

Graphics Programming

Lecture 2

Computer Graphics: Definitions

- ▶ Computer Graphics:
 - ▶ Producing pictures or images using a computer
- ▶ Imaging
 - ▶ Visual representation or reproduction of an object's form
- ▶ Modeling
 - ▶ Simulation of an object (usually in 3D)
- ▶ Rendering
 - ▶ Constructing 2D images from 2D/3D models
- ▶ Animation
 - ▶ Simulating changes over time

HTML5

- ▶ Latest evolution of the standard that defines HTML
 - ▶ New version of HTML - new elements, attributes, and behaviours
 - ▶ Larger set of technologies that allows more diverse and powerful websites and applications.
 - ▶ Multimedia: Making video and audio first-class citizens in the Open Web.
 - ▶ 2D/3D graphics and effects: Allowing a much more diverse range of presentation options.
 - ▶ SVG
 - ▶ WebGL
 - ▶ Canvas
 - ▶ Performance and integration: Greater speed optimization and better usage of hardware.
 - ▶ Styling: Allowing authors write more sophisticated themes - CSS3
 - ▶ Device access: allowing for the usage of various input and output devices.
 - ▶ Connectivity: allowing you to communicate with the server in new and innovative ways.
 - ▶ Offline and storage: allowing webpages to store data on the client-side locally and operate offline more efficiently.

Graphics



HTML5 Canvas

HTML5
< canvas >

- ▶ The HTML <canvas> element is used to draw graphics, on the fly, via JavaScript.
 - ▶ The <canvas> element is only a container for graphics.
 - ▶ Must use JavaScript to actually draw the graphics.
 - ▶ Has several methods for drawing paths, boxes, circles, text, and adding images.

▶ Browser Support

Element					
<canvas>	4.0	9.0	2.0	3.1	9.0

- ▶ A canvas is a rectangular area on an HTML page. By default, a canvas has no border and no content.
- ▶ The markup looks like this: `<canvas id="myCanvas" width="200" height="100"></canvas>`

Canvas: Draw a Line/Circle

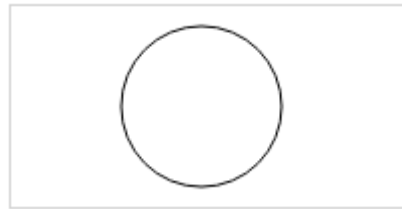
►

```
var c = document.getElementById("myCanvas");  
var ctx = c.getContext("2d");  
ctx.moveTo(0,0);  
ctx.lineTo(200,100);  
ctx.stroke();
```



►

```
var c = document.getElementById("myCanvas");  
var ctx = c.getContext("2d");  
ctx.beginPath();  
ctx.arc(95,50,40,0,2*Math.PI);  
ctx.stroke();
```



Canvas: Draw Text/Stroke Text

►

```
var c = document.getElementById("myCanvas");  
var ctx = c.getContext("2d");  
ctx.font = "30px Arial";  
ctx.fillText("Hello World",10,50);
```

A rectangular canvas box containing the text "Hello World" in a bold, black, sans-serif font. The text is positioned in the upper-left corner of the box.

Hello World

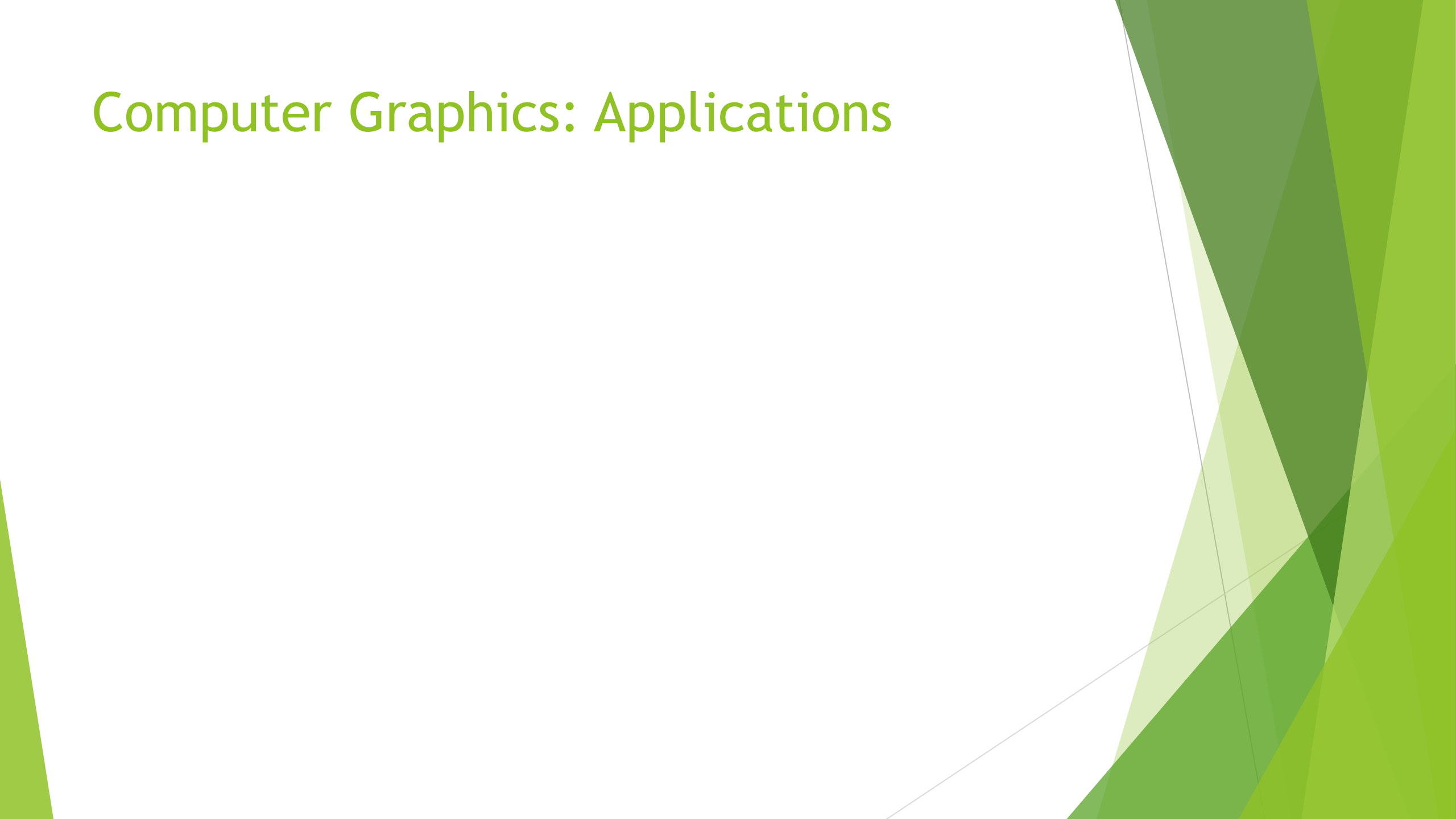
►

```
var c = document.getElementById("myCanvas");  
var ctx = c.getContext("2d");  
ctx.beginPath();  
ctx.arc(95,50,40,0,2*Math.PI);  
ctx.stroke();
```

A rectangular canvas box containing the text "Hello World" in a black, sans-serif font. The text is positioned in the upper-left corner of the box and has a thin black outline (stroke) around it.

