MUNI HCI LAB

PA199
Advanced Game Design

Lecture 1

Introduction to Advanced Game Design

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Fotis Liarokapis

- PhD in Computer Engineering
  - University of Sussex, UK
- MSc in Computer Graphics and Virtual Environments
  - University of Hull, UK
- BSc in Computer Systems Engineering
  - University of Sussex, UK

My Research

- Research areas:
  - Computer Graphics
  - Virtual Reality
  - Augmented Reality
  - Interactive Environments
  - Brain Computer Interfaces
  - Serious Games
  - User studies

Contact Details

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- Office Hour:
  - Friday 11:00 to 12:00

Course Details

- Prerequisites
  - Knowledge of computer graphics fundamentals
- Lectures
  - Every Friday
  - Time: 12:00 to 14:00
  - Location: A320
- Lab/Seminar
  - Every Friday
  - Time: 14:00 to 15:00
  - Location: A215

Course Objectives

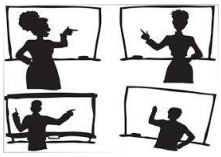
- Demonstrate an understanding of the main mathematical concepts used in computer game design
- Mathematically model all the components of an interactive computer game
- Have a good understanding of the collision detection techniques that are used in computer games and apply them in practice
- Design and implement an interactive computer game from scratch (i.e. not using a games engine)

Syllabus

- Introduction to advanced games design
- Game engine architectures
- Mathematics and physics for computer game design
- Collision detection techniques for computer games
- Fractal terrain generation
- City and road modeling
- Fluid modeling
- Deformation techniques for games
- Procedural texturing techniques
- Animation for computer games
- Crowd modeling techniques for game
- Online virtual environments
- Mobile game development
- Advanced interaction techniques
- Serious games

Teaching Methods

- Delivery of the material will be based on
  - Expositional lectures
  - Reinforced by computer demonstrations of the application of the material
  - Video demonstrations



Assessment Methods

- One Assignment
  - Will be assessed on:
    - Implementation (60%)
    - Report (40%)
- Note that all the code must be provided in a CD/DVD or uploaded into the system
- Exams…

Plagiarism and Cheating

- If you use an external resource cite it clearly!
- Don't do things that would be considered dishonest... if in doubt ask
- Cheating earns you:
  - Fail in the class
  - Getting reported to the University
  - No exceptions

Literature

- D.F. Rogers and J.A. Adams. Mathematical Elements for Computer Graphics, Second Edition, McGraw Hill, 1990. ISBN: 0070535299
- D.H. Eberly. 3D Game Engine Design, A Practical Approach to Real-Time Computer Graphics, Morgan Kaufmann, 2001. ISBN: 1558605932
- A. Watt. 3D Computer Graphics, 3rd Edition, Addison-Wesley, 2000, ISBN: 0201398559
- H. Pottman, A. Asperl, M. Hofer, A. Kilian. Architectural Geometry, Bentley Institute Press, 2007, ISBN: 978-1-934493-04-5
- J. Schell. The Art of Game Design: A Book of Lenses, Second Edition Paperback, November 24, 2014, ISBN-13: 978-1466598645

Introduction to Games

What is a Game?

- Game
  - An activity engaged in for diversion or amusement
- Video Game
  - "An electronic game played by manipulating moving figures on a display screen, often designed for play on a special gaming console rather than a personal computer"

http://www.yourdictionary.com/video-game

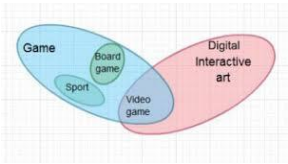
Another Definition

- "Interactive software that is used for entertainment, role playing and simulation. Played on a specialized device mobile device or personal computer, video games have become extremely realistic, not only in their graphics and animation, but in their themes"

http://www.yourdictionary.com/video-game

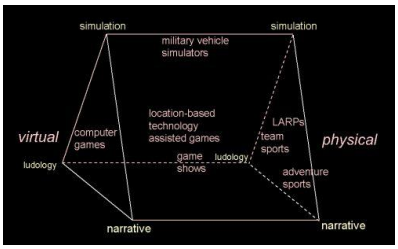
Games and Video Games

- Sports, board-games, videogames can be grouped under "game" because all of them are susceptible to being broken down and analyzed with game grammar (they all have rules)



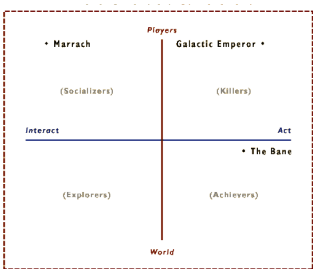
http://www.raphkoster.com/2012/03/13/x-isnt-a-game/

