

Computer Graphics

Rachel McDonnell

Assistant Professor of Creative Technologies

Rachel.McDonnell@cs.tcd.ie

Office: 02-011 Stack B, Customs House Quay

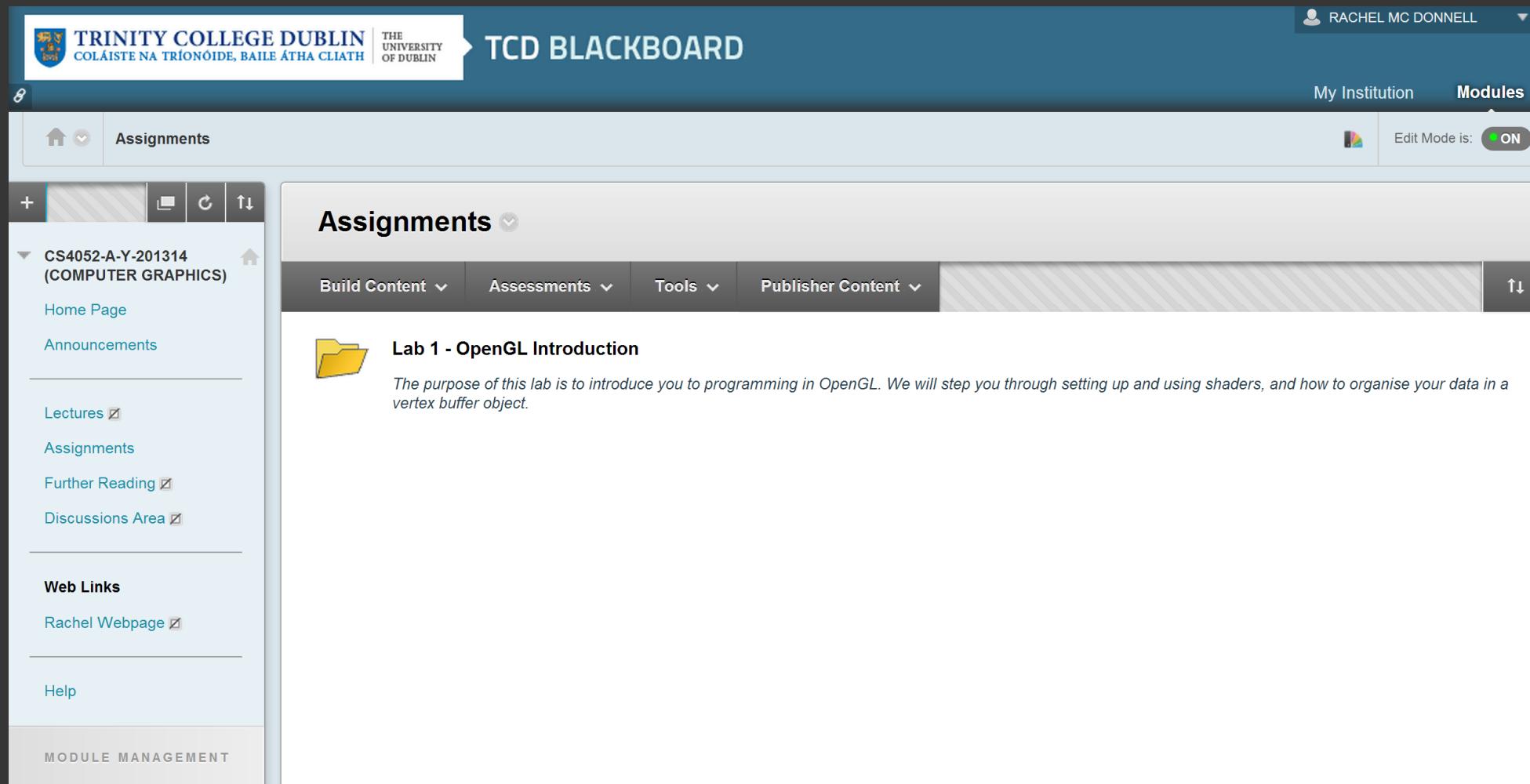
Introduction

- BA Computer Science/ BAI Engineering / Maths
- CS4052 / CS4D3A
- 5 ECTS
- Michaelmas wks 1-12
 - Reading week 22nd October

Lectures

- Lecture 3-4pm Monday, LB 04
- Lecture 11-12pm Tuesday, LB 04
- Lab 12-1pm Tuesday, ICT Lab 1&2
 - Demonstrators: Emma Carrigan/Sebastian Luz, Pisut Wisessing, Goksu Yamac, Chao Liu
- Content on Blackboard

BlackBoard



The screenshot shows the TCD Blackboard interface. At the top, the Trinity College Dublin logo and the text "TCD BLACKBOARD" are visible. The top right corner shows a user profile for "RACHEL MC DONNELL". Below the header, there are navigation links for "My Institution" and "Modules". The main content area is titled "Assignments". On the left, a sidebar for the module "CS4052-A-Y-201314 (COMPUTER GRAPHICS)" lists sections like "Home Page", "Announcements", "Lectures", "Assignments", "Further Reading", and "Discussions Area". The "Assignments" section is expanded, showing a folder icon and the title "Lab 1 - OpenGL Introduction". A descriptive text follows: "The purpose of this lab is to introduce you to programming in OpenGL. We will step you through setting up and using shaders, and how to organise your data in a vertex buffer object." At the bottom of the sidebar, there are links for "Web Links" (including "Rachel Webpage") and "Help".

Source CS4052-A-Y-201516 | Destination CS4052-A-Y-201718 is complete. To access the detailed log, click here

Further Reading

Build Content Assessments Tools Partner Content

 [Step by Step OpenGL tutorials](#)
These are good OpenGL tutorials which will help you to understand the basics of creating and rendering objects in OpenGL.

 [OpenGL Tutorials](#)
Another set of tutorials that will step you through the basics of modern shader-based OpenGL

 [Anton's OpenGL Tutorials](#)
Anton has created a series of OpenGL tutorials that cover the basics well. A good idea would be to start a Visual Studio project from scratch and work through the first few tutorials to get a good understanding of the basics.

 [Video Tutorials on OpenGL](#)
Excellent set of video tutorials which take you through shaders and OpenGL step by step.

 [GLUT tutorial](#)
Understanding the event loop and how GLUT works.

 [Blender Tutorial](#)

 [Model View Projection Matrix](#)
Camera in OpenGL.

 [OpenGL reference card](#)
Quick reference card for OpenGL 4.x. Very useful when checking for the most up to date functions and checking if a function that you are trying to use is from an older version of OpenGL

 [Transformations Demo](#)
Use this to look at how matrices work on transformations

Labs

- OpenGL 3/4
- C++
- Problems get increasingly more complex, and each lab teaches you how to use several new features
- Viewing, animation, lighting and materials, textures etc., creating a game
- Mark awarded for final project

Labs

- Demo program to demonstrators who will grade it
- Feed-back from grades available online NOT in-class
- Report submitted via Blackboard

Assessment

- Project (20%)
 - Will be developed in increments throughout
- End of year exam (80%)

Communication

- Attend lectures and labs
- Interactive - bring pen and paper
- Check Blackboard
- Check your email
- Email me: Rachel.McDonnell@cs.tcd.ie