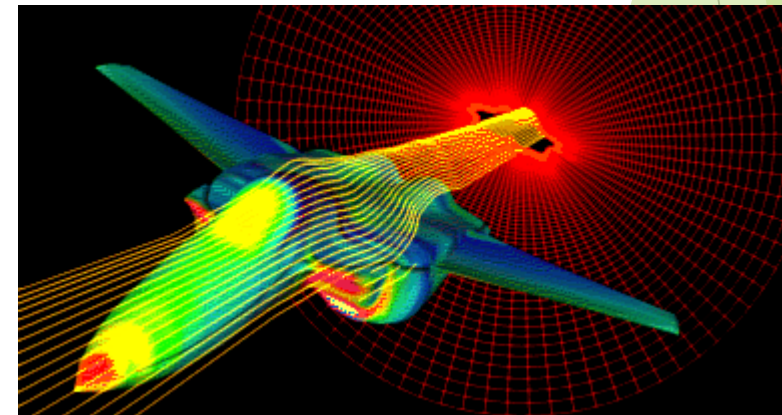
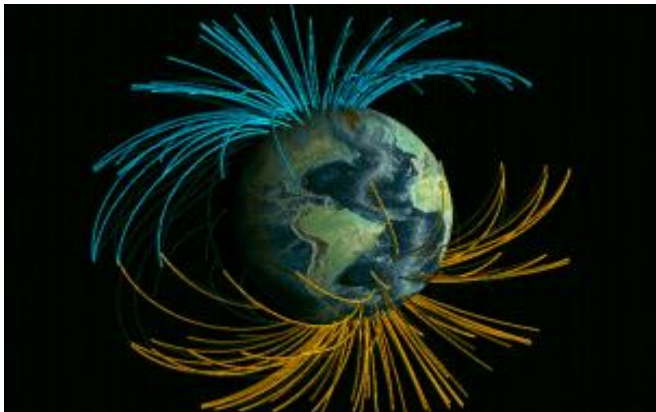
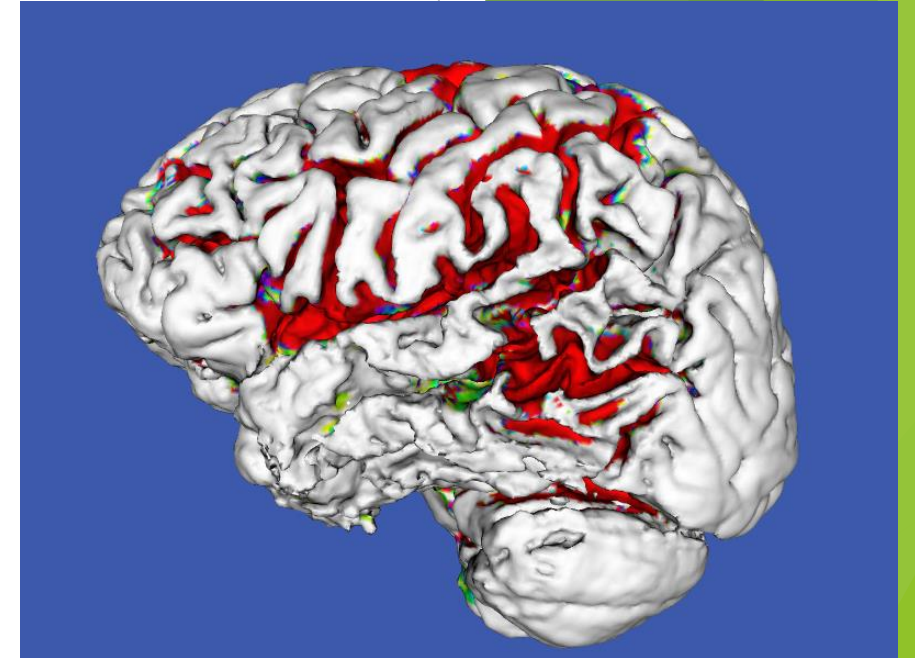
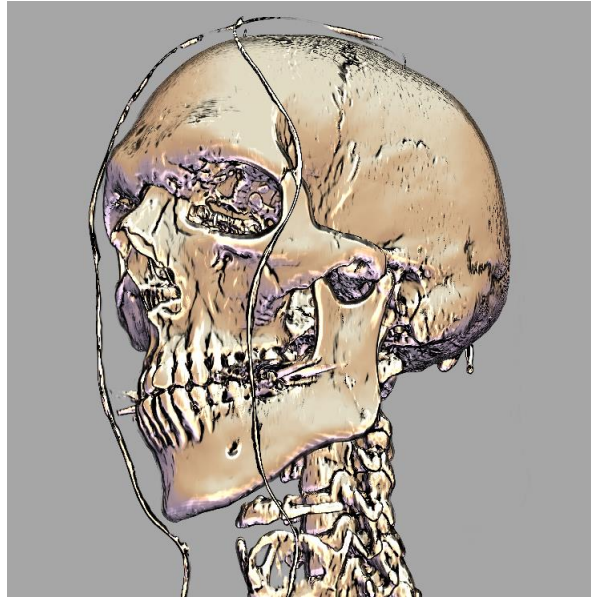
Hello World

