
SCHOOL of ELECTRICAL ENGINEERING & COMPUTING
FACULTY of ENGINEERING & BUILT ENVIRONMENT
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Comp33208 Computer Graphics

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LECTURE w02

History of Computer Graphics

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History of Computer Graphics

The history of computer graphics can be described in different ways. We could start with the Gutenberg bible in 1450, the invention of the computer screen, the first computer games or with the development of techniques typical for computer graphics.

History 1940–1970

- **1946:** Parry Moon and Domina Spencer create a coloured paper image which is based on results of their mathematical calculations of a radiosity type illumination model <http://www.helios32.com/resources.htm>
- **1961:** MIT students implemented Spacewar on a 4 Kbyte RAM PDP-1-Computer using joysticks and a round monitor.
- **1963:** First CG film by Edward Zajac: A box shaped satellite moves through space
<http://www.visualnews.com/2012/07/18/first-computer-graphics-film-ever-from-1963/>
- **1965:** 1st computer art exhibitions in New York and Stuttgart.
- **1966:** Odyssey is the first commercial computer game and was produced by Magnavox.

History 1970–1980

- **1973:** Edwin Catmull's dissertation: z-buffer-Method, textur-mapping
- **1975:** George Lucas founded Industrial Light + Magic (ILM).
- **1977:** Star Wars: Oscar for Visual Effects
- **1977:** Atari produces the game console VCS, later called Atari 2600 (USD 250)
- **1979:** Turner Whitted describes the raytracing method for reflections and modelling transparency.

History 1980–1985

- **1980:** Namco sells the first slot-machines which perform the game Pac-Man.
- **1980:** Atari offers the first 3d-game, called Battlezone. It is a tank simulation with line graphics. The US army orders a special version.
- **1982:** Tron : The first movie that contains a larger amount of computer generated images.
- **1982:** Star Trek II: The Wrath of Khan (effects by ILM)
- **1985:** Alexei Paschitnow invents the game Tetris (www.tetris.com)

History 1986–1990

- **1986:** Steve Jobs and Edwin Catmull found a company and animation studio called Renderman. Its origin is the computer-graphics department of Pixar/Lucasfilm. The Pixar production Luxo Jr. by John Lasseter was the first completely computer generated 3D-animation that was nominated for an Oscar (compare cover of Foley et al. 1994).
- **1988:** Tin Toy (Pixar): Oscar for Best Short Film - Animated
- **1988:** Who framed Roger Rabbit (effects by ILM): Oscar for visual effects. Animated cartoons play together with human actors.
- **1989:** The Abyss (effects by ILM): Oscar for visual effects. Film-script by James Cameron.

History 1991–1995

- **1991:** Terminator 2 (effects by ILM and others): Oscar for visual effects. Film-script by James Cameron.
- **1992:** SGI introduces OpenGL.
- **1993:** Jurassic Park (effects by ILM and others): Oscar for visual effects. For the first time the effects aim to remain hidden. Most animals are computer generated.
- **1993:** id Software releases the game Doom (classified).
- **1994:** Forrest Gump (effects by ILM): Oscar for visual effects.
- **1994:** James Cameron and others found the trick studio Digital Domain. 1995 Toy Story (Pixar): First completely computer generated movie. 110 people worked for 4.5 years.
- **1995:** DirectX introduced as standard for multimedia application development on the Windows platform.
- **1995:** 'Outside In' by the Geometry Center.
https://www.youtube.com/watch?v=c_058ewaoPk

History 1996–1999

- **1996:** Independence Day: Oscar for Visual Effects. However many explosions were taken from real models.
- **1996:** id Software releases the game Quake (rated R).
- **1997:** Geri's Game (Pixar): Oscar for Best Short Film - Animated.
- **1997:** Titanic (effects Digital Domain and others) Oscar for Visual Effects. Computer generated ship models. Simulated ocean waves.
- **1999:** The Matrix (effects by Manex): Oscar for visual effects. Bullet time Photography.

History 2000

- **2000:** Gladiator (effects by Mill Film): Oscar for visual effects.
- **2000:** Father and Daughter Oscar in category Short Film - Animated.
- **2000:** 'Walking with Dinosaurs' - Framestore (UK)
- **2000:** Release of DirectX 8.0.
- **2000:** Sony Playstation 2
- **2000:** Microsoft X-Box prototype shown at SIGGRAPH 2000

History 2001–2003

- **August 2001:** Final Fantasy (Production: Squaresoft www.squareusa.com) everything including human figures is computer generated. For the voices some actors were employed. Movements recorded via motion capture.
- **November 2001:** 'Walking with the Beasts' - Animation by Framestore (UK)
- **2001:** Movies: Monsters Inc.(Pixar), Harry Potter, A.I., Lord of the Rings, Shrek(PDI), The Mummy Returns (ILM), Tomb Raider (Cinesite), Jurassic Park III, Pearl Harbor (ILM), Planet of the Apes (Asylum)
- **2001:** Microsoft xBox and Nintendo Gamecube released
- **2002:** Minority Report, Spielberg, ILM effects, hologram scene <https://www.youtube.com/watch?v=DTjv5nm-BVo>
- **2003:** The Matrix Reloaded.