Wk	Topic	Monday	Tuesday	Tuesday
1	Introduction & Graphics Programming	Lecture	Lecture	OpenGL setup
2	Graphics Programming I	Lecture	Lecture	OpenGL setup
3	Maths & Transformations	Lecture	Lecture	Transformations Lab
4	Graphics Programming II	Lecture	Lecture	Viewing Lab
5	Viewing	Lecture	Lecture	Hierarchy Lab
6	Illumination I	Lecture	Lecture	Lighting Lab
7	Reading week	--	--	--
8	Illumination II	Lecture	Lecture	Lighting Lab
9	Raytracing	Lecture	Lecture	Final project
10	Animation Intro	Lecture	Lecture	Final project
11	Curves	Lecture	Lecture	Final project
12	Modelling	Lecture	DEMO	DEMO

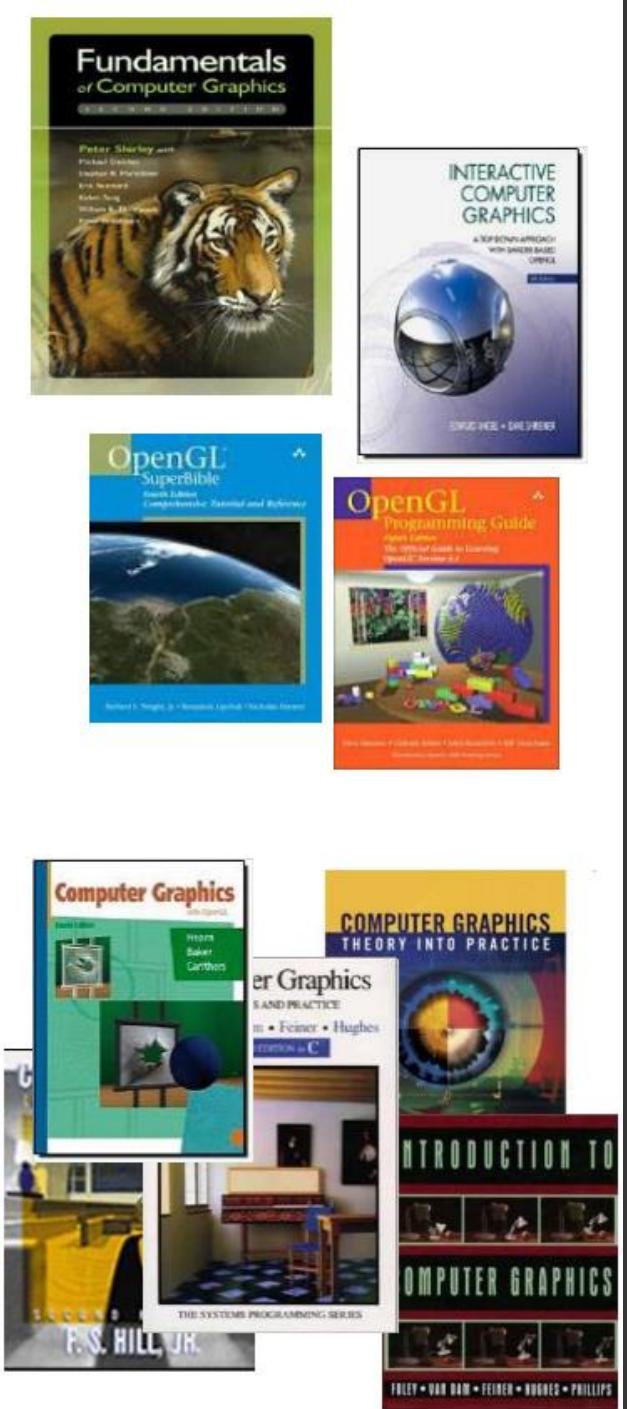
Final Project

- Explore an aspect of the course that you are interested in



Recommended Texts

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

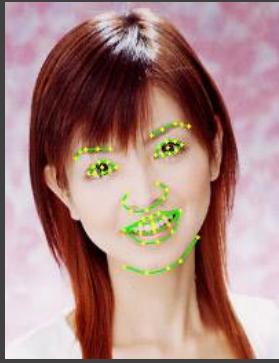


Visual Computing

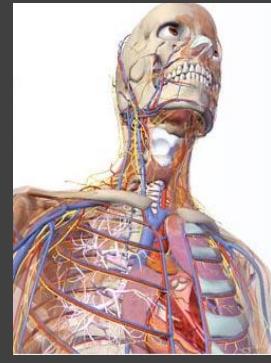
Graphics



Vision



Visualisation

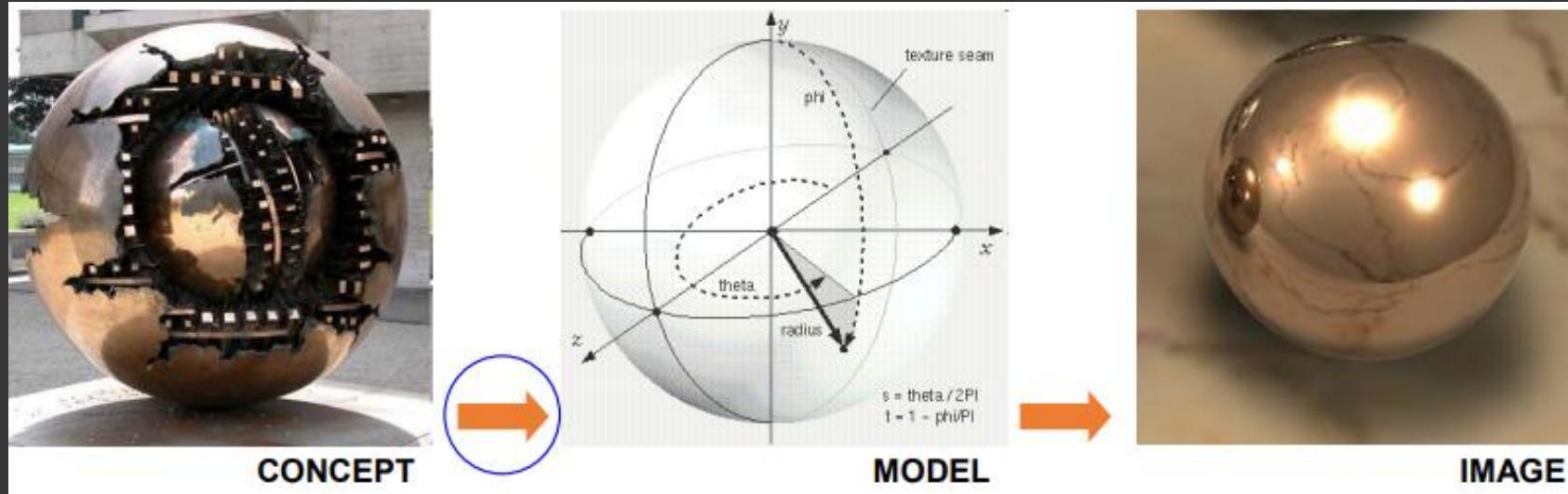