Computer Graphics: Applications

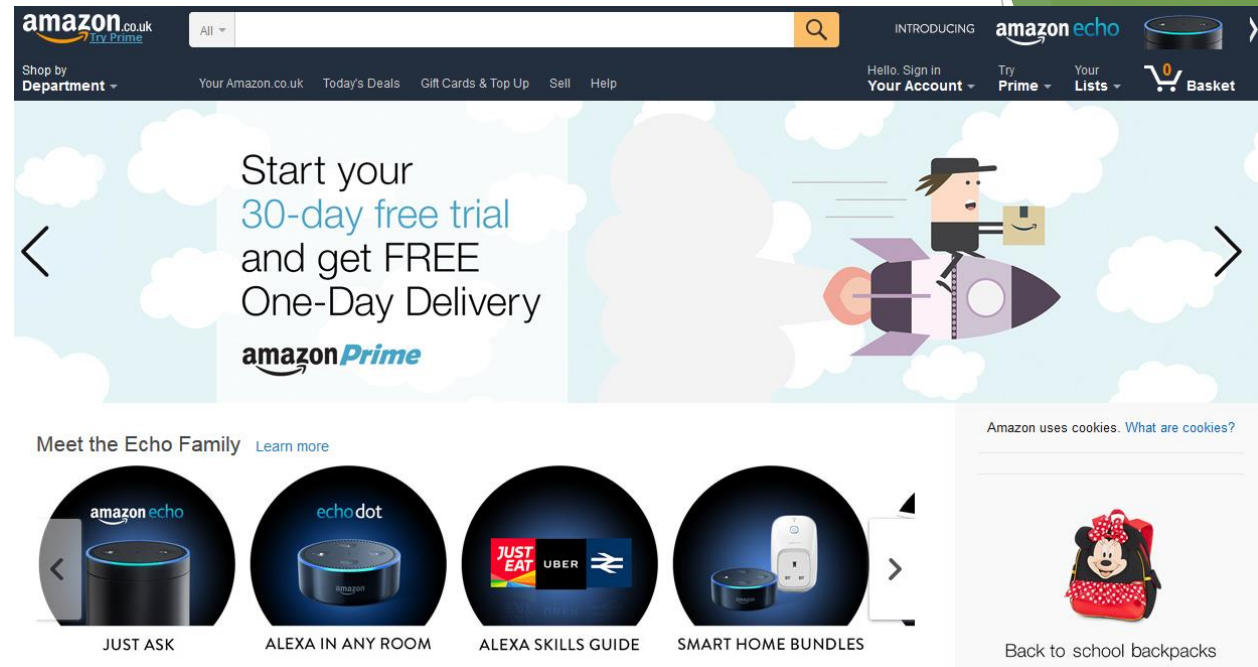


Scientific Visualisation

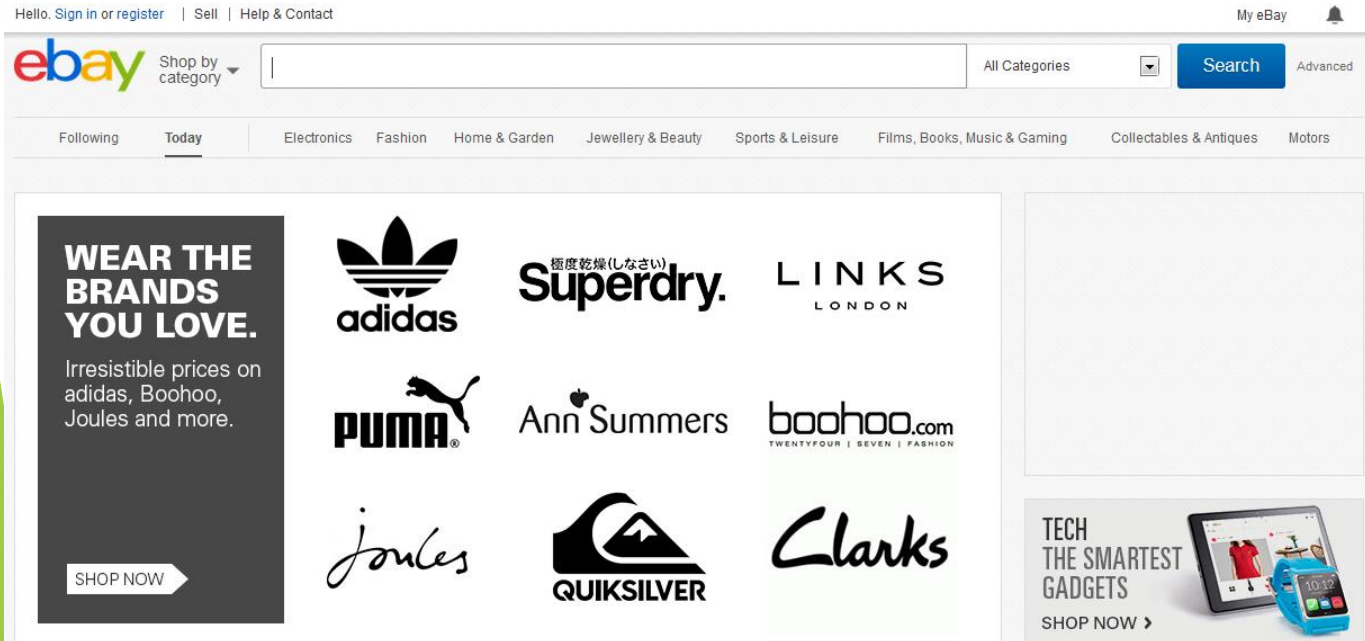
- Data analysis



E-Commerce



The screenshot shows the Amazon.co.uk homepage. At the top is a navigation bar with the Amazon logo, a search bar, and links for 'INTRODUCING amazon echo', 'Hello, Sign in Your Account', 'Try Prime', 'Your Lists', and a shopping basket. Below the navigation bar is a large banner for Amazon Prime with the text 'Start your 30-day free trial and get FREE One-Day Delivery' and an illustration of a delivery person on a rocket. Underneath the banner is a section titled 'Meet the Echo Family' with four circular icons: 'amazon echo', 'echo dot', 'JUST EAT UBER', and 'SMART HOME BUNDLES'. To the right of this section is a small box titled 'Amazon uses cookies. What are cookies?' with a Minnie Mouse backpack icon and the text 'Back to school backpacks'.



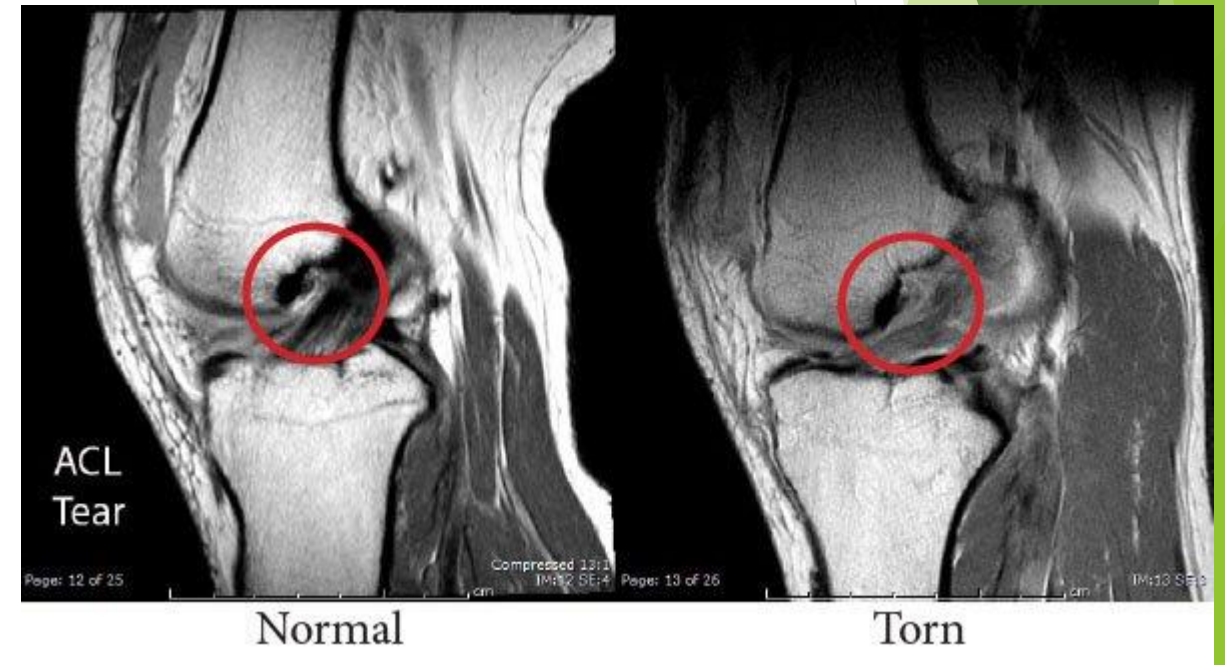
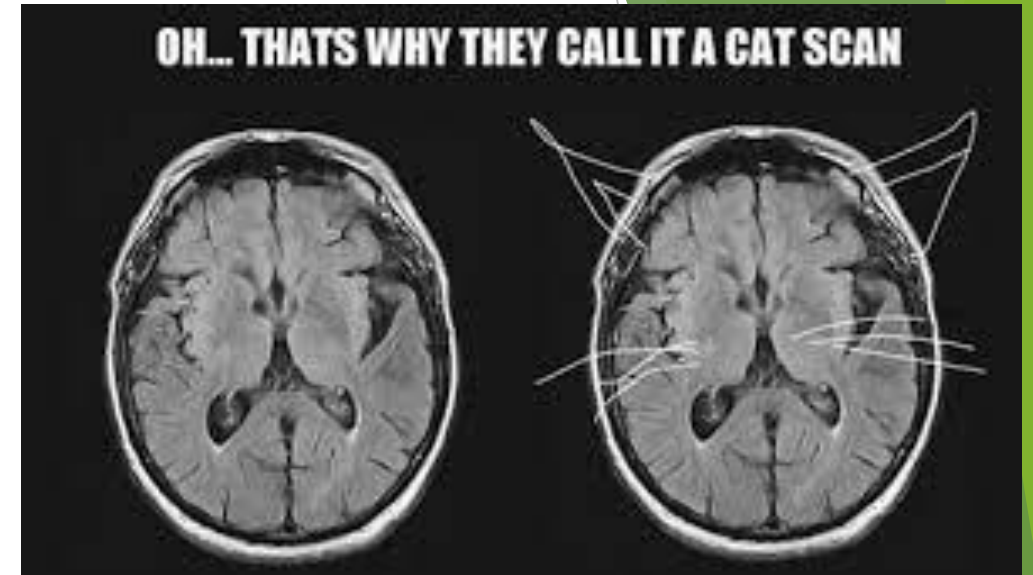
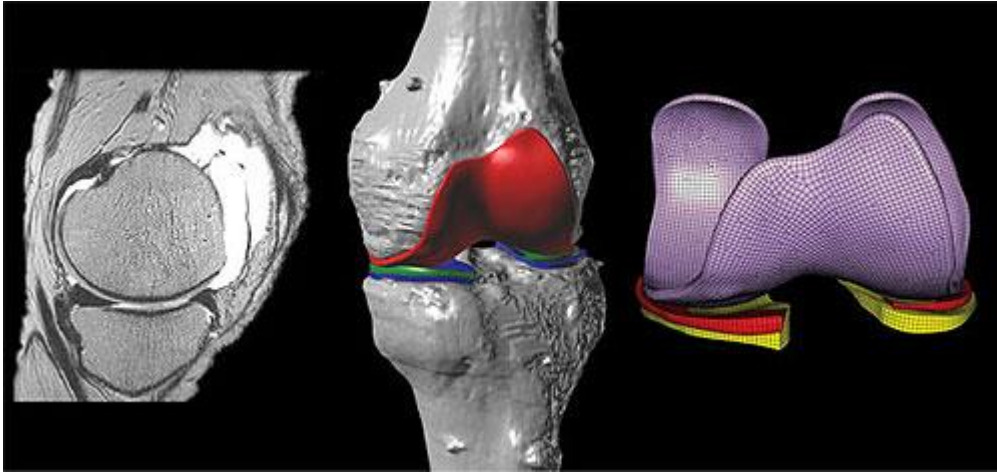
The screenshot shows the eBay homepage. At the top is a navigation bar with the eBay logo, a search bar, and links for 'Hello, Sign in or register', 'Sell', and 'Help & Contact'. Below the navigation bar is a section titled 'Shop by category' with a dropdown menu. Underneath this is a row of category links: 'Following', 'Today', 'Electronics', 'Fashion', 'Home & Garden', 'Jewellery & Beauty', 'Sports & Leisure', 'Films, Books, Music & Gaming', 'Collectables & Antiques', and 'Motors'. The main content area features a large advertisement for 'WEAR THE BRANDS YOU LOVE.' with logos for adidas, Puma, Ann Summers, Joules, Quiksilver, Superdry, Links London, and boohoo.com. Below the logos is a 'SHOP NOW' button. To the right of the logos is a section titled 'TECH THE SMARTEST GADGETS' with an illustration of a tablet and a smartphone, and a 'SHOP NOW' button.

