

# Computer Graphics

CS7GV6 2021/2022

Lecturer:

Prof. Carol O'Sullivan, [carol.osullivan@tcd.ie](mailto:carol.osullivan@tcd.ie)

Demonstrator:

Bharat Vyas, [vyasb@tcd.ie](mailto:vyasb@tcd.ie)

Course Content: Blackboard

# My Background

- Professor of Visual Computing, TCD
- 1997-now: Trinity College Dublin
- 2013-2016: Disney Research Los Angeles
- 2012-2013: Seoul National University
- Long time ago: Dow Chemical, Germany

# Lectures

- 4-5pm Tuesday
  - lecture/discussion
- 5-6pm Tuesday
  - lecture/lab/discussion
  - demonstrator is your point of contact
  - discussion boards on Blackboard
- All content on Blackboard



**CS7GV6-A-SEM101-202021 (COMPUTER GRAPHICS)**

Announcements

GV6 Calendar

Online Lectures

Lecture Notes

Labs

Projects

Discussion Boards

Further Reading

Home

### Lecture Notes

 [Content Forum](#)  
Post your questions about course /lecture content to this forum and the demonstrator will answer them.

 [Lecture 9 & 10 - Lighting and Shading !\[\]\(62d4d3494d4340f830d2a84926a2cbde\_img.jpg\)](#)  
Lecture 10 - Shading and Illumination Models - is now online.  
Note: Goksu is working on an overview of Lighting in OpenGL which will be posted here soon.

 [Lecture 8 - Hierarchical Transformations](#)

 [Lecture 7 - Viewing](#)

 [Lecture 6 - Transformations](#)

 [Lectures 3, 4 & 5 - Graphics Programming](#)

 [Lecture 2 - Graphics Pipeline](#)

 [Lecture 1 - Introduction](#)

### Labs

 [Lab Forum](#)  
Post your questions on labs to this forum, and the demonstrator will answer them.

 [Lab 7 - Phong Illumination !\[\]\(1f875e8ff0db454eb302861a56ff194f\_img.jpg\)](#)  
The purpose of this lab is to help you with implementing lighting in OpenGL.

 [Lab 6 - Hierarchical Transformations !\[\]\(e63e8c500251dacf23596c452b949a7b\_img.jpg\)](#)  
The purpose of this lab is to get you familiar with the concept of relative modelling.

 [Lab 5 - Viewing !\[\]\(291d60f8ea76bfcdc84ecdc27afad621\_img.jpg\)](#)  
The purpose of this lab is in getting you familiar with the model/view, projection and camera matrices.

 [Lab 4 - Transformations !\[\]\(403ebf52593e340687e8aded0b7b53fb\_img.jpg\)](#)  
The purpose of this lab is to introduce you to working with transformations.

 [Lab 3 - Modelling !\[\]\(232de3636ca251589b129aeedc51159a\_img.jpg\)](#)  
The purpose of this lab is in getting you familiar with modelling packages and how to use them.

 [Lab 2 - OpenGL Programming \[Solution available\] !\[\]\(ad1048dc3d84320ca7de02b9d612d2b6\_img.jpg\)](#)  
The purpose of this lab is to allow you to become more comfortable with OpenGL.

### Projects

 [Final Submissions due Jan 5th, 2021](#)

 [Projects Forum](#)  
Post your general questions about the projects here, and the demonstrator will answer them.

Questions about OpenGL programming should be posted to the Lab Forum.

 [Project 2 - Group Project !\[\]\(aa734cea3e36b1c3166cac7fb4edde58\_img.jpg\)](#)

 [Project 1 - Individual !\[\]\(11a2fa9a69650a704a393f3cdf226529\_img.jpg\)](#)

 [D1.3 Demo Timetable - 08/12/2020 !\[\]\(152cb66dc989f223d6e87b88a162579c\_img.jpg\)](#)

# Labs

- OpenGL 3/4
- C++
- Each lab teaches you how to use several new features
- Viewing, animation, lighting and materials, textures etc.,
- NB: Try out Lab 1, troubleshoot

# Assessment

- Individual Project (60%)
  - available next week (week 2)
  - developed in increments through the labs
  - lab 1 is available now to get started and troubleshoot
    - Ask questions/report problems via the lab discussion forum
- Group Project (40%)
  - individual (20/40) and group (20/40) assessment
  - Available week 6
  - Weekly deliverables weeks 9-11



# Communication

- Blackboard announcement on Monday by 11am
- Check Blackboard
- Discussion Forums (lectures, labs & projects)
- Email me: [carol.osullivan@tcd.ie](mailto:carol.osullivan@tcd.ie)
- Email your demonstrator [vyasb@tcd.ie](mailto:vyasb@tcd.ie)

# Topics

- An introduction to computer graphics; problem domain and applications;
- Linear algebra – two and three dimensional transforms; geometric operations; hierarchical 3D transformations;
- The computer graphics pipeline and the OpenGL API for 3D computer graphics;
- Illumination models and rendering algorithms;
- Research topics in computer graphics.