Virtual Reality



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

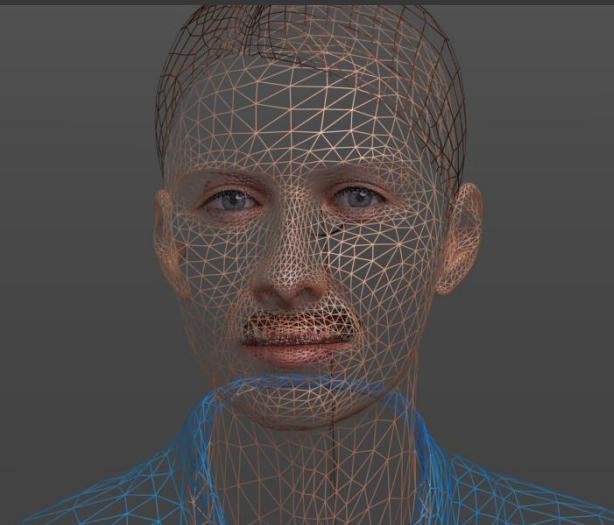
Computer Graphics



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

Computer Graphics

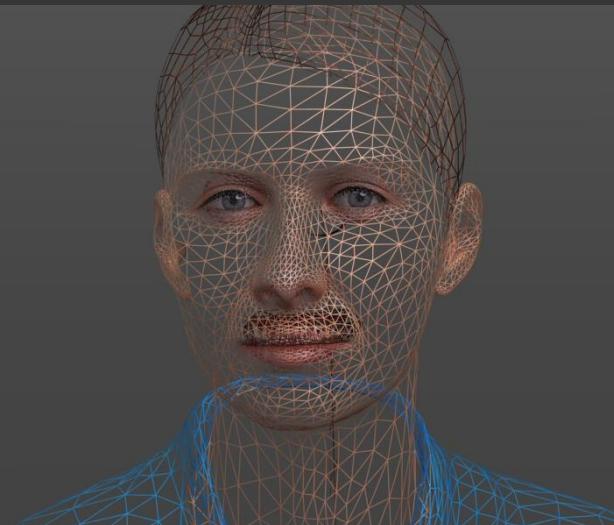
Modelling



Creating or
capturing the
representation of
objects - motion
often geometrical

Computer Graphics

Modelling



Creating or
capturing the
representation of
objects - motion
often geometrical

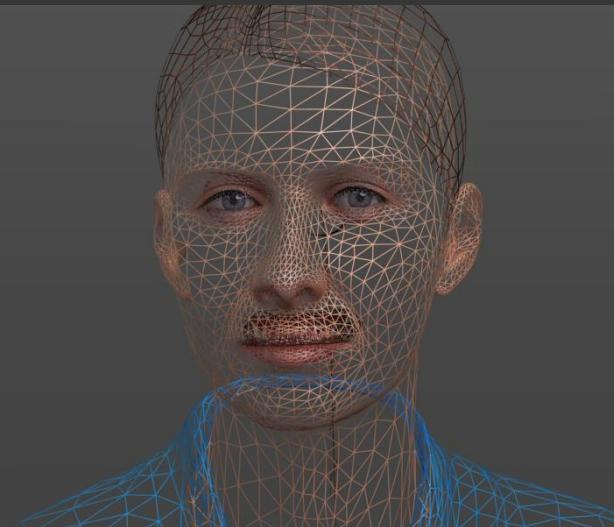
Rendering



Creating an
image of these
objects on a
display device

Computer Graphics

Modelling



Creating or capturing the representation of objects - motion often geometrical

Rendering

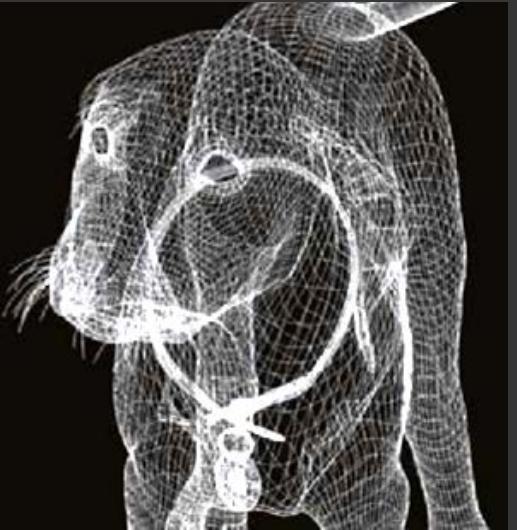


Creating an image of these objects on a display device

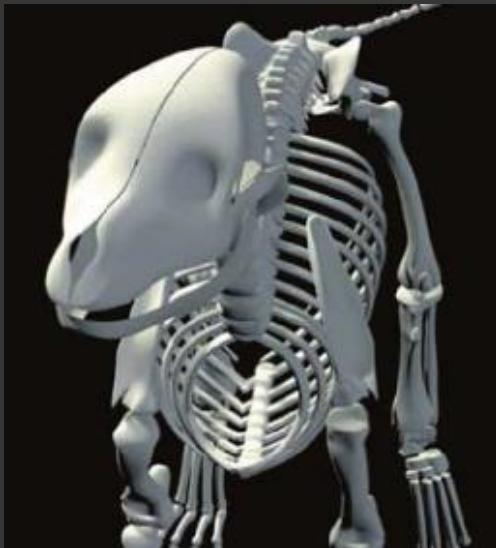
Animating



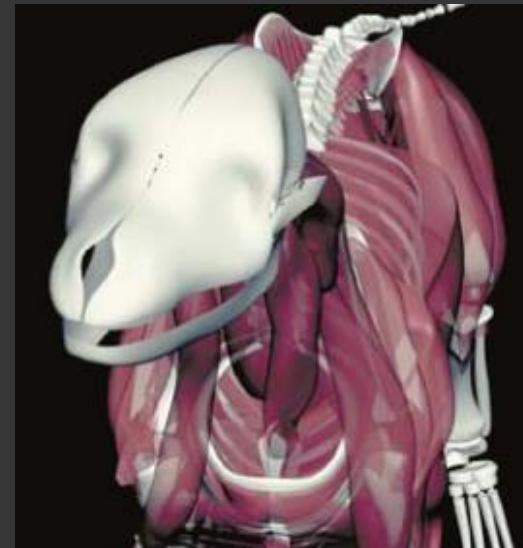
Making objects move by describing how they change over time