3D personalized avatars e.g. teleconferencing



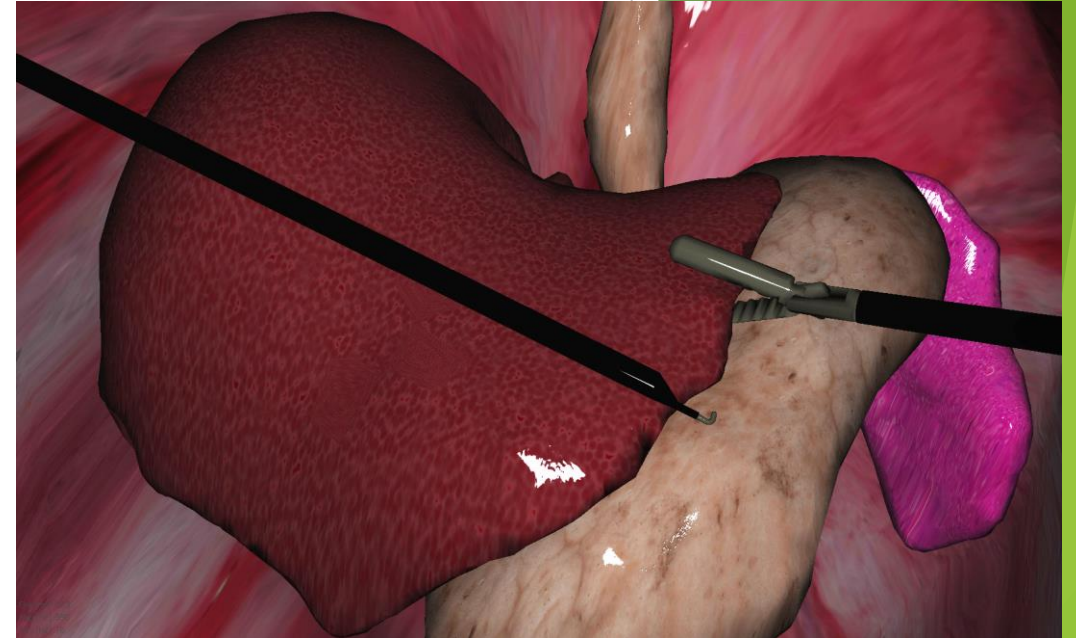
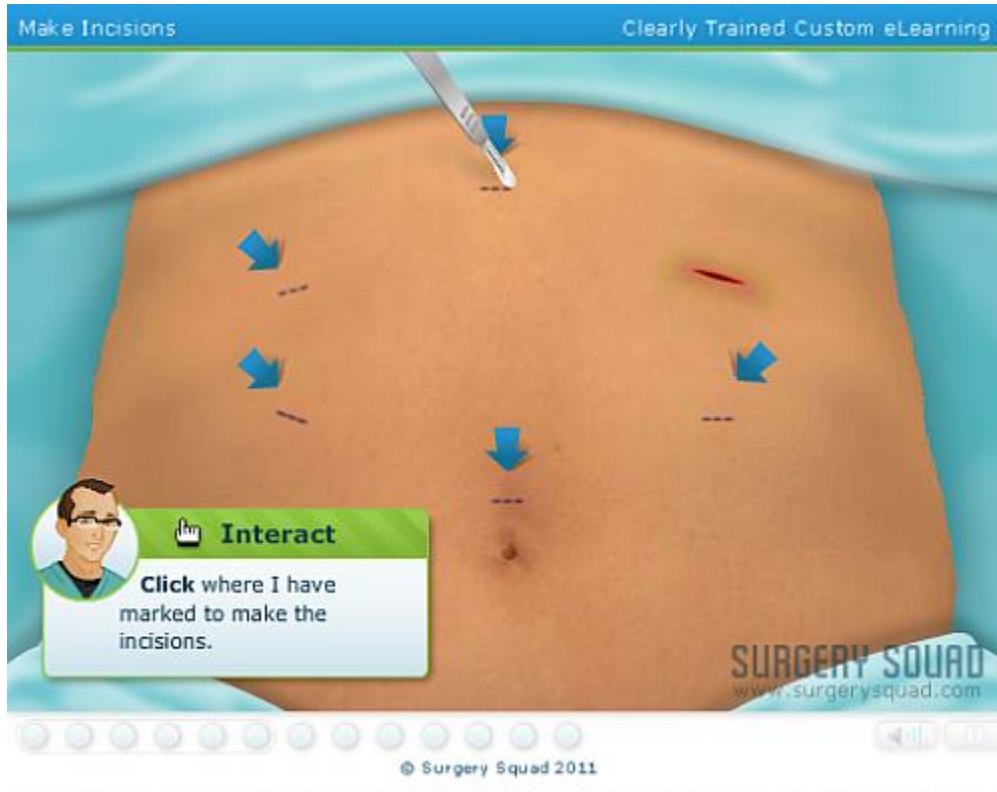
Medical applications