Fiction to Non-Fiction Gaming



http://www.gamasutra.com/view/feature/131205/game_taxonomies_a_high_level_.php?print=1

Richard Bartle's Game Chart



http://www.skotos.net/articles/TTnT_25.html

Evolution of Video Games

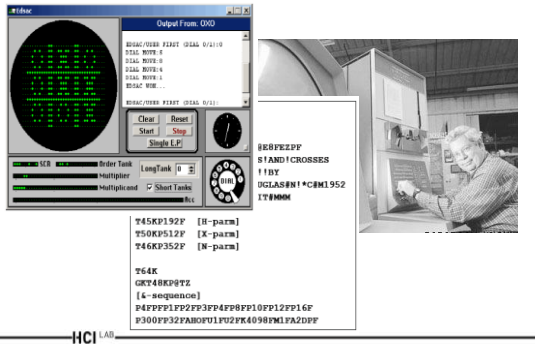
http://blog.seagate.com/consumer/the-evolution-of-video-games/

History of Games

First Game 1952

- 1952 W. A. Higgenbotham
  - Willy Higginbotham on an oscilloscope connected to analog Donner computer
  - Idea was to use a small analog computer to graph and display the trajectory of a moving ball on an oscilloscope, with which users can interact
  - By this he converted an oscilloscope into a pinball game – an abstract simulation of the game of tennis
  - Made a scientific instrument attractive for a nonscientific

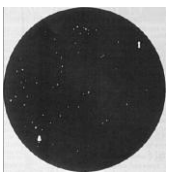
First Game 1952 .



First Game Video

Spacewar 1962

- 1962: "Spacewar" (Steven Russell)
  - Developed at MIT using vector graphics on PDP-1
  - Sega releases Periscope: electronic shooting game - first arcade game



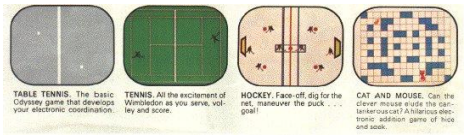
Spacewar Video

First Commercial Games 1971

- 1971-Nolan Bushnell develops Computer Space
  - First commercial arcade game based on SpaceWar
  - Vector graphics, but really cool real-time space game
  - Too sophisticated for market and fails

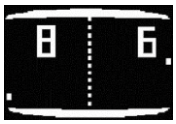
First Commercial Games 1972

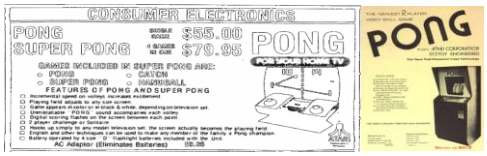
- Magnavox builds Odyssey



First Commercial Games 1973

- Pong in Arcades by Atari
  - By Magnavox

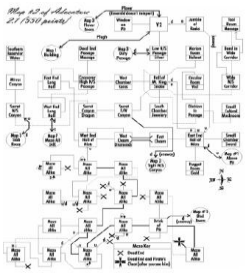




Pong Video

First Commercial Games 1972-1976

- Adventure: The Colossal Cave
  - William Crowther and Don Woods
  - First text-based adventure game



Games 1980-1981

- Phillips Odyssey2 (1978) and Mattel Intellivision
  - Mattel had better graphics, but terrible controller
- Namco has Pac-Man
  - >$1 billion ($2.3 in 1997 dollars)
  - 300,000 arcade units sold since introduction
- Atari doing $1 billion:
  - Asteroids & Battlezone released
- Williams releases Defender
- Zork released by Infocom, Ultima released

Games 1980-1981 .

- Game industry > $6 billion in sales
- Nintendo: Donkey Kong
- Galaxian, Centipede, Tempest, Ms. Pac-Man
- IBM introduces the IBM PC

Games 1982

- Atari sales down 50% -- starts to lose $$'s
  - Releases 5200
  - But it still controlled 80% of the market
  - Atari buys rights to ET for $22 Million
  - Produced more PacMan cartridges than systems
- Activision releases Pitfall
- ColecoVision gets Donkey Kong
- Game companies start just for home computers
  - Sierra On-Line, Broderbund, BudgeCo
- Electronic Arts is formed