Wireframe
Model



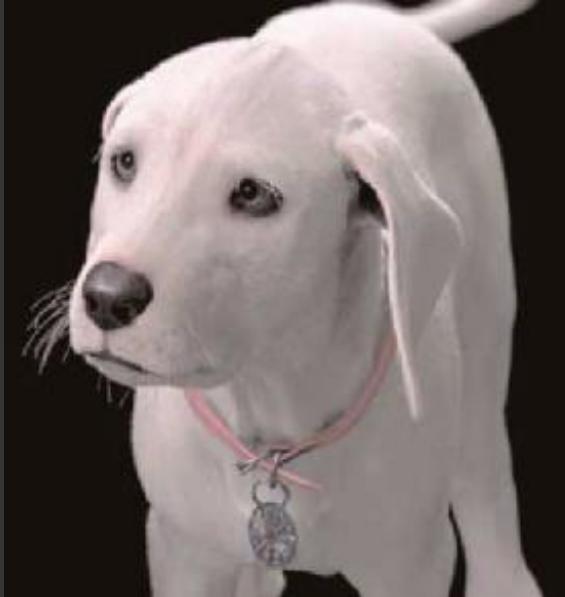
Skeletal
Model



Muscle
Model



Skin

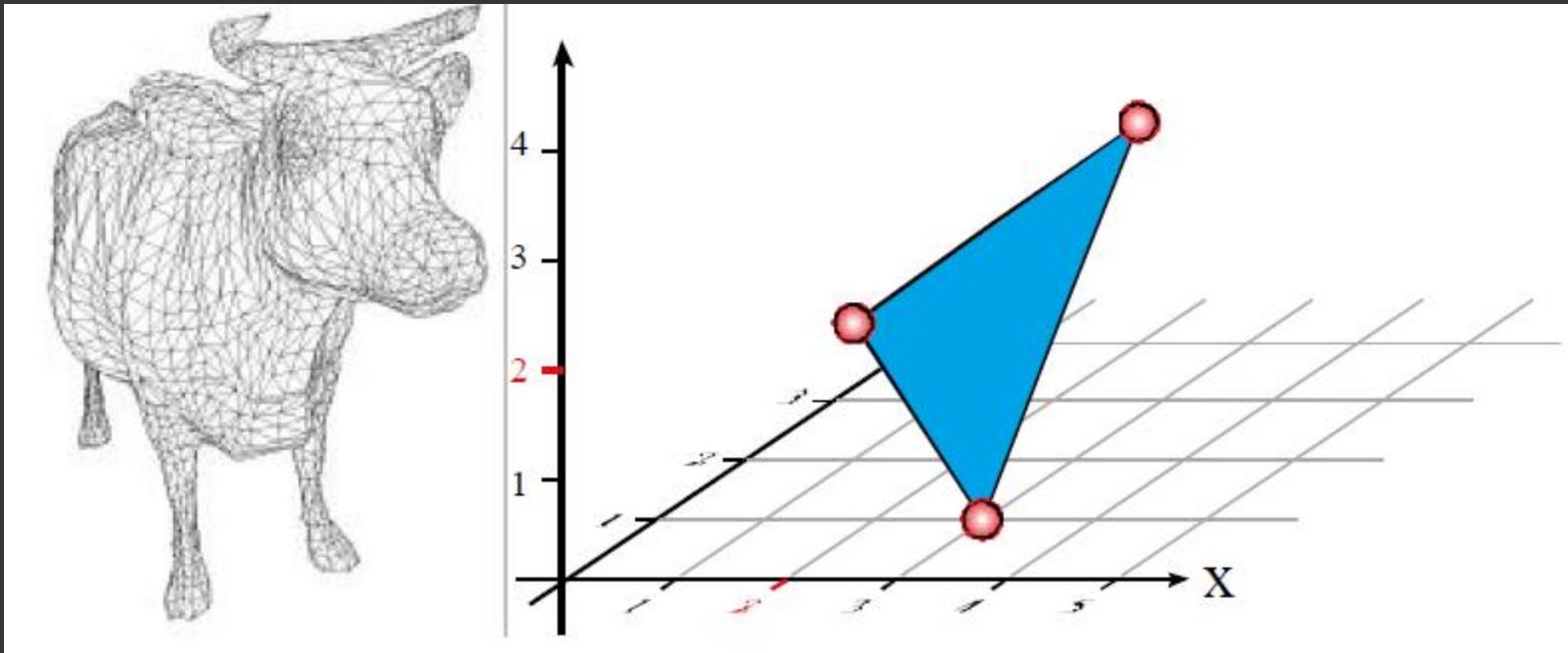


Hair

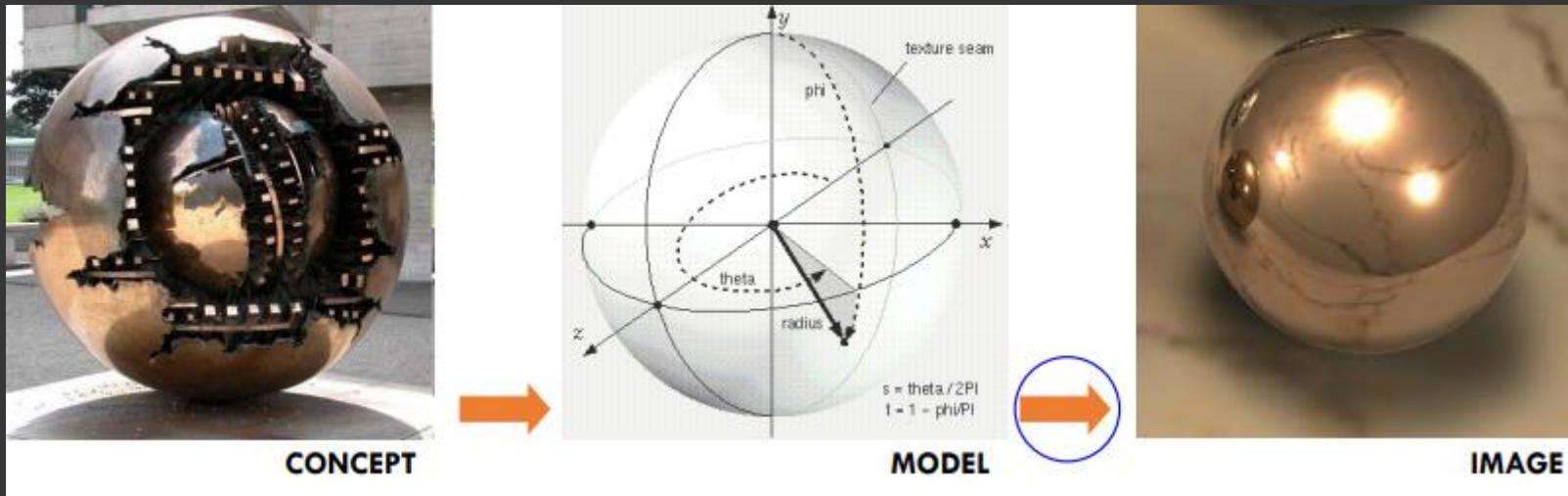


Render and Touch
up © Walt Disney and TSL

Polygons

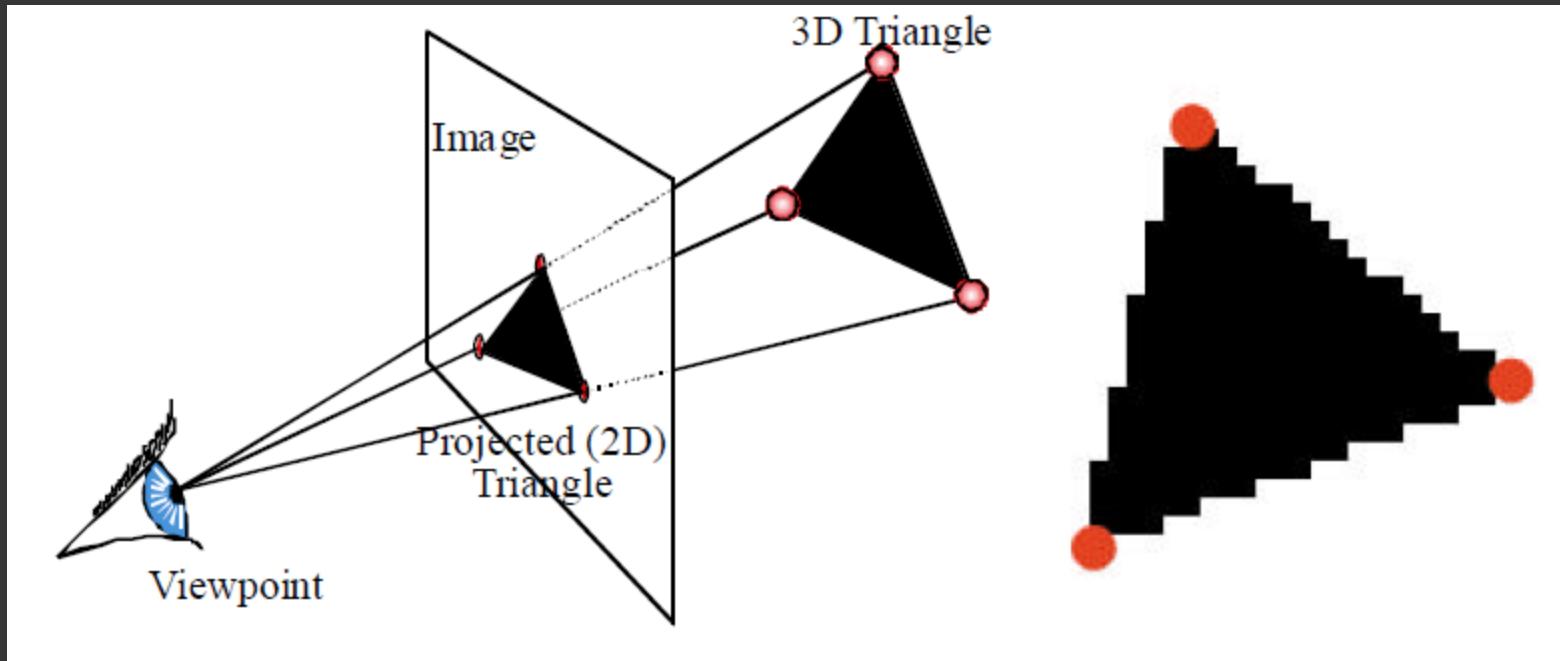


Rendering

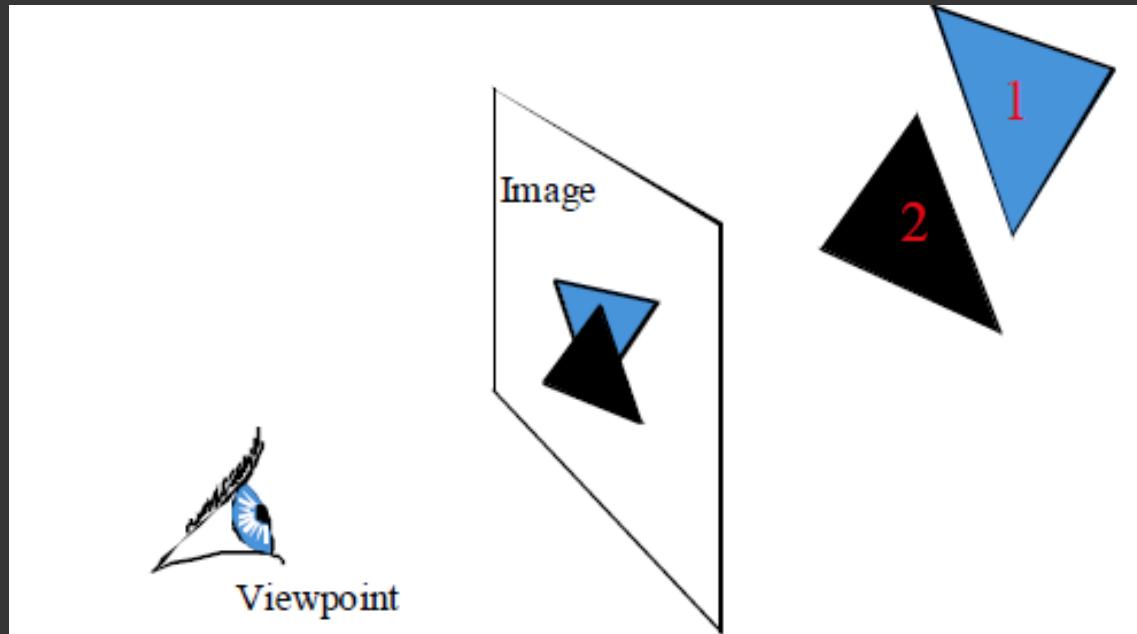