- ▶ Diagnosis support
 - ▶ e.g. Visualisation of CAT/MRI scans



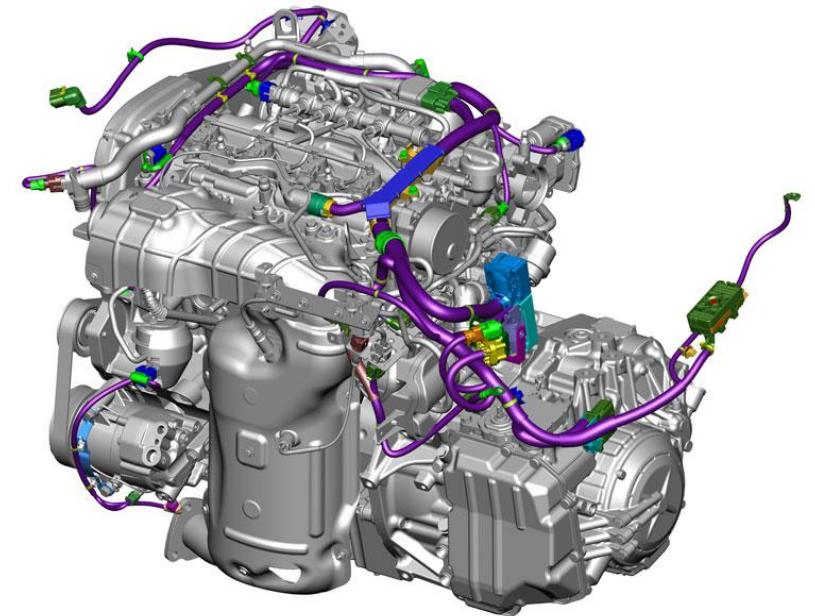
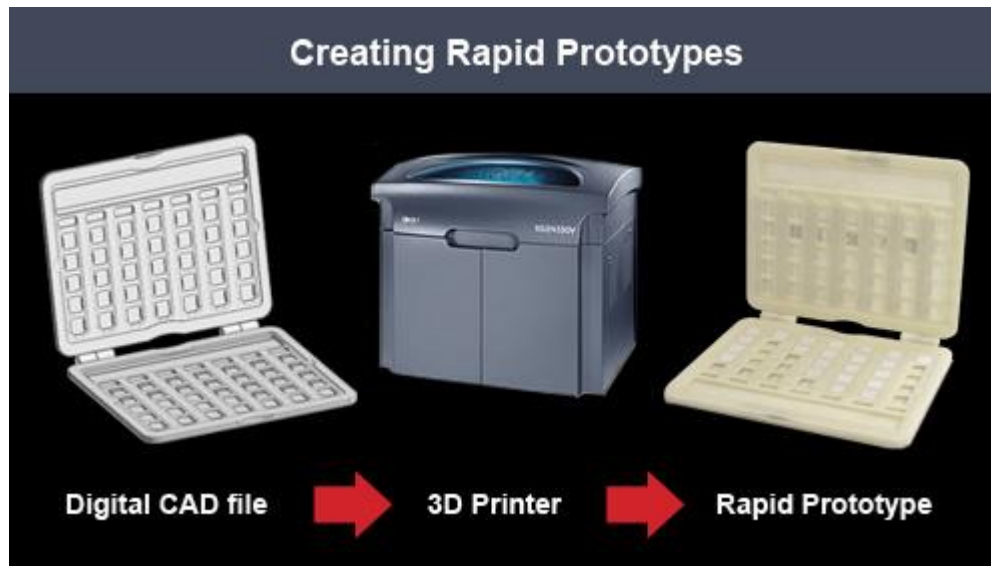
Medical applications