History 2004–2006

- **2004:** SIGGRAPH 2004.
- **2004:** Movies: Finding Nemo.
- **2004:** Sejong Park's Birthday Boy: Best animated short
- **2005:** Movies: I Robot , Star Wars Episode III .
- **2005:** 'Google Earth' (<http://earth.google.com>)
- **2005:** 21.December: QUIDAM by N-Sided: A 3D-character modeling tool.
- **2006:** Disney acquires Pixar for \$7.4B; Ed Catmull named President; Steve Jobs joins Disney Board
- **2006:** Apple Computer adopts the Intel chip, introduces Bootcamp to run Windows.
- **2006:** "Lady in the Water" by M. Night Shyamalan: ILM awarded for visual effects.
- **2006:** By 2006 ILM has been awarded 14 Academy Awards for Best Visual Effects and received 16 Scientific and Technical Achievement Awards.

History 2007

- **2007:** Michael Bay's Transformers.
- **2007:** June 2007, Rome Reborn 1.0: Interactive 3D digital model of ancient Rome.
- **2007:** Grzegorz Jonkajtys: award-winning short animation, "Ark."
- **2007:** To illustrate the programmable shaders in Nvidia's 8000 family of graphics cards a real-time rendered 3D CG Adrienne Curry was created using: Autodesk Maya, Pixologic ZBrush, Adobe Photoshop.
- **2007:** Harry Potter and the Order of the Phoenix: Thestrals are hairless horses with bat wings. ILM scanned a model the size of a horse to have a point cloud; used lots of pictures; modelers used several software packages; finally took subdivision surfaces into Zeno.

History 2008

- **2008:** Visual effects in films: The Dark Knight (e.g. Batman's motorcycle), Iron Man (Tony Stark and his suit), The Chronicles of Narnia: Prince Caspian (quality of the environments and creatures), Speed Racer (new concept for set design, animation, and color treatment), Indiana Jones and the Kingdom of the Crystal Skull (destruction of the temple 3D cracking algorithm), Quantum of Solace, The Day the Earth Stood Still, The Spirit (every shot in the film is a visual effect), 10,000 BC (mammoths), Hellboy II: The Golden Army, The Curious Case of Benjamin Button (aging reverse, facial animation), Wall-e (terrifying view of our planet in the future), Kung Fu Panda, Waltz with Bashir, Bolt, Madagascar: Escape 2 Africa, Horton Hears a Who!, The Tale of Despereaux.

History 2008

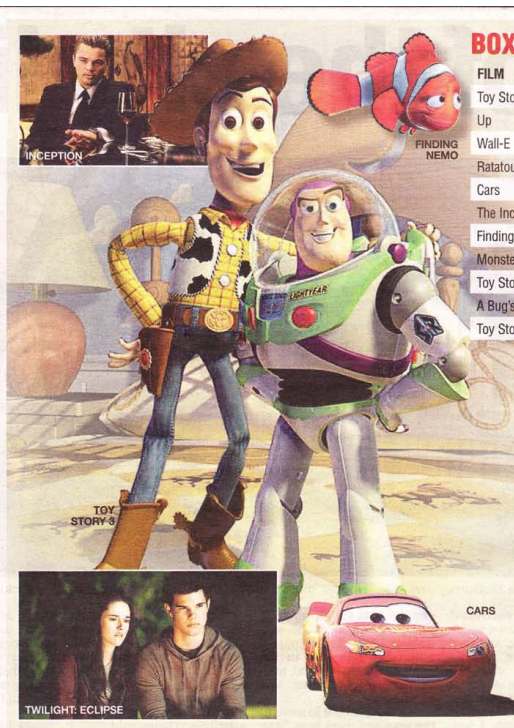
- **2008:** Kynogon/Autodesk's Kynapse: AI solution for driving virtual entities in games, can be used for architectural simulations, e.g. study evacuation scenarios using a horde of virtual pedestrians within a digital replica of a baseball stadium.
- **2008:** Star Wars: The Force Unleashed is an example of next-generation gaming. Players battle Felucian warriors and other creatures that can act independently in the interest of their own self-preservation. NPCs movements are no longer driven by pre-canned animation cycles, but by a nervous system that responds intelligently to sensory input about the environment (Euphoria's Dynamic Motion Synthesis (DMS)).
- **2008:** Massive Software is introducing AI-driven agents specifically designed for architectural simulation.