The rendered IMAGE is a visual representation of the model on digital output media.

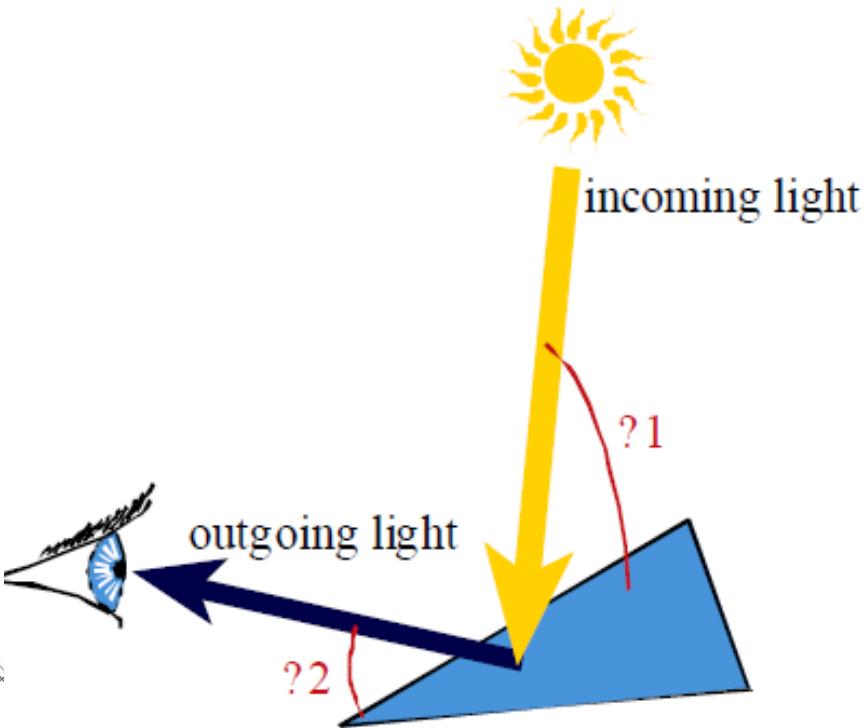
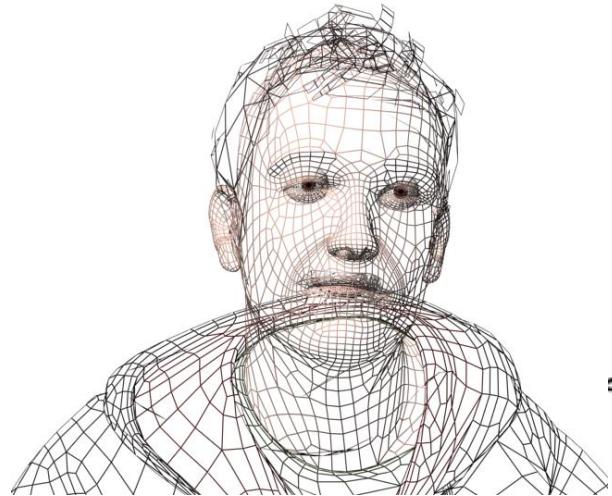
Rendering

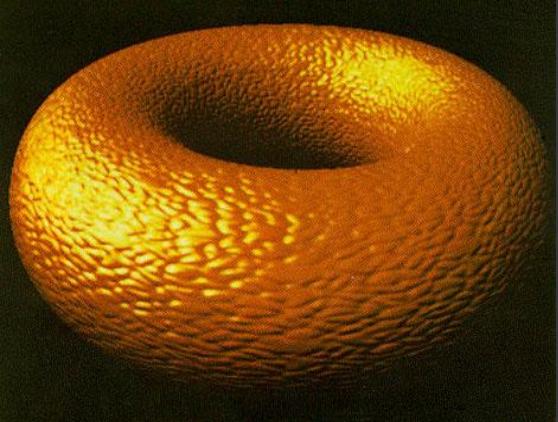


Visibility

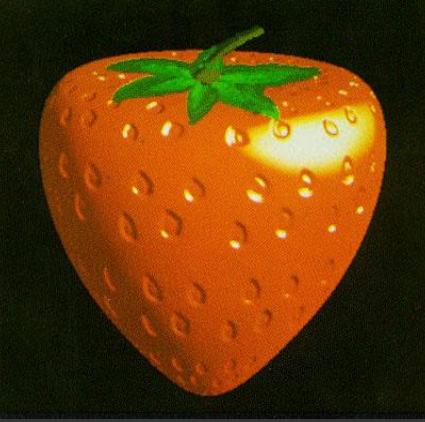


Shading and Materials





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)

CG or Real?



CG or Real?



CG or Real?



CG or Real?