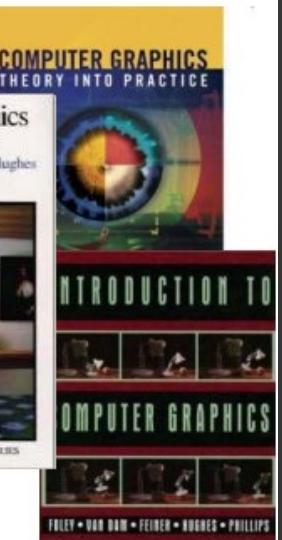
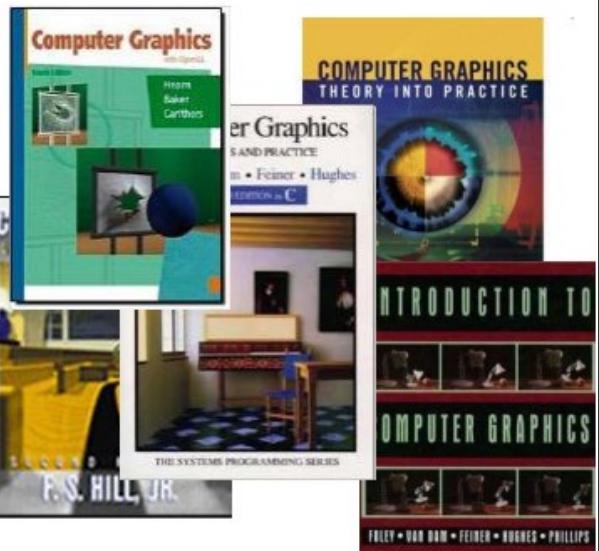
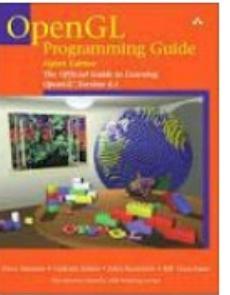
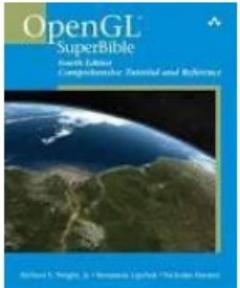
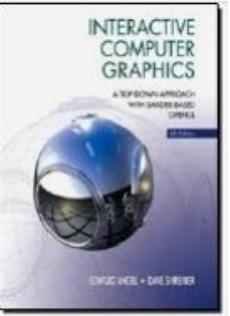
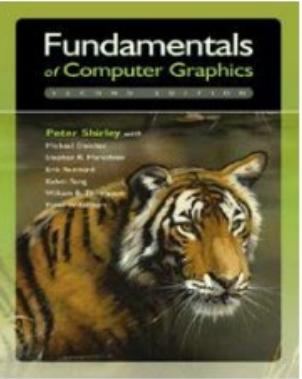
# Final Project

- Extend the theory you learned in lectures
- Interactive application with OpenGL



# Recommended Texts

- **Fundamentals of Computer Graphics 3<sup>rd</sup> Edition,** Shirley, Marschner
- **Computer Graphics Principles and Practice 3<sup>rd</sup> Edition** Hughes, van Dam, etc.
- **Interactive Computer Graphics: A top-down approach with shader-based OpenGL, 6<sup>th</sup> edition,** Angel
- **Three Dimensional Computer Graphics:** Watt
- **OpenGL Programming Guide, 8<sup>th</sup> Edition,** Shreiner
- **Elementary Linear Algebra** Howard Anton