History 2009

- **2009:** Transformers-Revenge of the Fallen: ILM 46 robots, Digital Domain 13 robots, Asylum added non-robot effects.
- **2009:** Star Trek film: 7th time, ILM creates CG effects
- **2009:** Terminator Salvation, ILM: new energy-conserving shaders, efficient and accurate reflections, choreographing the light playing across a surface, liquid metal
- **2009:** Stereoscopic 3D films: Coraline, Monsters vs Aliens, G-Force, and Cloudy with a Chance of Meatballs (release in September). (by Sony Pictures Imageworks).
- **2009:** HP s DreamColor LP2480zx display, a 24-inch, color-critical LCD monitor designed in partnership with DreamWorks Animation: 30-bit color images (10-bit per channel)
- **2009:** MadWorld by Platinum Games: Developers Atsushi Inaba, Shigenori Nishikawa, Tatsuya Minami, and Hideki Kamiya (Resident Evil, Devil May Cry, Okami, and Viewtiful Joe) develop brutal b/w third-person action game for the Wii platform. It was banned in Germany and ignited a global firestorm of controversy upon its release.

History 2010

- **2010:** *Max for Live*: A combination of Max (Cycling 74) and Live (Ableton) for Computer Music, Interactive and New Media, and Sound Design.
- **2010:** nVidia: New version of the Quadro Digital Video Pipeline. GPU based; applications in movie-production and mastering; 4 HD-SDI or 2 stereoscopic 3D sources can be processed in real-time.
- **April 2010:** Apple released the first iPad. It sold 3 million of the devices in 80 days. During 2010, Apple sold 14.8 million iPads, representing 75 percent of tablet PC sales.
- **November 2010:** Kinect for Xbox 360 (Project Natal).



BOX OFFICE: PIXAR PERFECT

FILM	RELEASED	AUSTRALIA	WORLDWIDE
Toy Story 3	2010	\$40.2m*	\$US828m*
Up	2009	\$28.2m	\$US731m
Wall-E	2008	\$18m	\$US521m
Ratatouille	2007	\$14.5m	\$US624m
Cars	2006	\$17.5m	\$US462m
The Incredibles	2004	\$27m	\$US631m
Finding Nemo	2003	\$37m	\$US868m
Monsters Inc	2001	\$25m	\$US525m
Toy Story 2	1999	\$20m	\$US485m
A Bug's Life	1998	\$20m	\$US364m
Toy Story	1995	\$14m	\$US362m

TOP-GROSSING MOVIES OF 2010

1. Toy Story 3	\$40.2m*
2. Alice in Wonderland	\$37.6m
3. Twilight: Eclipse	\$30.7m*
4. Shrek Forever After	26.9m*
5. Iron Man 2	\$25.8m
6. Sex and the City 2	\$23.5m
7. How To Train Your Dragon	\$20.5m
8. Clash of the Titans	\$19.2m
9. Inception	\$16.3m*
10. Valentine's Day	\$15.8m

*AND COUNTING

Sources:
boxofficemojo.com or urbancinefile.com.au

Nemo left in wake of appealing Toys

WHILE sci-fi brain twister *Inception* continues to dazzle at the top of the Australian box office charts, family friendly *Toy Story 3* has quietly achieved a remarkable milestone.

The enduring all-ages appeal of cowboy Woody, space ranger Buzz Lightyear and the rest of the gang from Andy's toy box has pushed *Toy Story 3* past *Finding Nemo* as Australia's top Pixar movie.

The Disney animation studio has had an unbroken string of 11 hits since its first film, 1995's *Toy Story*.

The latest in the series has



Finding Nemo as Pixar's top-grossing film.

The undersea adventures of a curious clownfish and his over-protective father sold \$37 million worth of tickets in 2003.

Toy Story 3 has now taken \$40.2 million in six weeks, its box office receipts boosted by the extra \$3 to \$4 for tickets to 3D sessions.

While *Finding Nemo* remains

In Australia, the animated heart-warmer sits at No.4 on the box office chart this week and is still showing on 281 screens.

Despite growing doubts over its diminishing novelty, the new generation of 3D technology has boosted the takings of the year's most popular movies.

Half of Australia's 10 top-grossing films so far in 2010 were shown in 3D.

In addition, James Cameron's 3D trailblazer *Avatar* earned the bulk of its record \$115 million in the first 20 calendar days.