What is CG used for?

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



Tron Legacy, 2010



The Curious Case of Benjamin Button , 2008



The Social Network, 2010

Games



Fortnite, Epic Games, 2018



Uncharted 5, Naughty Dog, 2018



Spiderman, Insomniac Games, Sony, 2018

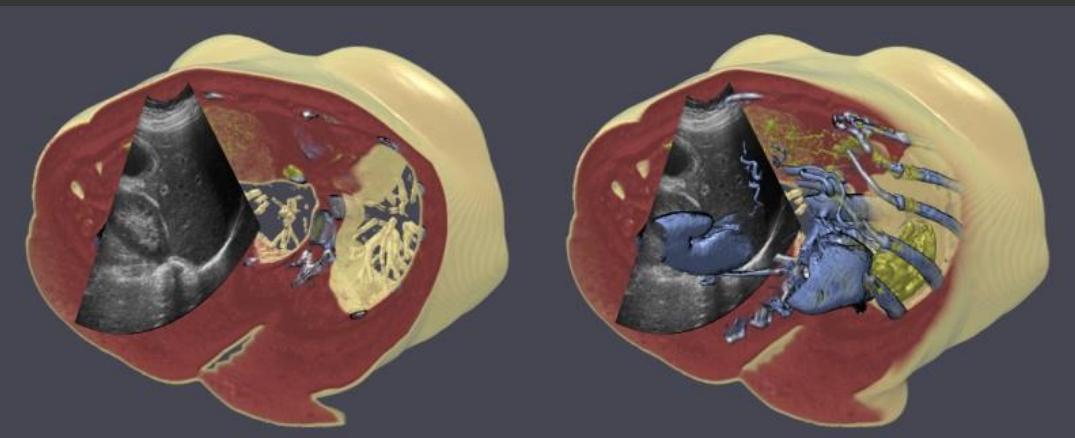


Minecraft, Mojang, 2011

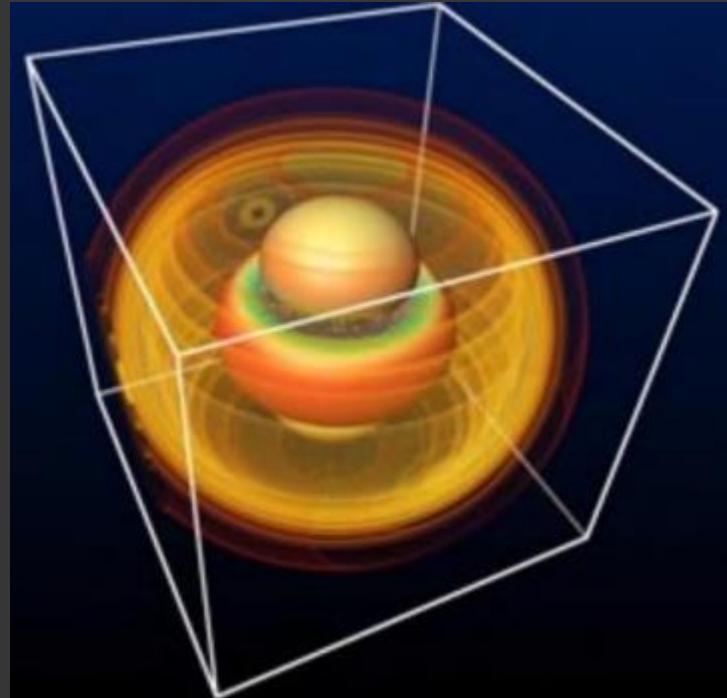
Room Layout Design & Architectural Simulations



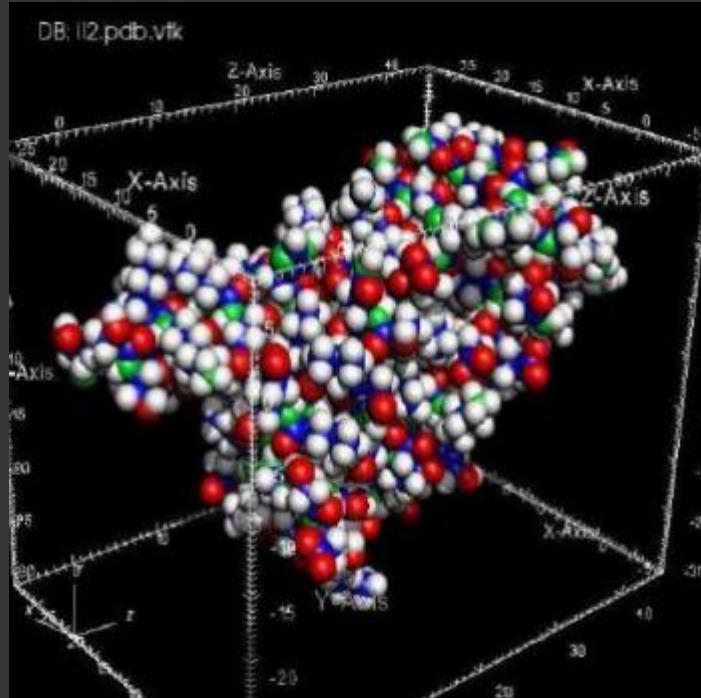
Medicine and Virtual Surgery



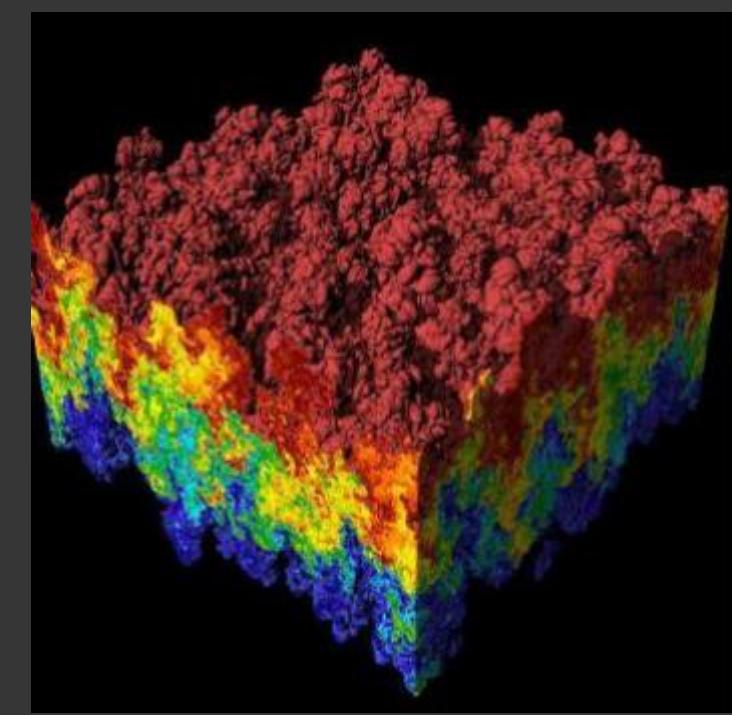
Scientific Visualization



Gravity Waves,
Ian Foster,
Carl Kesselman & Steve Tuecke



Molecular Visualization, by UCRL-WEB



Fluid simulation,
by Lawrence Livermore National Laboratory

History and cultural heritage



Augmented and Virtual Reality



Graphics and the Computer Engineer

- Knowledge of the Interdisciplinary Background to Graphics Related Problems
- Ability to Implement Computer Solutions based on interdisciplinary techniques in computer systems
- Knowledge of existing hardware and software frameworks for Computer Graphics applications
- Optimization! Realism/Fidelity vs. Speed