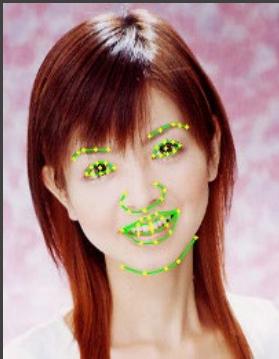


# Visual Computing

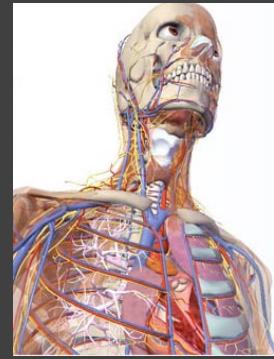
Graphics



Vision



Visualisation

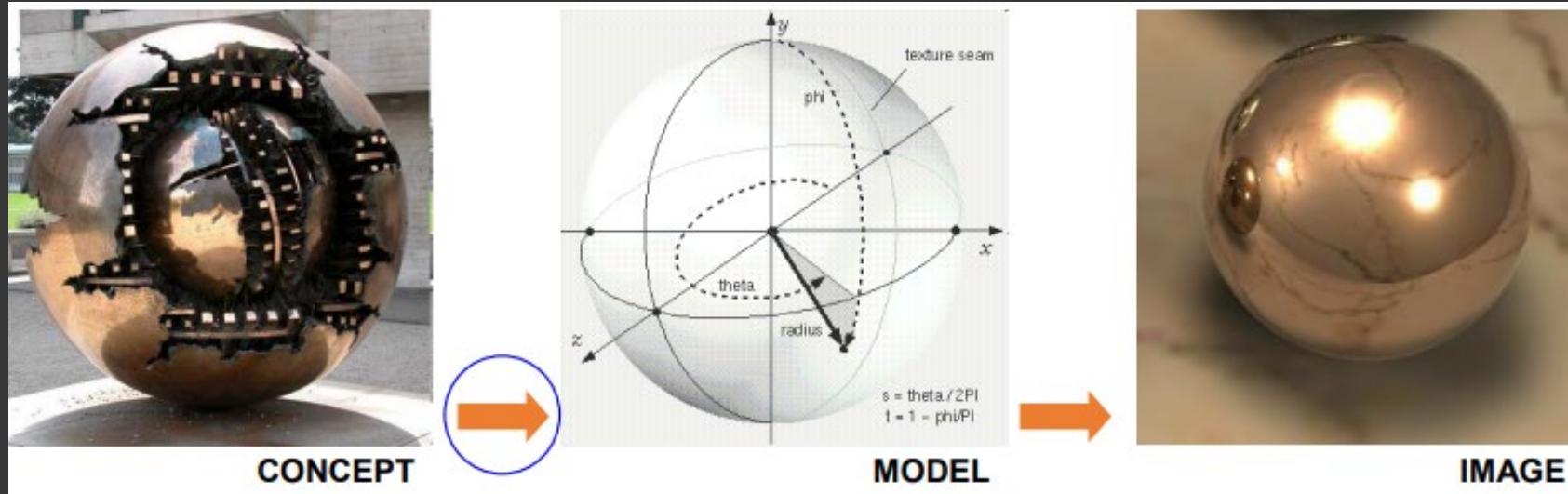


Virtual and  
Augmented  
Reality



Using computers both to generate visual images synthetically and to integrate or alter visual and spatial information sampled from the real world

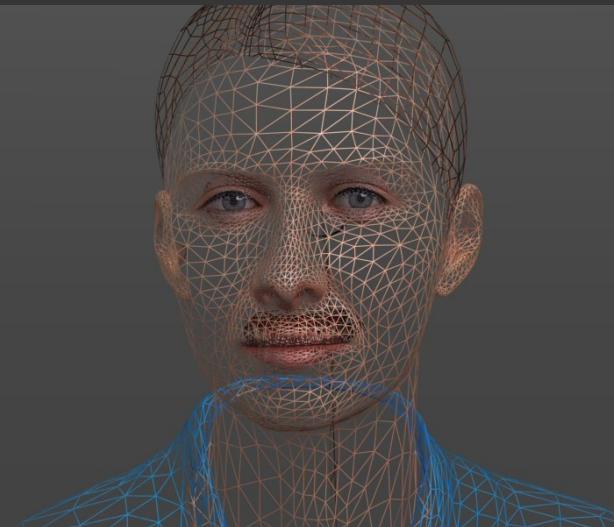
# Computer Graphics



“Computer Graphics is concerned with producing images (or animations) using a computer.”

# Computer Graphics

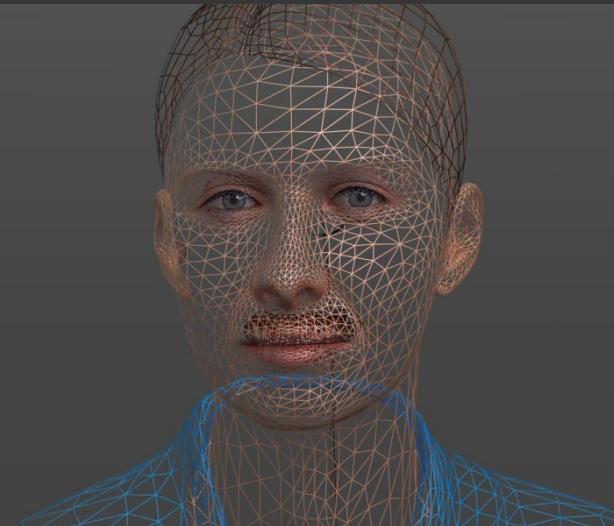
## Modelling



Creating or  
capturing the  
representation of  
objects - motion  
often geometrical

# Computer Graphics

Modelling



Creating or  
capturing the  
representation of  
objects - motion  
often geometrical