► Virtual/tele surgery



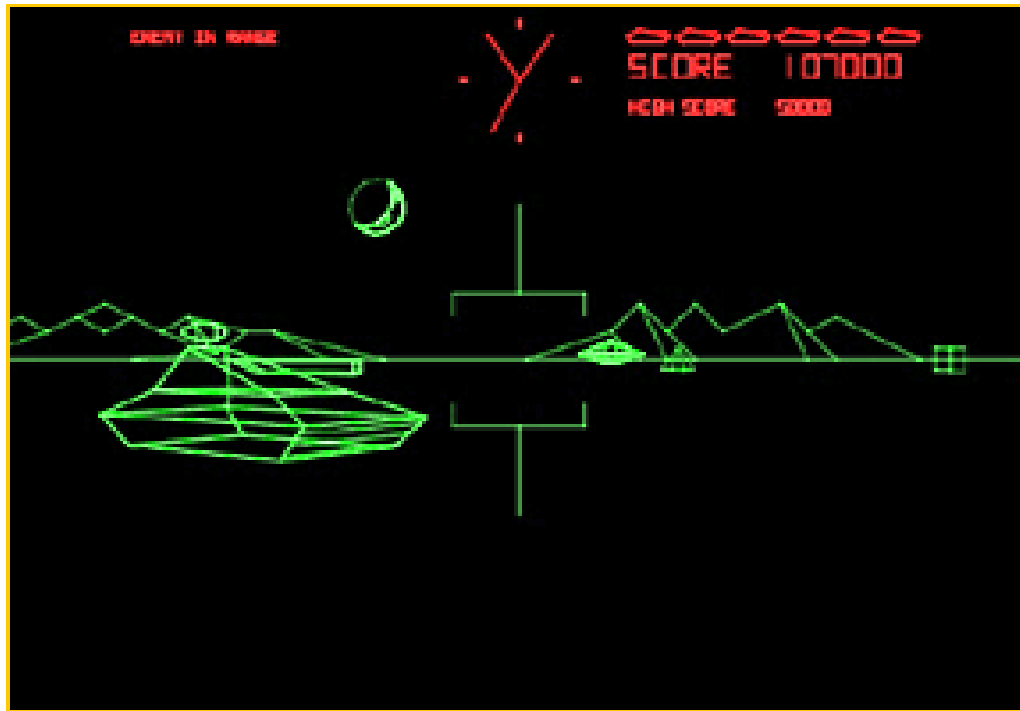
Manufacturing

- CAD
- Rapid Prototyping

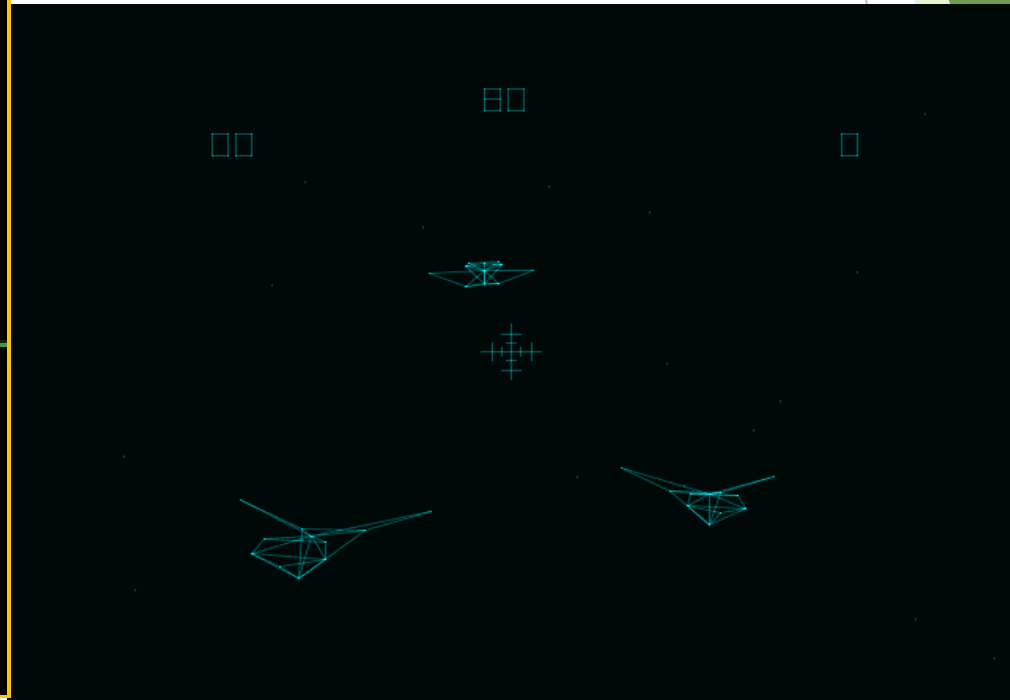


Entertainment: Videogames

Most in-demand field of applications



Battlezone – Atari 1980



Tailgunner - Cinematronics 1979

Entertainment: Videogames

Most in-demand field of applications



Doom – IDsoft 1993



Virtua Fighter - Sega 1993

Entertainment: Videogames

Most in-demand field of applications



Doom 3- ID soft 2004



**World of Warcraft,
Blizzard Entertainment 2004**

Entertainment: Videogames

Most in-demand field of applications



Doom 3- ID soft 2004



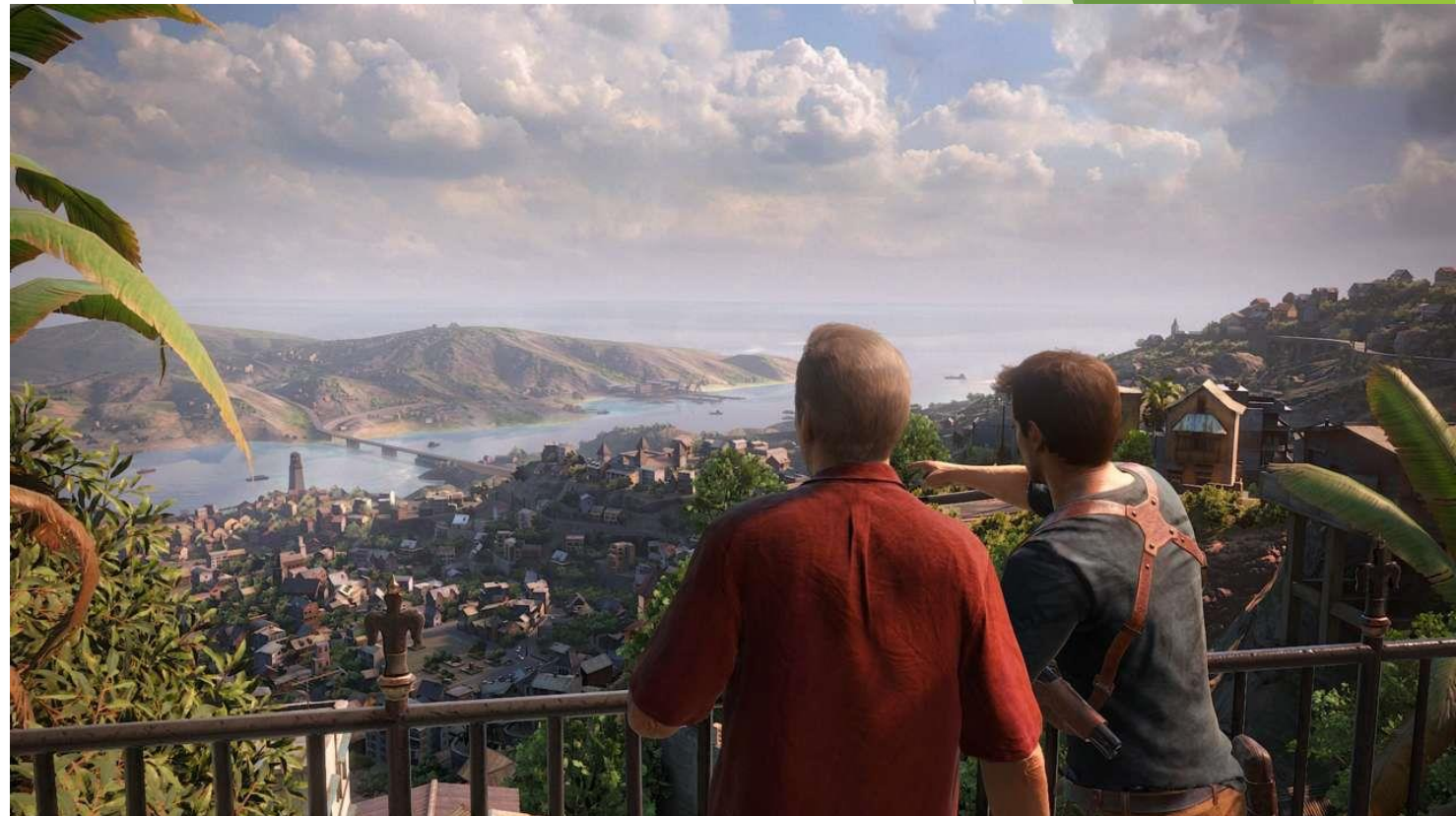
**World of Warcraft,
Blizzard Entertainment 2004**

Entertainment: Videogames

Most in-demand field of applications



Uncharted 4 – PS4 – 2016
<https://www.youtube.com/watch?v=yrN5arZKJok>



Entertainment: Videogames

► Virtual Reality



Entertainment: Movie Industry

CG Animations

High performance graphics possible at the time with offline rendering (different to real time requirement for games)



Luxo Jr - Pixar 1986

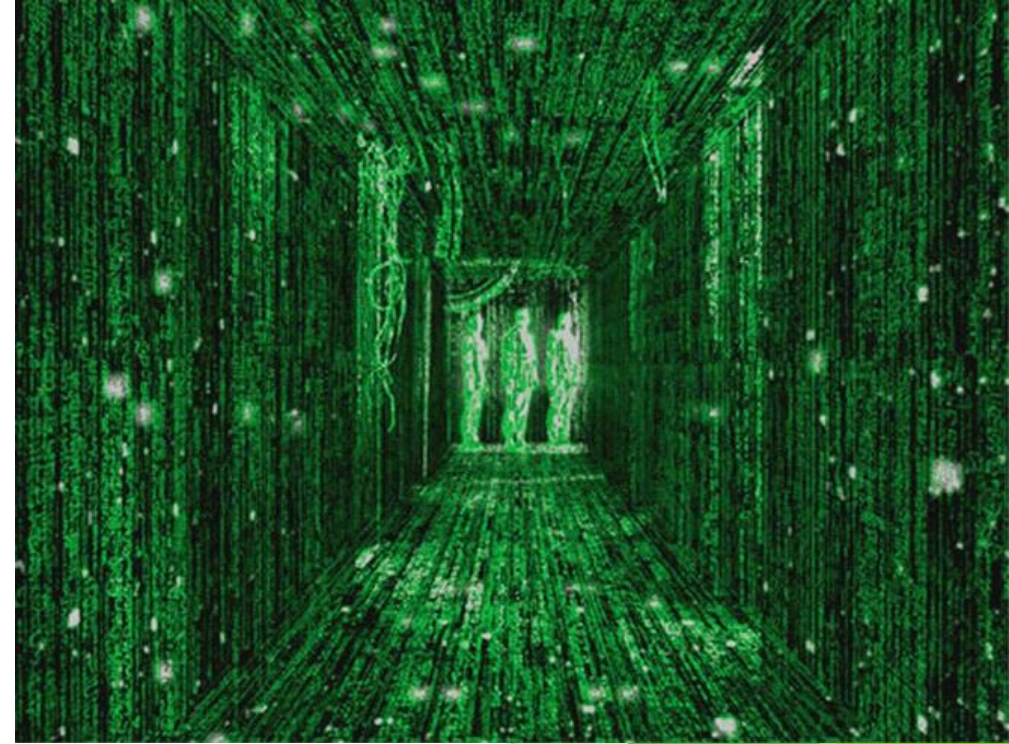


Geri's Game - Pixar 1997

Entertainment: Movie Industry

Visual Effects (not special fx)

Special effects are carried out on set during production and *visual effects* are done in post-production