Graphics, Vision & Visualisation Group



My Research



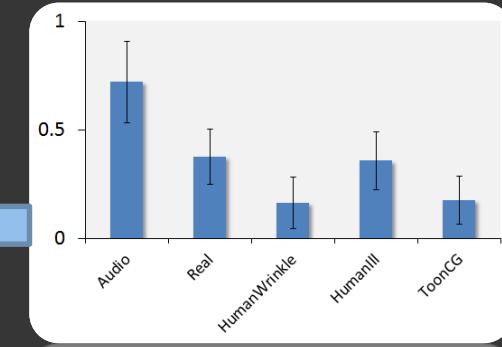
Performance capture



Virtual Reality



Computer Animation/ Render Style



Visual Perception

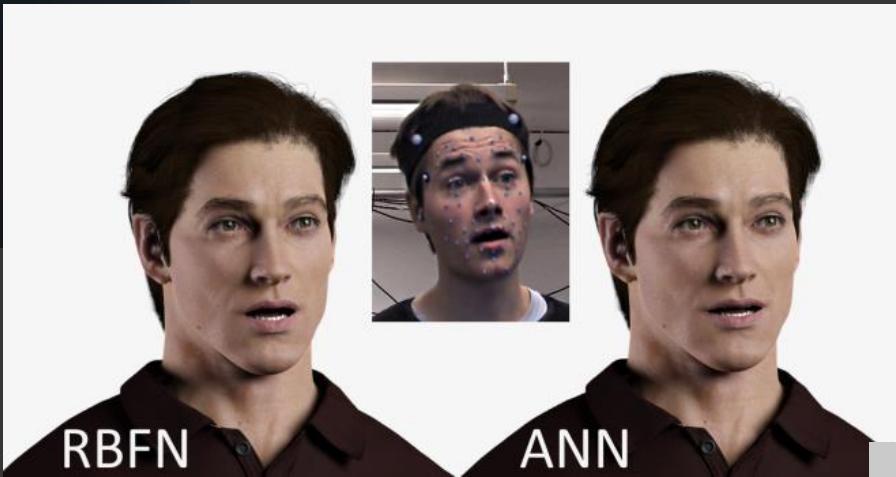
Clones



Variety



Emotions



CHALLENGES

- Mapping Mocap
- Speed of production
- Reduce manual effort
- Retain emotion
- Realistic vs. Cartoon?
- New Applications
 - Mobile devices
 - HMD



Avengers: Age of Ultron, Marvel 2015



Example Motion Capture from GV2

Render Style

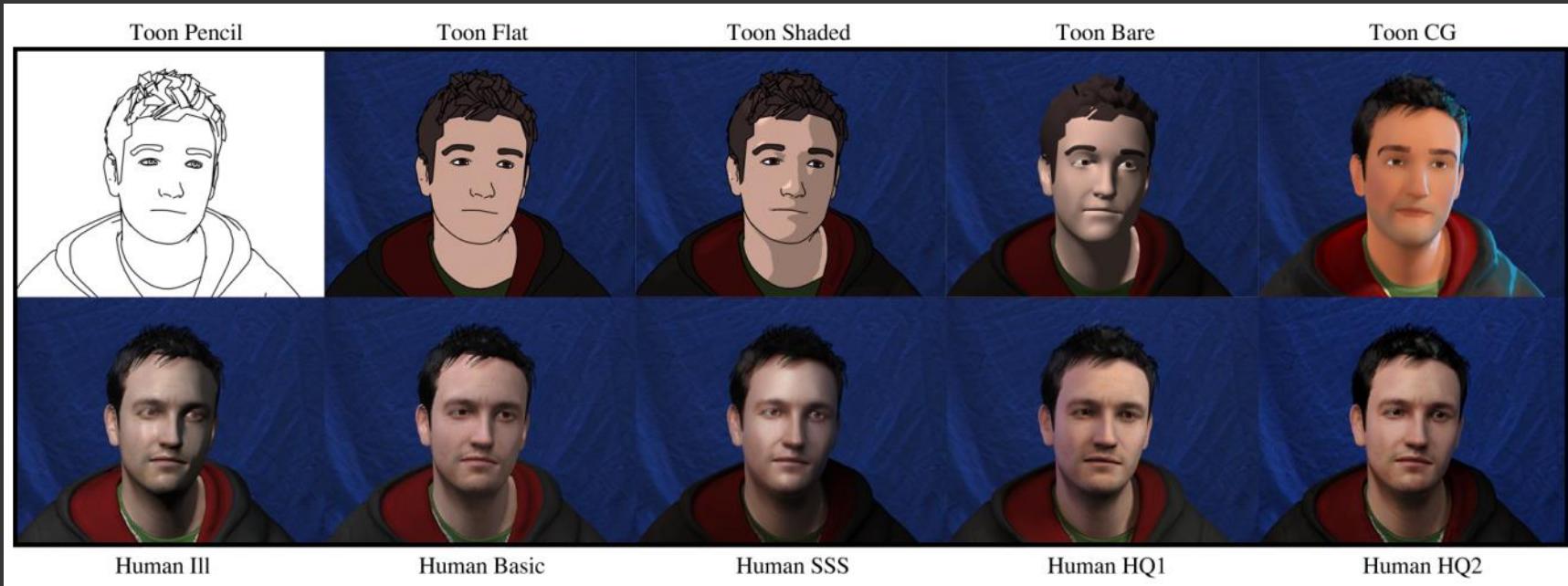


The Adventures of Tintin
(Columbia Pictures, Paramount Pictures, 2011)