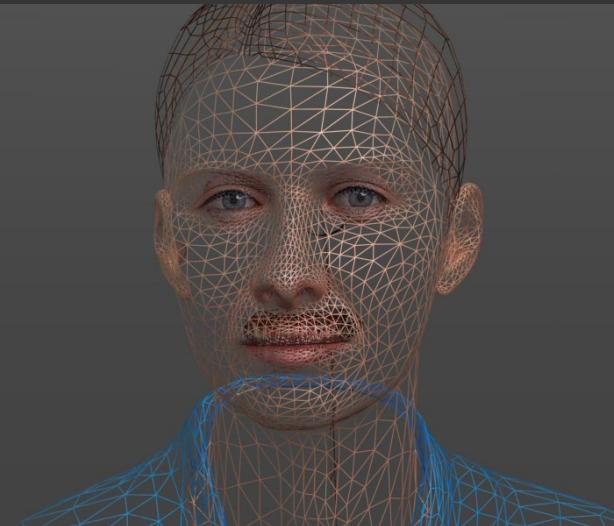
Rendering



Creating an  
image of these  
objects on a  
display device

# Computer Graphics

Modelling



Creating or capturing the representation of objects - motion often geometrical

Rendering



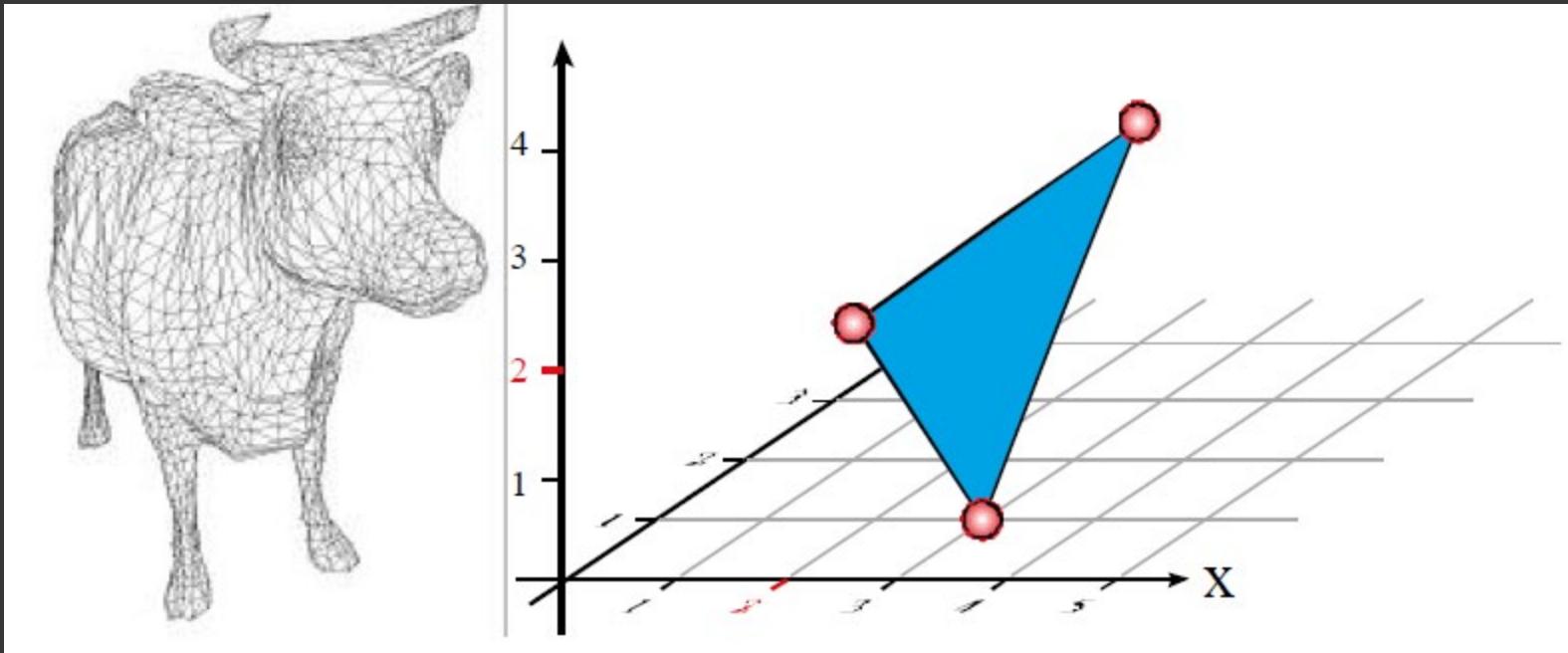
Creating an image of these objects on a display device