Games 1983

- Mattel losses $225 million from Intellivision
  - Doesn't ship the Aquarius
  - Loses as much as it had made the four prior years
- Atari loses money
  - Market flooded with poor quality games:
  - Fox, CBS, Quaker Oats, Chuck Wagon dog food
- Coleco crashes
  - Saved by Cabbage Patch Kids
- Commodore 64 - home computer
  - 17-22 million total sold
- Dragon's Lair released
  - Laserdisk
  - 6 years to make - Bluth Studios

Games 1984

- Industry drops to below $800 M
- Apple introduces the Macintosh
  - Birth of modern computer: good resolution, sound
  - Games not a priority
  - 100,000 sold in first six months
- King's Quest is released by Sierra On-Line

Games 1985

- Nintendo introduces Nintendo Entertainment System
  - Strict control on software
- Lockout chip, and restricts companies to 5 games/year
- Nintendo sells cartridges to software distributors
- Atari tries to come back with 16-bit 520ST
  - Computer and Game system
- Carmen Sandiego released by Broderbund

Games 1986

- Commodore ships Amiga: cool but marketing kills it
  - Computer system designed to support games – 3D color
  - Developed by Atari hardware engineer Jay Miner
- Sega ships Sega Master System console
  - Superior to Nintendo, but it ignores third-party developers and fails because of lack of games
- Atari ships 7800
- Nintendo outsells competitors 10 to 1

Games 1987-1989

- 1987:
  - EA releases their first game: Skate or Die
  - Serious games start to show up for IBM PC's: VGA and SVGA help
- 1988:
  - Tetris imported from Soviet Union
  - Coleco files for bankruptcy
- 1989:
  - Sega Genesis is released: 16-bit
    - Attacks console market with EA sports titles
    - Aggressive marketing at older market (> 13 year old)
  - Nintendo sticks with 8-bit
    - Releases Gameboy
  - Maxis releases SimCity

Game Consoles 1990

- Nintendo releases Super Mario 3
  - all-time best-seller 11M
- Amiga and Atari ST die out
- PC's and Consoles are major game platforms
- Electronic Arts starts to acquire other game publishers

Game Consoles 1991

- Nintendo launches Super-NES (16-bit)
- S3 introduces first single chip graphics accelerator for PC
- Capcom releases Street Fighter II for arcades – big hit
- id releases Wolfenstein 3D
- Civilization released

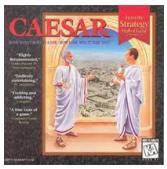
Game Consoles 1992

- PC gaming explodes: Dune II
- Nintendo has $7 billion in sales ($4.7B in U.S.)
  - Higher profits than all U.S. movie and TV studios combined
- Midway releases Mortal Kombat for arcades – extreme violence

Dune 2 Video

Games 1993

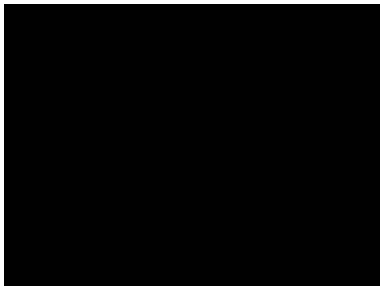
- Pentium chip is launched
- Consoles (Sega and Nintendo) are 80% of game market
- Panasonic ships Real-3DO: 32-bit
  - Now out of business
- Caesar released



Games 1994

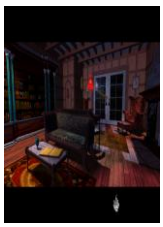
- Atari ships Jaguar: 64 bit
  - Very expensive for console ~$700, >$100/game
- DOOM released by id
- MYST released
  - All time biggest selling PC game until 2002
- Warcraft
  - Orcs and Humans released

Doom Video



Games 1995 (32-Bit)

- Sega ships Saturn (32-bit)
  - Sony ships Playstation (32-bit)
  - Microsoft releases Window 95
    - Includes the Game SDK - Direct-X
    - Bring major game performance to Windows
  - Internet and WWW expanded
  - Command & Conquer released
  - Full-motion video becomes a part of games: 7th Guest



Playstation 1995

- Launched in U.S., Sept. 1995
  - 300,000 polygons/sec., 30MIPS processor, 4MB RAM, 2MB VRAM
  - 400 U.S. Titles
  - 20% penetration in U.S. homes
- Analysis:
  - Multi-platform games look worse on Playstation
  - Playstation-only games look good, but grainy
  - Cheap and lots of them for software developers

Games 1996

- – Nintendo ships Nintendo 64
  - Originally promised for 1995
- Multi-player gaming goes commercial
  - Via modem and internet and network companies
- TEN, Mplayer, …
  - First commercial MMOG: Meridian59