The Matrix - 1999

Before and After

- Guardians of the Galaxy



Before and After

- Pirates Of The Caribbean



Before and After

► Hobbit



Before and After

- Twilight Saga: Eclipse



Before and After

- Game Of Thrones



Before and After

- ▶ Alice In Wonderland



Before and After

► Life Of Pi



Photorealistic feature movies

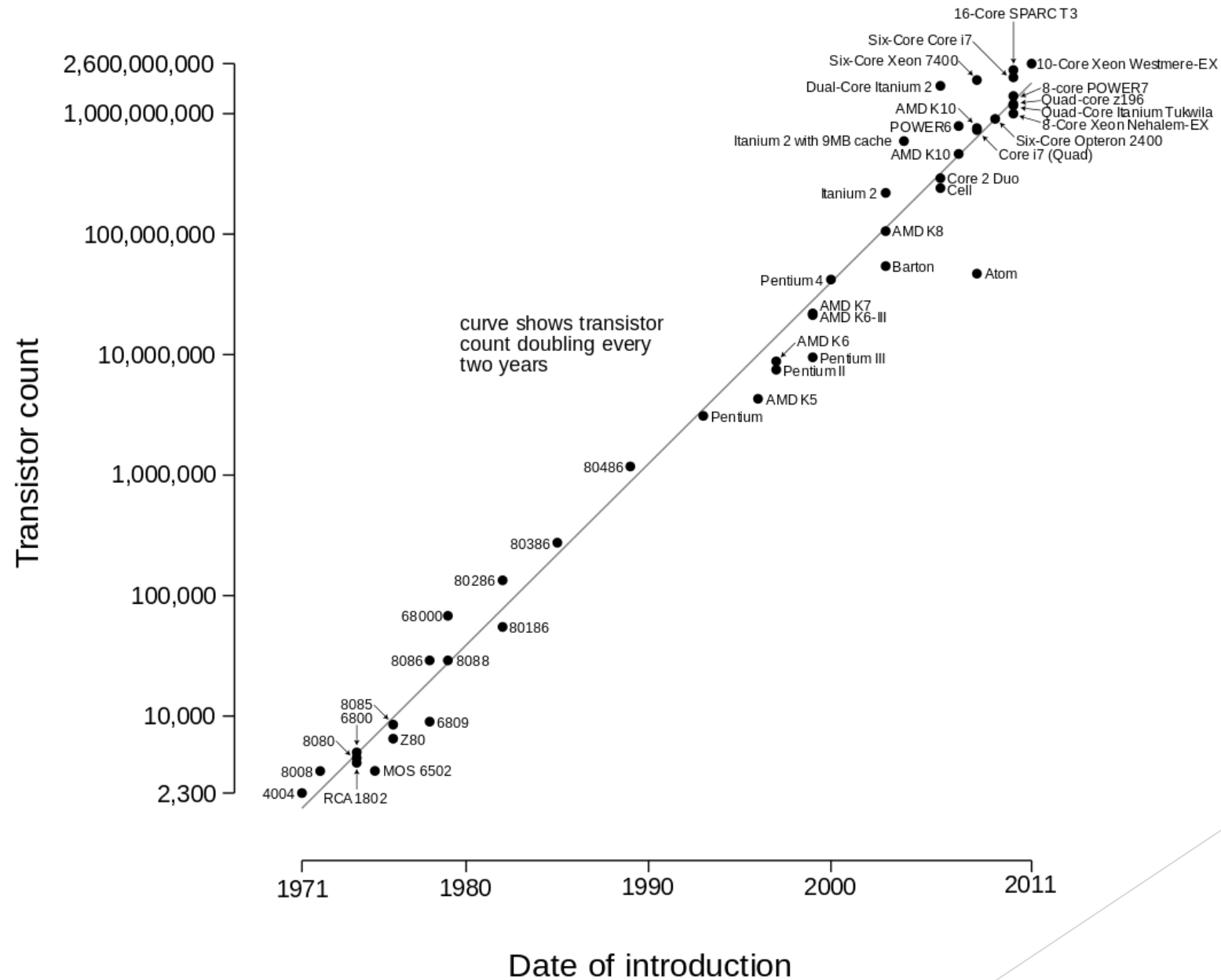
- Final Fantasy (video is completely computer generated)



Moore's Law

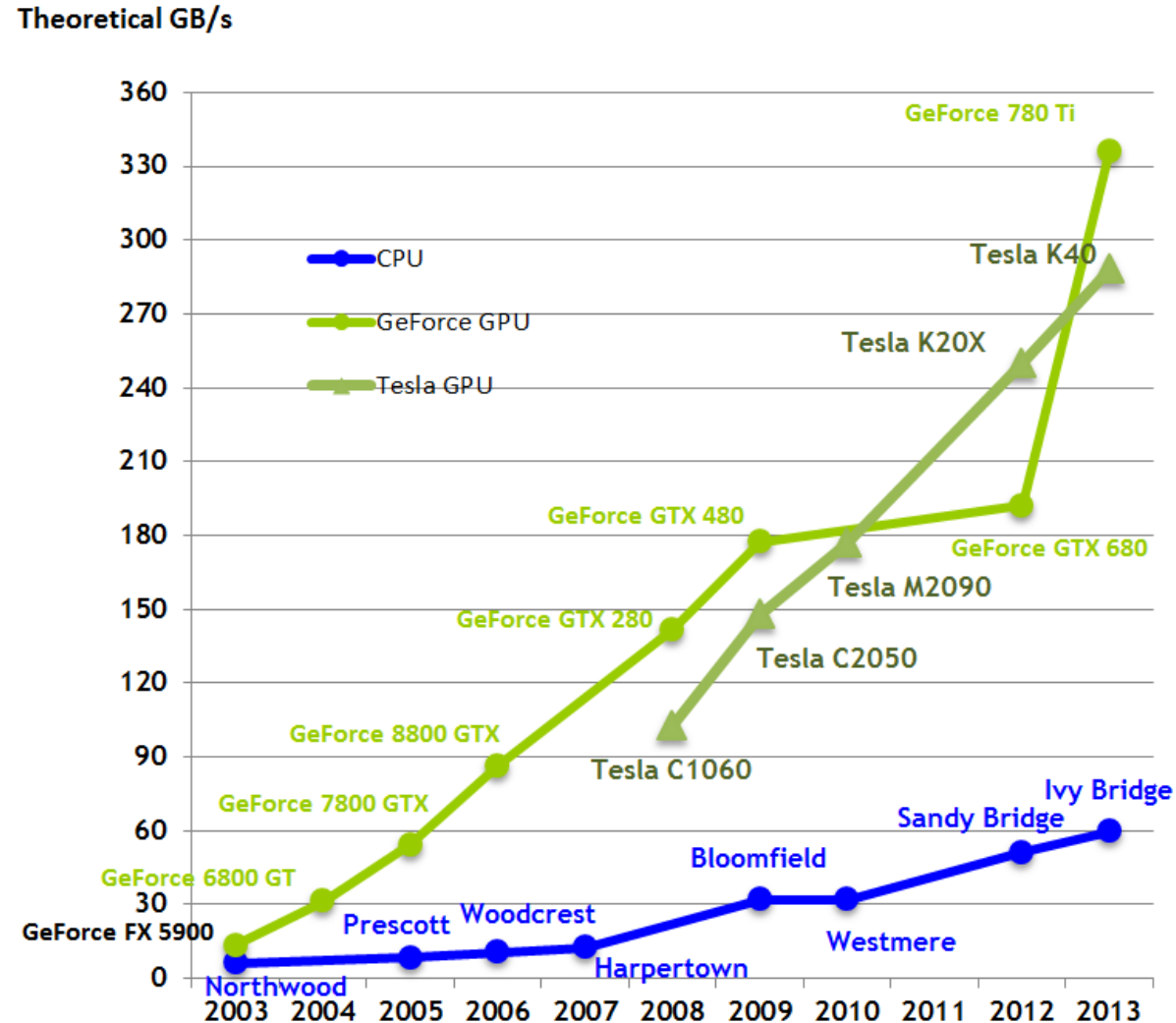
- ▶ In 1965, Gordon **Moore**, co-founder of Intel, said that the number of transistors per square inch on integrated circuits had doubled every year since the integrated circuit was invented. **Moore** predicted that this trend would continue for the foreseeable future.