Animating

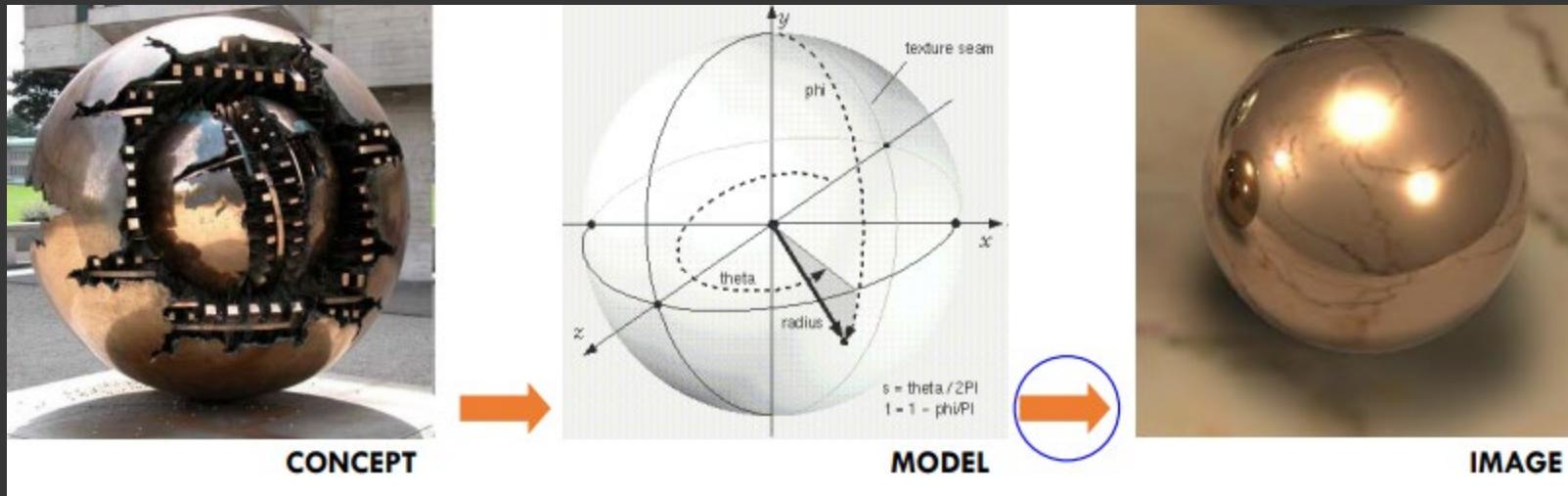


Making objects move by describing how they change over time

# Modelling

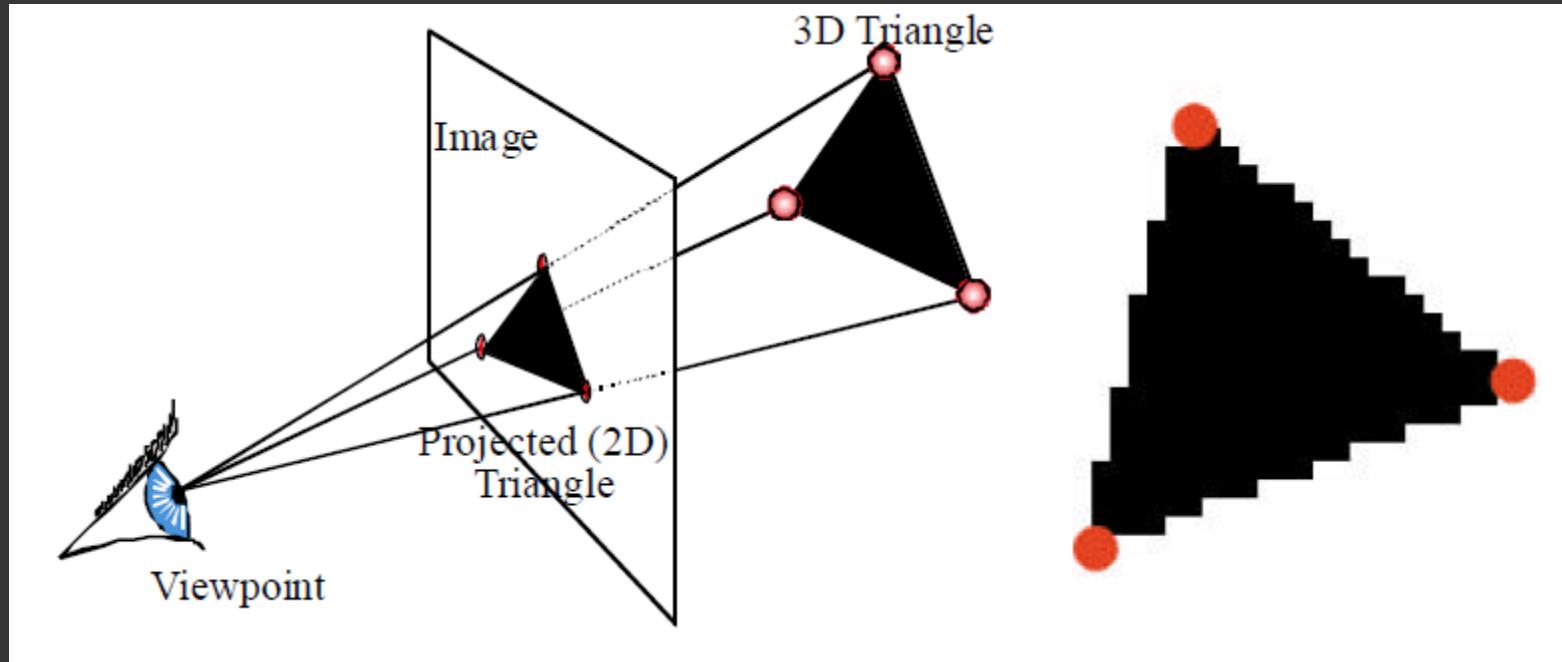


# Rendering

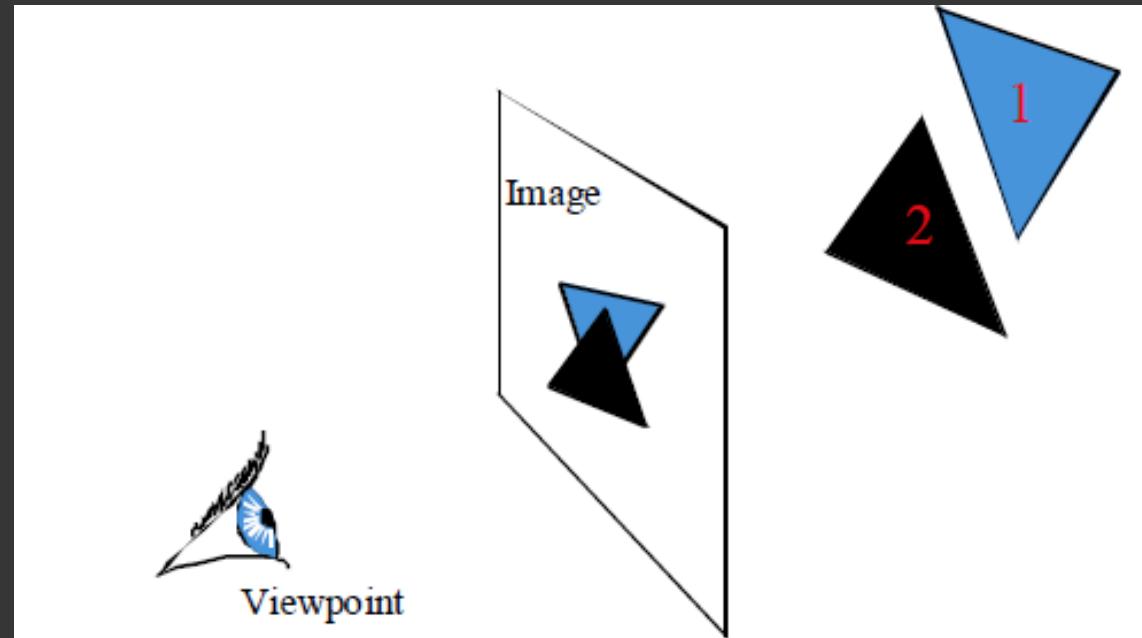


The rendered IMAGE is a visual representation of the model on digital output media.