Nintendo 64 - 1996

- Launched in U.S., Sept 1996
  - 93.75 MH 64 Bit CPU, 64-bit MIPS co-processor
    - over 500,000,000 16-bit operations/sec
    - Built-in Pixel Drawing Processor (RDP)
  - 4.5MB RAM, 150,000 polygons/sec
  - Originally aimed at younger market
  - Cartridge makes it very expensive
  - Very dependent on software
  - Legend of Zelda: Ocarina of Time generates more
  - Revenue in last 6 weeks of 1998 than any film

Games 1997

- 3D acceleration starts to standardize on 3D-FX
  - Games start to assume 3D acceleration
- Pentium II's at 200Mhz make powerful game machines
- Ultima Online launches – first MMORPG in 3D
  - Isometric view
- Age of Empires, Total Annihilation released

Games 1998

- Lots of good PC games
  - StarCraft, CivII, Caesar III
- Playstation rules consoles
- NCSoft's Lineage, most popular MMORPG, launched in S. Korea

Games 1999

- Dreamcast
- Maximum Score for Pac-Man Achieved
  - Billy Mitchell achieves the highest score of 3,333,360
- EverQuest is launched
  - First non-wireframe 3D Massive Multiplayer Online Role Playing Game (MMORPG)
- SM Alpha Centauri released, BigHugeGames founded

Games 2000

- Development moves from PC to consoles
- Playstation II
  - See next slide
- Diablo II sells 1 million units in 1 week
- SIMS sells 2.3 million units ($95M)
  - + 1.4 mill. in expansions
- Shogun: Total War released

Sony Playstation 2 - 2000

- Launched May 4, 2000 in Japan
  - In U.S. on October 26, 2000: $299
  - 90 Million sold world wide by 2005 [2 years < PS1]
- Hardware
  - 128 Bit 300MHz processor
  - 3 Special purpose 150 MHz co-processors
  - 32MB DRAM: 3.2 GB/sec
  - DVD & CD
  - MPEG2 hardware
  - Dual Shock 2 analogue controller
  - Chip set will be available for other platforms
  - 66M polygons/sec geometry – 16M polygons/sec curved
- Software development is tough

Games 2001

- Gamecube (Nintendo)
- Xbox (Microsoft)
  - See next slide
- CivIII released

Microsoft Xbox - 2001

- Software
  - Direct X API
- Hardware
  - Pentium IV 733 Mhz
  - Custom 3-D 300Mhz GPU
  - 64MB Ram – 6.4 GB/sec
  - 8GB hard drive
  - DVD
  - 100 MBps Ethernet
- Performance
  - 150 million transformed and lit polygons per second
  - 100+ million polygons per second sustained performance (shaded, textured)
  - 300 million micropolygons/particles per second
  - 4 simultaneous textures
  - Full-scene anti-aliasing
  - 1920x1080 maximum resolution
  - HDTV support

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Games 2002

- Americas Army released as free game
- SIMS becomes the best-selling PC game of all time (March 2002)

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Games 2003

- SIMS continues to grow
  - Unleashed, Superstar
  - But SIMS Online fails
  - Star Wars Galaxies
  - > 275,000 Registered Users
  - Second biggest Massive Multiplayer Online Game (MMOG), fastest growing
- WarCraft III, UT 2003, GTA, ports from console
- Second Life and There.com launch
  - Different approach to MMOG
- EA grosses $2.5B in 2003
- Rise of Nations released

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Games 2004

- $7.3 B sales
- Madden sells 1.3M copies in one week
- Sequels rule: SIMS 2, Halo 2, Half-life 2, Doom 3
- Consoles: 2004
  - Stables of slow growth - lower prices
  - 1,000,000 GBAs sold
  - Nokia Ships >1,000,000 N-Gages
- Nintendo Launches DS
  - >5 million units worldwide by March 2005
  - Ninetendogs – 250K in one week – best handheld?
- Sony Launches PSP
  - 5 million units shipped by July 2005
  - Where are the games
- Shifting away from PC (15% sales) to Consoles

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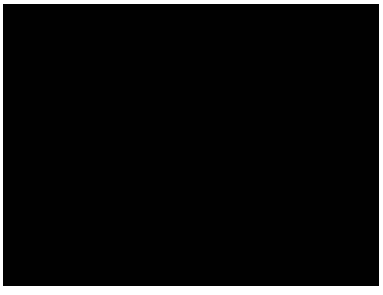
Hallo Video