A film that hasn't required an

film for the second week running.

It posted the biggest opening week for a Leonardo DiCaprio movie, bigger than even the blockbuster *Titanic*.

With ticket sales up to \$16.3 million, the cryptic tale of dream intruders has taken almost as much in two weeks as Russell Crowe's *Robin Hood* remake looted, about \$18.6 million, in its eight-week run.

Worldwide, *Inception* has taken \$US400 million, though it appears unlikely to match the \$US1 billion success of writer-director Christopher Nolan's previous block-

History 2011

- **March 2011:** Apple releases iPad2 (over 15 million sold).
- **2011:** Harry Potter and the Deathly Hallows
- **Siggraph2011:** *Computer Animation Festival Best in Show Award:* “The Fantastic Flying Books of Mr. Morris Lessmore” using a hybrid style that reminds of old Technicolor musicals.
- **3D Vision Wired Glasses:** NVIDIA software automatically converts standard PC games to stereoscopic 3D.
- **MIT Media Lab Medical Mirror:** tracks and displays a user’s heart rate in real time without the need for external sensors.
- **ATR Labs:** *Telenoid:* A tele-presence android for communication is controlled by a face-tracking system that automatically captures the operator’s facial movements and expressions.

History 2012-2013

- **Apple retina display:** the human eye is unable to notice pixelation at a typical viewing distance.
- **City Evolution project, Newcastle:** <http://cityevolutions.com>
- **Google Glass:** Wearable computer with head-mounted display.
- **Biometry, July 2013:** Recognising people by the way they walk and their silhouette (R. Mollineda, Univ. Jaume).
- **nVidia Quadro6000:** 12GB GDDR5 graphics memory, 2,880 streaming multiprocessor (SMX) cores, supports four simultaneous displays and 4K resolution.
- **Pacific Rim:** Industrial Light & Magic, Legacy Effects ,Hybride Technologies and others contributed to the visual effects. The Video Game was released along with the movie on July 12, 2013.

<http://www.cgw.com/Video-Center/Trailers/Pacific-Rim-Trailer.aspx#.UgrUPRYp-ZY>

History 2014

- **Journal of Personality and Social Psychology:** Dartmouth research finds that teen-agers who play mature-rated, risk-glorifying games are more likely to engage in deviant behaviors beyond aggression, alcohol use, smoking cigarettes, delinquency and risky sex.
- **Using TV, videos or a computer game as a stress reducer can lead to feelings of guilt and failure:** Reinecke et al. The Guilty Couch Potato: The Role of Ego Depletion in Reducing Recovery Through Media Use. Journal of Communication, 2014.
- **Hyve-3D:** A full scale immersive 3D environment where users collaboratively can create drawings on hand-held tables and can manipulate the sketches to create a 3D design within the space.
- **OpenGL 4.5:** Khronos Group has announced OpenGL 4.5 and the Next Generation OpenGL Initiative (OpenGL NG).

History 2015

- **Game of Thrones:** Seasons I-V in 2011-2015

<https://www.youtube.com/watch?v=vlaAlH1LVgw&list=RDvlaAlH1LVgw#t=348>

- **CeBit Australia 2015**

<http://www.theaureview.com/games/features/the-four-best-stalls-at-cebit-australia-expo-15>

- **nVidia:** GeForce GTX TITAN Black, 2880 CUDA cores, 889 MHz Base Clock Speed, 199.1 billion/sec texture fill rate, 336 GB/sec memory bandwidth.
- **Siggraph2015, 9.-13.8.:** The 2015 VR Village features real-time immersion in the latest virtual and augmented realities, including Nomadic Virtual Reality (VR), Tabletop Augmented Reality (AR), Full-Dome Cinema, and live performances and demonstrations in a 360-degree immersion dome.

<http://s2015.siggraph.org/attendees/program-preview-videos>

History 2016

- **Oculus Rift** VR head mounted display consumer version released; DK2 was released in mid 2014 and DK1 in late 2012.

