.com/>
- Advanced procedural modeling in Houdini:
  - <https://www.sidefx.com/>



<https://www.adobe.com/products/substance3d-painter.html>



<https://www.thegnomonworkshop.com/tutorials/creating-procedural-environments-in-houdini>

# Hot topics?

- Real-time ray-tracing: <https://developer.nvidia.com/rtx/ray-tracing>
- Physically-based rendering/shading:  
<https://blog.selfshadow.com/publications/s2020-shading-course/>
- Physically-based animation: <https://www.physicsbasedanimation.com/>
- Production unification: USD, Omniverse: <https://developer.nvidia.com/usd>
- VR/AR: <https://developer.nvidia.com/vrworks>
- ML/DL for rendering and modeling (NVIDIA GTC, SIGGRAPH, etc.)
- Rendering and modeling for ML/DL – digital twins, graphics for industry (NVIDIA GTC)

Thank you!

# Repo

- <https://github.com/lorentzo/IntroductionToComputerGraphics>