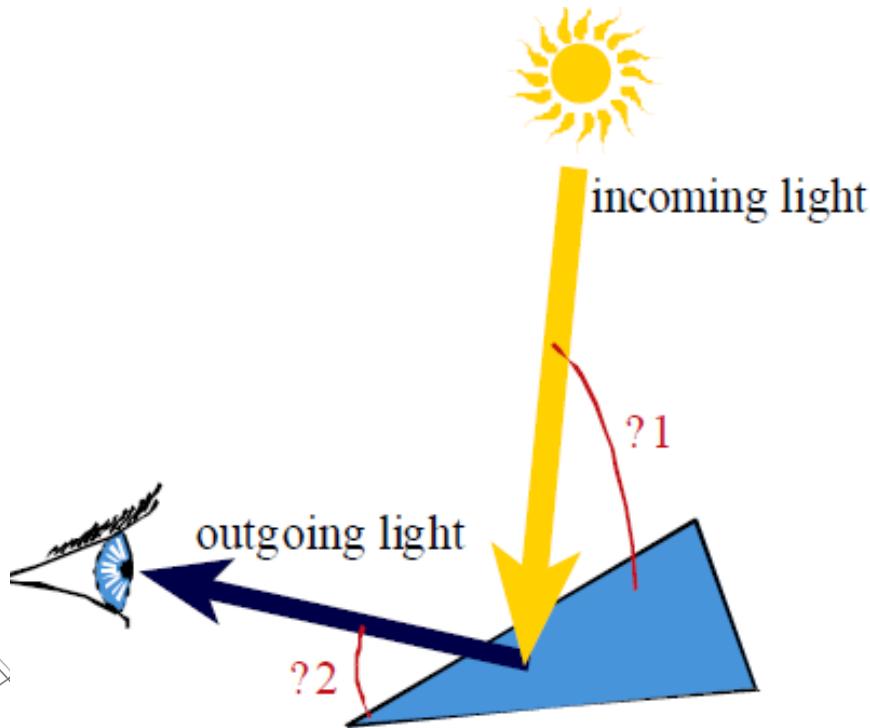
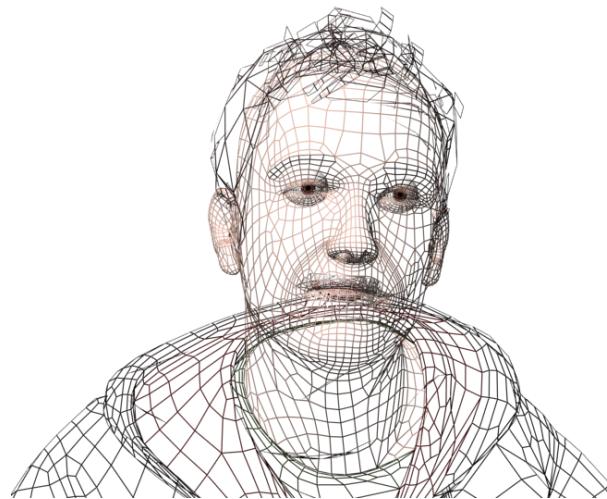
# Rendering

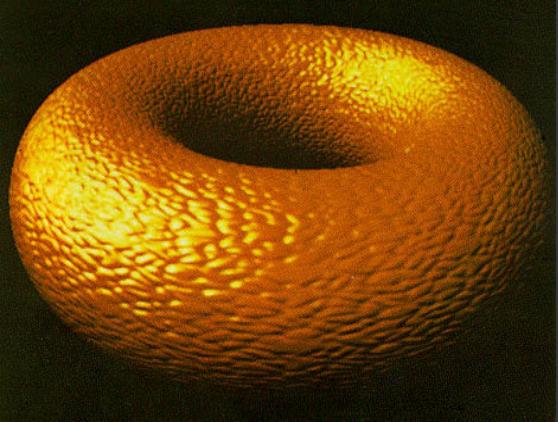


# Visibility

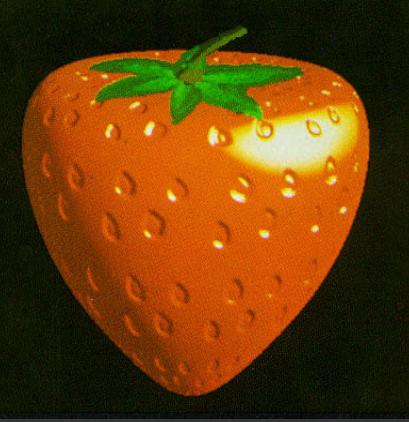


# Shading and Materials





First bump-mapped images (Blinn 1978)