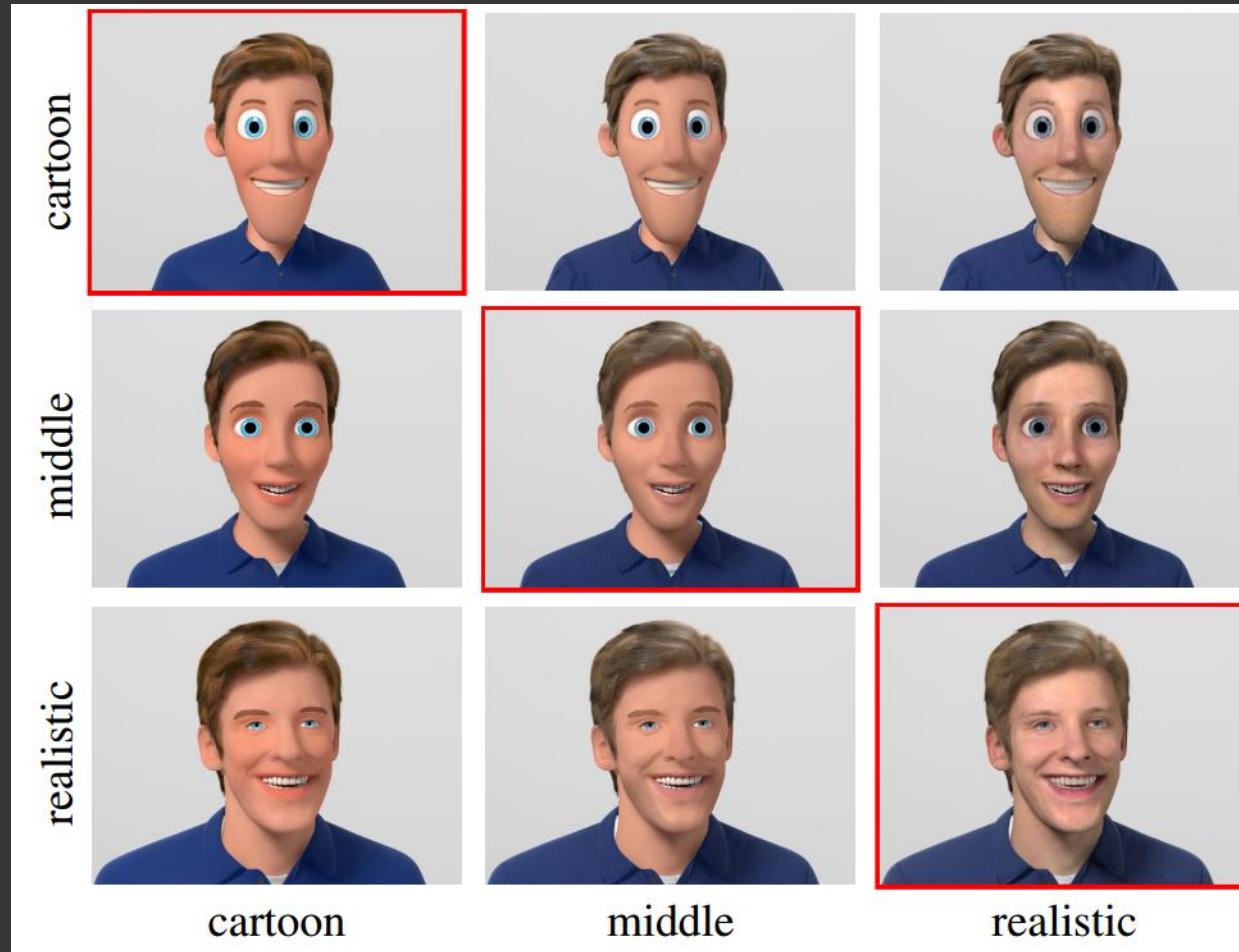


Tangled
(Walt Disney Animation Studios, 2010)

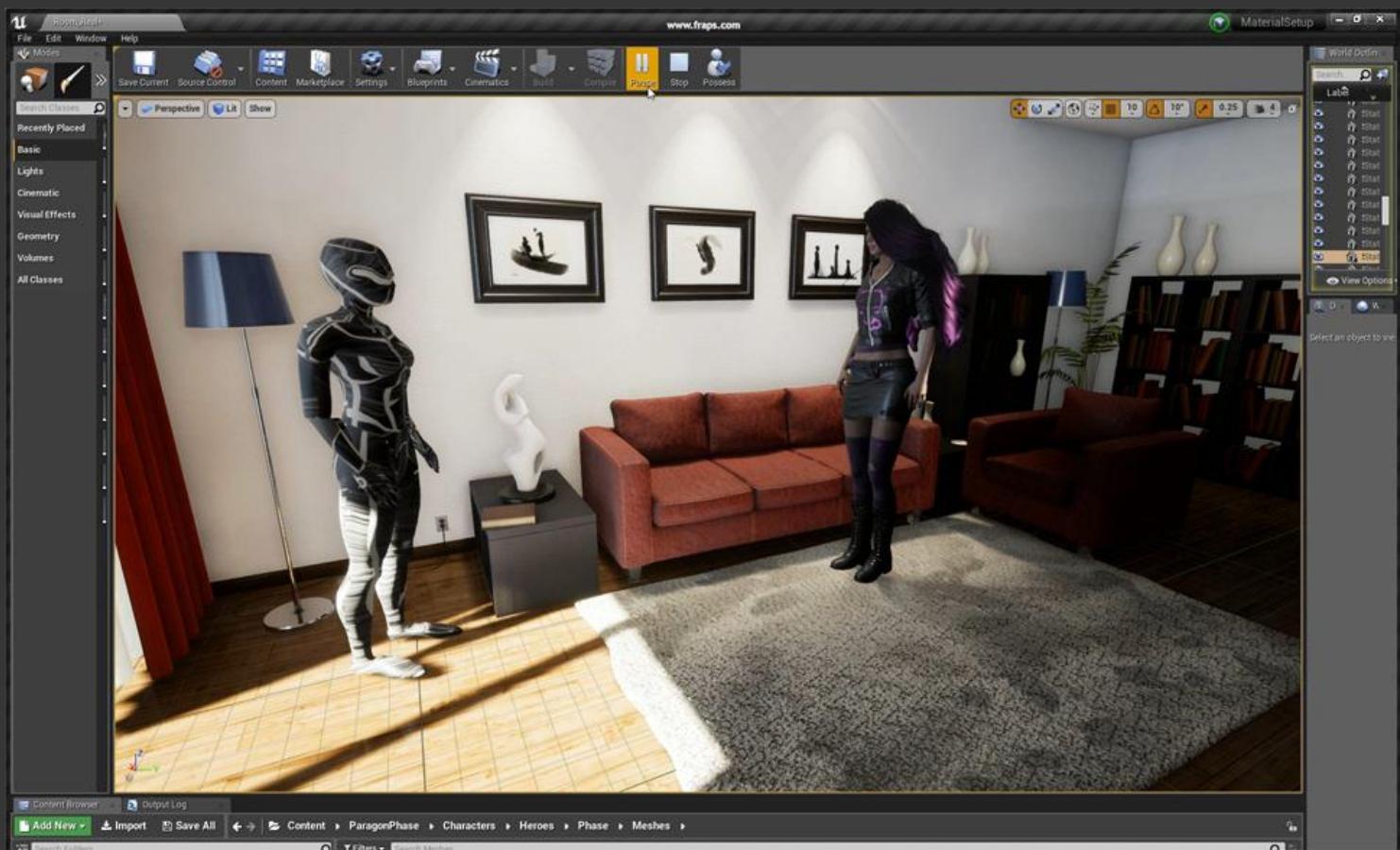
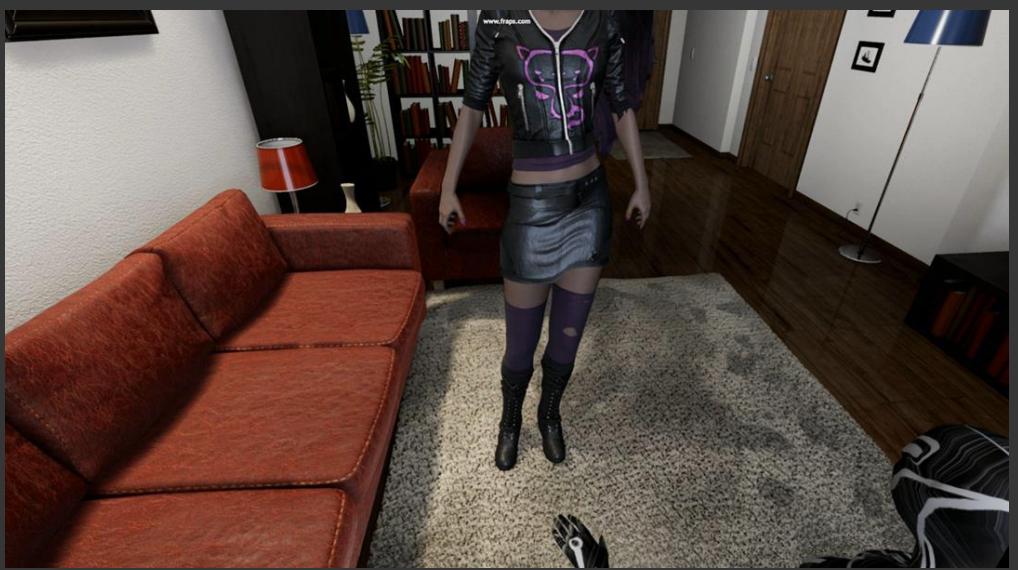
Render Style



Shape vs. Material



Self-Avatar/ Embodiment



Summary

- Outline of the course
- What computer graphics is used for
- Research in TCD
- Next Lecture
 - Graphics Programming!