- **CeBit Australia 2016:**

<http://www.theaustralian.com.au/life/from-hycycling-to-selfsailing-cebit-technology-fair-has-it-all/news-story/7d594805ff6cee739aa38e8901885661>

- **nVidia:** Nvidia GeForce GTX 1080 and Titan X (3584 CUDA cores @1.5Hz, 12 GB GDDR5X), new Pascal architecture.
- **Siggraph2016, 24-28 July:**
 - Virtual Interior Stylization - uses augmented/virtual reality on mobile phones for virtual interior stylization.
 - Zushiki Light Art: Form Finding and Making through Paper Folding: demonstrates a practical application of origami
- **Pokémon Go:** Over 75 m downloads 1 month after release in July by Niantic.
- **A.I. Experiments:** Visualizing High-Dimensional Space
<https://www.youtube.com/watch?v=wvsE8jm1GzE&t=91s>

History 2017

- "3D/VFX Showreel - 2017" - by Dennis Mielke <https://www.youtube.com/watch?v=K3-QoUdV9zg>
- nVidia Volta release at GTC2017: Equipped with 640 Tensor Cores, Volta delivers over 100 Teraflops per second (TFLOPS) of deep learning performance, over a 5X increase compared to prior generation NVIDIA Pascal architecture.
- The World In 2050 - BBC Documentary 2017: <https://www.youtube.com/watch?v=XeEYaX82jSE>
- The 10 Most Realistic Games Ever Next-Gen Graphics Upcoming 2017 And beyond
<https://www.youtube.com/watch?v=8xBpGE1r5YU>
- <https://www.youtube.com/watch?v=FWybv7Hmb18>

History 2018

- Deadpool 2: CG augmented and was digitally blended with real-world elements.
- Blade Runner 2049: Archival footage and stills of actor Sean Young from the original 1982 Blade Runner are used to represent and revive character Rachael.
- Nvidia Quadro GV100 supports up to four 5K monitors at 60Hz, or dual 8K displays at 60Hz.
- ADAM: Humanizing Robotics. A proof-of-concept demo that has grown into a viral hit. It is a fully real-time series rendered in Unity engine.
- SIGGRAPH 2018, Disney will debut its first VR short film, "Cycles."

Exercises for week 3

Exercise 9 (Rotations in 2D)

Please visualise by drawing the following two situations:

a) A vector (or point) with coordinates $\begin{pmatrix} \cos \alpha \\ \sin \alpha \end{pmatrix}$ rotates around the origin. Can you see that $\sin^2 \alpha + \cos^2 \alpha = 1$?

b) Now consider an additional vector $\begin{pmatrix} \cos(\alpha + \beta) \\ \sin(\alpha + \beta) \end{pmatrix}$ in the same drawing and show that

$$\begin{pmatrix} \cos(\alpha + \beta) \\ \sin(\alpha + \beta) \end{pmatrix} = \begin{pmatrix} \cos \beta & -\sin \beta \\ \sin \beta & \cos \beta \end{pmatrix} \cdot \begin{pmatrix} \cos \alpha \\ \sin \alpha \end{pmatrix}$$

c) If $\begin{pmatrix} \cos \beta & -\sin \beta \\ \sin \beta & \cos \beta \end{pmatrix}$ describes the counter-clockwise (= mathematically positive) rotation by an angle β , what describes the inverse rotation, i.e. the rotation by the angle $-\beta$ (i.e. the clockwise rotation by angle β)?

Exercises for week 3, cont.

Exercise 10 (Additivity of rotations in 2D)

Question: Let $R(\beta) = \begin{pmatrix} \cos \beta & -\sin \beta \\ \sin \beta & \cos \beta \end{pmatrix}$ be the counter-clockwise rotation by an angle β about the origin.

Show that for all $\alpha, \beta \in [0, 2\pi]$, we have $R(\alpha) R(\beta) = R(\alpha + \beta)$.

Exercise 11 (Rotations in 3D)

Question: Use standard mathematical notation in 3-dimensional space and describe the rotation matrices about the x , y , z axis for $90^\circ, 180^\circ, 270^\circ, 360^\circ$.

Exercise 12 (Rotations in 3D: Non-commutativity)

Question: Use rotations in 3D and calculate the matrix for an x -roll of 30° (i.e. rotation about the x -axis), followed by an y -roll of 45° , followed by a z -roll of 60° .

First calculate each of the the matrices $R_x(30^\circ)$, $R_y(45^\circ)$, $R_z(60^\circ)$ and the product $R_z(60^\circ) \cdot R_y(45^\circ) \cdot R_x(30^\circ)$.

Is it different from $R_x(30^\circ) \cdot R_y(45^\circ) \cdot R_z(60^\circ)$?

Which is the correct order and why ?

Exercises for week 3, cont.

Exercise 13 (Inverse of a matrix)

Question: What is the inverse (if it exists) of:

a) The 2×2 matrix

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix},$$

where $a, b, c, d \in \mathbf{R}$.

b) The 3×3 matrix

$$B = \begin{bmatrix} -3 & 5 & -4 \\ 2 & -6 & 12 \\ 1 & -2 & 2 \end{bmatrix}$$

c) The 3×3 matrix

$$M = \begin{bmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{bmatrix}$$

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