Early texture-mapped image (Catmull 1974)



First distributed ray traced image (Cook 1984)



First ray traced image (Whitted 1980)

# What are the applications of Computer Graphics?



# Computer Animation



Inside Out, Disney 2015



Peter Rabbit, Sony Pictures, 2018



Incredibles 2, Disney, 2018

PIXAR  
ANIMATION STUDIOS

# Visual Effects

CGI augmenting reality



Avengers Infinity War, 2018



Ted, Universal Pictures, 2012

# Visual Effects

CGI replacing reality



Rogue One: A Star Wars Story, 2016



The Irishman, 2019



The Social Network, 2010

# Games



Fortnite, Epic Games, 2018



Uncharted 5, Naughty Dog, 2018



Spiderman, Insomniac Games, Sony, 2018



Minecraft, Mojang, 2011

# Virtual Influencer / Model



# Augmented and Virtual Reality



# Virtual Concerts



# Chatbot

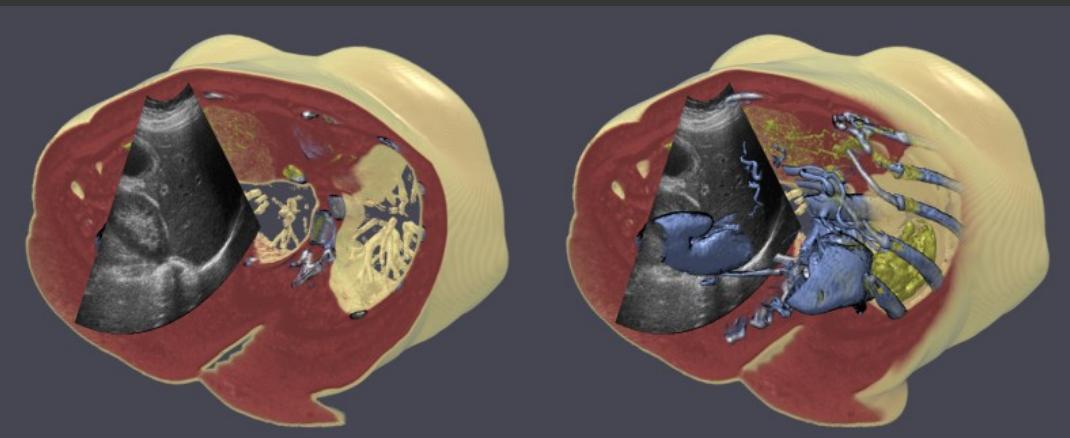


Autodesk, Soul Machines

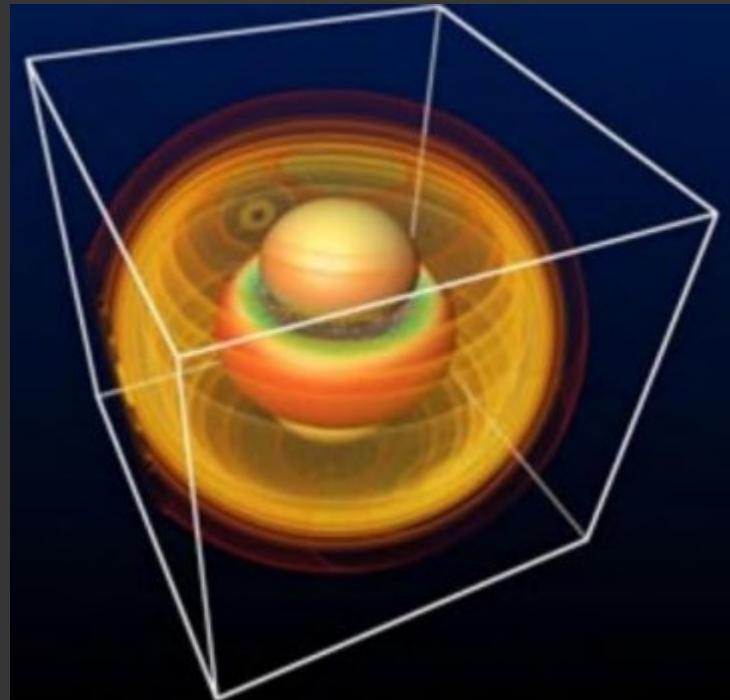
# Room Layout Design & Architectural Simulations