Microprocessor Transistor Counts 1971-2011 & Moore's Law



GPU is where computing is advancing most rapidly

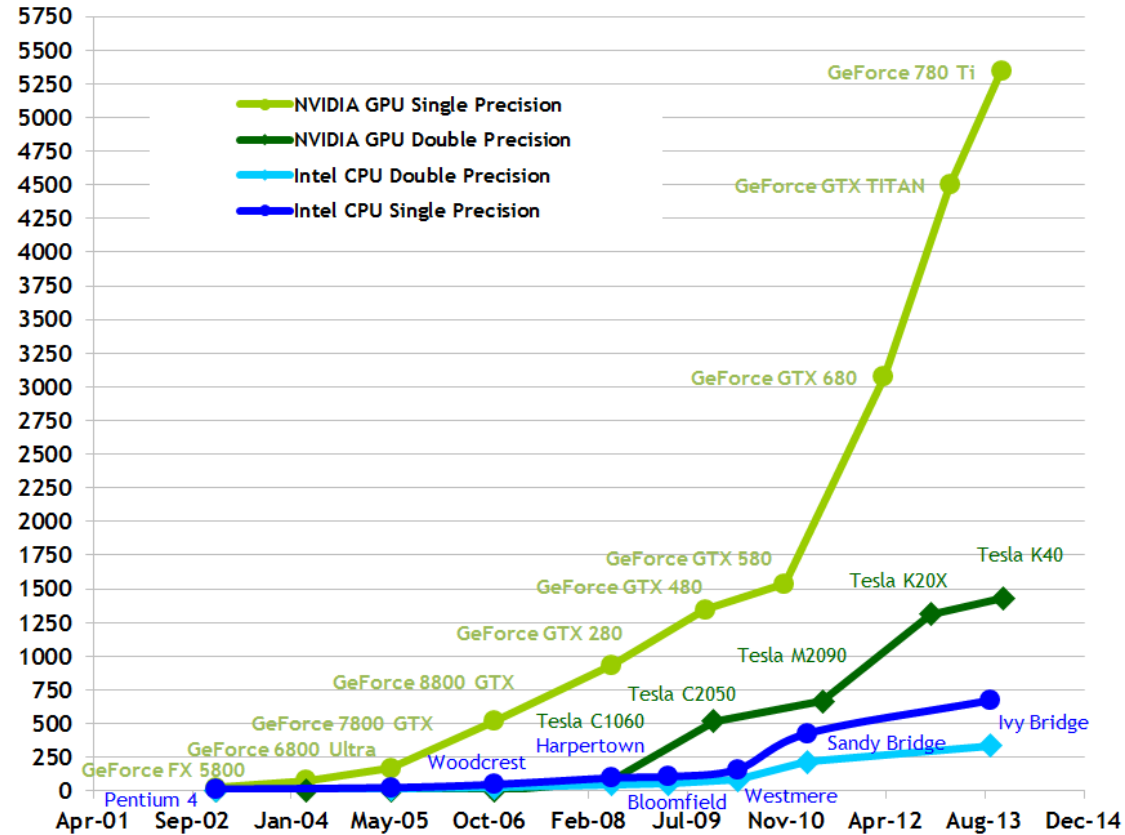
With heat dissipation, faster processors no longer possible. Instead processing power will increase with increased parallelism



GPU is where computing is advancing most rapidly

With heat dissipation, faster processors no longer possible. Instead processing power will increase with increased parallelism

Theoretical GFLOP/s



Floating-Point Operations per Second - Nvidia CUDA C Programming Guide
Version 6.5 - 24/9/2014 - copyright Nvidia Corporation 2014

Cultural heritage

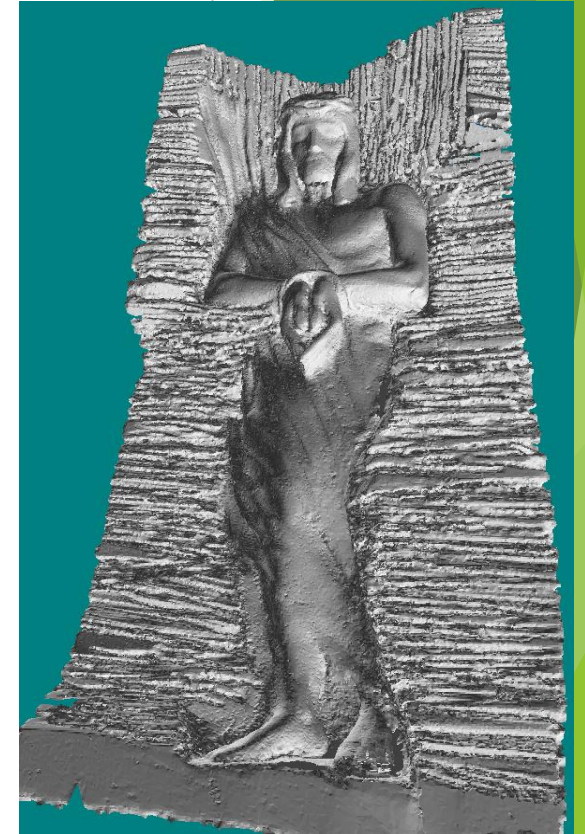
- ▶ Exhibition
 - ▶ Virtual Museums
 - ▶ Catalogues
 - ▶ Educational Tools
- ▶ Restoration
 - ▶ 3D Modelling
 - ▶ Simulations



Oriental Museum in Chicago

Cultural heritage

- ▶ Restoration
- ▶ First step is *3D Acquisition*



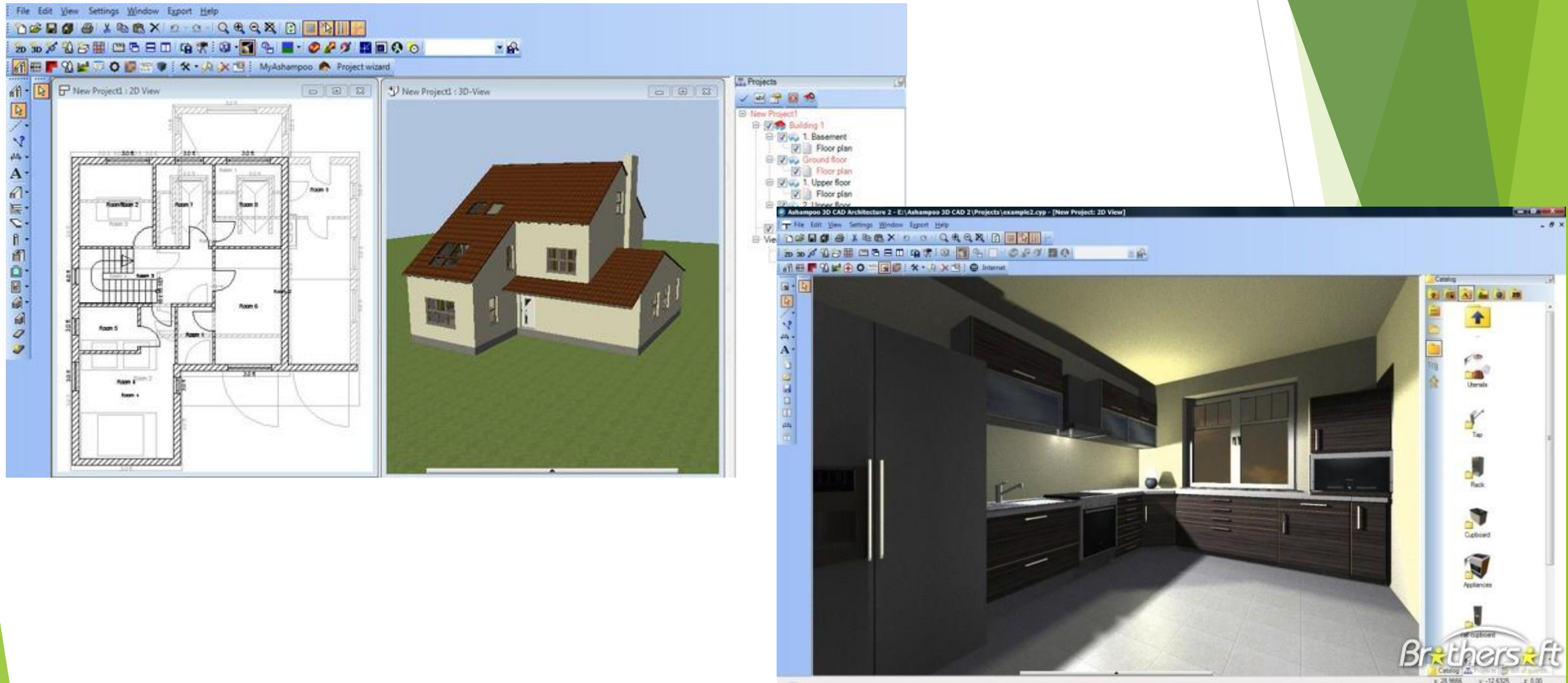
Cultural heritage

- ▶ Restoration
- ▶ First step is *3D Acquisition*



3D model of the ancient Temple of Bel, at Palmyra, Syria,

Architecture: Design aid tool



Architecture: Design aid tool

- ▶ Architecture:
 - ▶ preview:
 - ▶ User interaction
 - ▶ Design check



Computer-Generated Models of Physical, Financial and Economic Systems for Educational Aids



Flight Simulator



Mars Rover Simulator