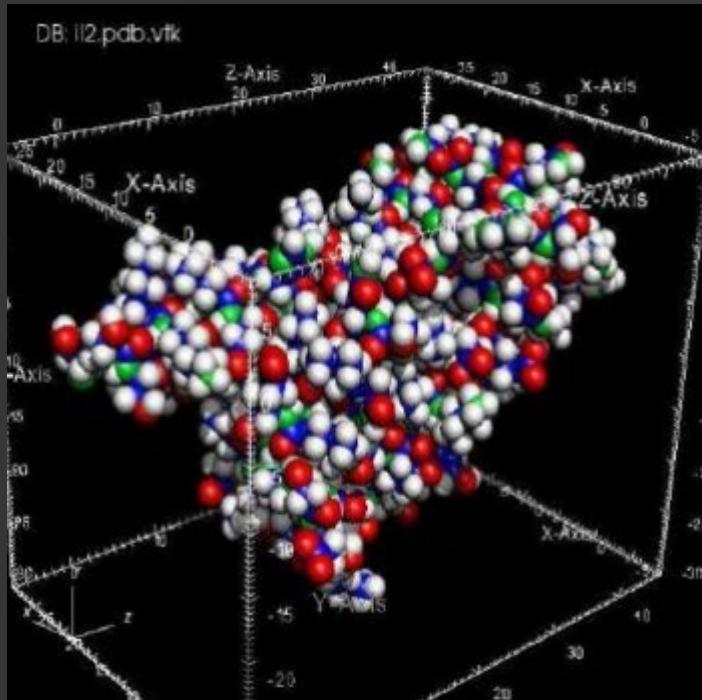
# Medicine and Virtual Surgery



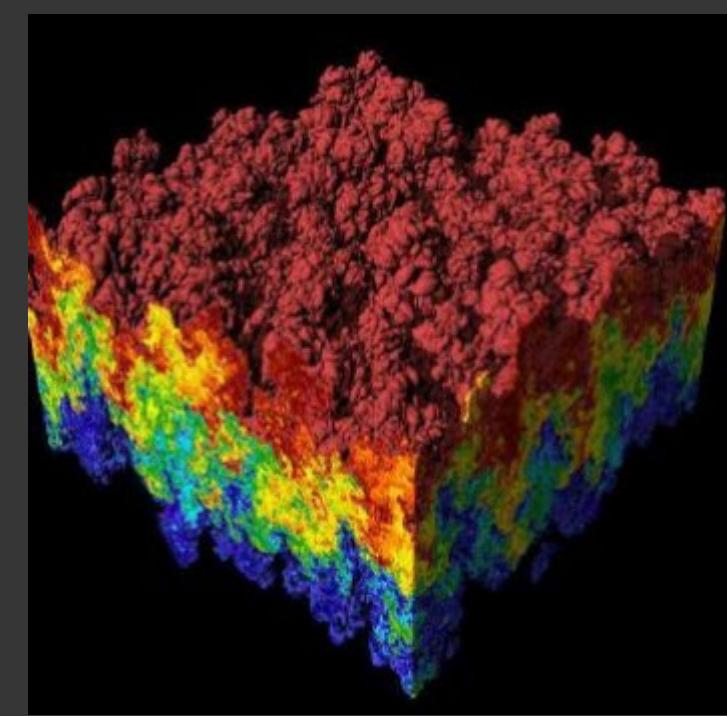
# Scientific Visualisation



Gravity Waves,  
Ian Foster,  
Carl Kesselman & Steve Tuecke



Molecular Visualisation, by UCRL-WEB



Fluid simulation,  
by Lawrence Livermore National Laboratory

# History and cultural heritage



# Flight Simulator



Microsoft Flight Simulator 2020

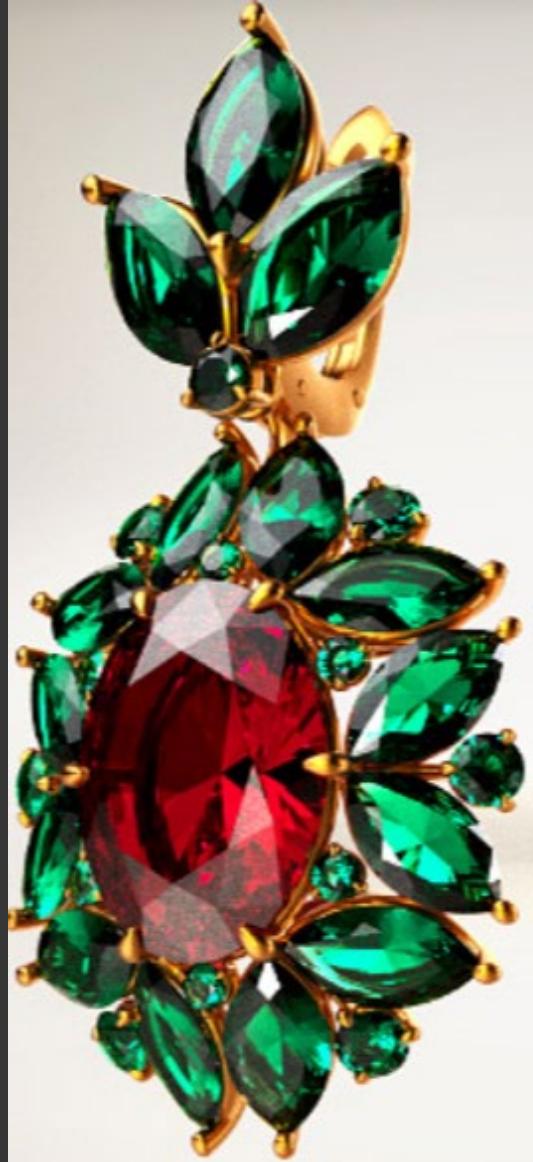
**REAL OR COMPUTER GRAPHICS?**















# Graphics, Vision & Visualisation Group