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Games 2005

- US Top Selling PC Games
  - World of Warcraft
    - 4 Million Subscribers ($700M/year subscriptions)
- EA rolls along:
  - Madden NFL 2006, sold 1.7M in first week
- Gamestop and EB games merge
- CivIV released
- Next Gen Consoles coming
  - Difficult software development
  - Very expensive for development (teams twice size)

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XBOX 360 - 2005

- Custom IBM PowerPC CPU
  - 3 symmetrical cores: 3.2 GHz each, 2 threads/core, VMX-128 vector unit/core, 1MB L2 cache, CPU Game Math: 9.6B dot product/sec
- Custom ATI Graphics Processor
  - 10MB DRAM, 48-way parallel floating point, Unified shader architecture, 500 million triangles/sec, 16 gigasamples/sec, 48 billion shader operations/sec, Supports 16:9, 720p or 1080i – HD output
- 512 MB of 700MHz GDDR3 RAM – unified memory architecture
  - 22.4 GB/s interface bus bandwidth, 256 GB/s memory bandwith to EDRAM, 21.6 GB/s front-side bus
- Overall system floating-point: 1 teraflop
- Detachable and upgradeable 20GB hard drive
- 12x dual-layer DVD ROM

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PC Games 2006

- US Top 10 best selling console games (May)
  - 1. New Super Mario Bros-Nintendo (DS)
  - 2. Kingdom Hearts II-Square Enix (PS2)
  - 3. Brain Age: Train Your Brain In Minutes-Nintendo (DS)
  - 4. God of War-Sony Computer Entertainment (PS2)
  - 5. Tom Clancy's Ghost Recon Advanced Warfighter-UbiSoft (Xbox 360)
  - 6. Elder Scrolls IV: Oblivion-Bethesda Softworks (Xbox 360)
  - 7. MLB '06: The Show-Sony Computer Entertainment (PS2)
  - 8. Guitar Hero (with Guitar)-RedOctane (PS2)
  - 9. Grand Theft Auto: San Andreas-Take Two Interactive (PS2)
  - 10. Kingdom Hearts-Square Enix (PS2)

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Console Games 2006

- US Top 10 best selling PC games (August):
  - 1. World of Warcraft - Blizzard
  - 2. The Sims 2 - Electronic Arts
  - 3. Nancy Drew: Danger By Design - Her Interactive
  - 4. Civilization IV: Warlords - 2K Games
  - 5. The Sims 2 Open For Business - Electronic Arts
  - 6. Roller Coaster Tycoon 3: Gold - Atari
  - 7. Cars - THQ
  - 8. The Sims 2 Family Fun Stuff - Electronic Arts
  - 9. Civilization IV - 2K Games
  - 10. Sim City 4 Deluxe - Electronic Arts

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Playstation 3 - 2006

- Cell processors (1 PowerPC PPE, 8 SPE) @3.2 GHz each
- Graphics: Nvidia 550 Mhz GPU 1.8 Tflops
  - 100 billion shader ops/sec
  - 51 billion dot products/sec
  - Full HD (1080p)
- Floating point performance: 2 TFlops
- 512MB RAM
  - Split between CPU and graphics
- 512KB L2 cache
- 7 AltiVec vector processing units
- Blue-ray DVD may make it very expensive
- Removable hard drive

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Nintendo Wii - 2006

- > 101 million units sold by 2009
- Competes with Microsoft's Xbox 360 and Sony's PlayStation 3
  - It succeeds the Nintendo GameCube
- CPU: PowerPC-based Broadway processor
- GPU: ATI Hollywood GPU made with a 90 nm CMOS process
- 512 MB built-in NAND flash memory

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Xbox 360 Kinect - 2010

- Kinect is a motion sensing input device for the Xbox 360 and Windows PCs
- Enables users to control and interact with the Xbox 360 without the need to touch a game controller, through a natural user interface using gestures and spoken commands
- A version for Windows was released on February 1, 2012

Wii U - 2012

- Competes with Sony's PlayStation 4 and Microsoft's Xbox One
- First Nintendo console to support high-definition graphics
- Espresso CPU, designed by IBM, consists of a PowerPC 750-based tri-core processor with 3 MB of shared L2 cache memory and clocked at approximately 1.24 GHz
- Wii U games can be downloaded digitally through Nintendo eShop, or at retail on physical media

Nintendo 3DS

- Portable game console (Nintendo)
- Displaying stereoscopic 3D effects without the use of 3D glasses or additional accessories
- CPU
  - Dual-Core ARM11 MPCore, single-core ARM9
- Memory
  - 128 MB FCRAM, 6 MB VRAM
- Storage
  - 1 GB internal flash memory

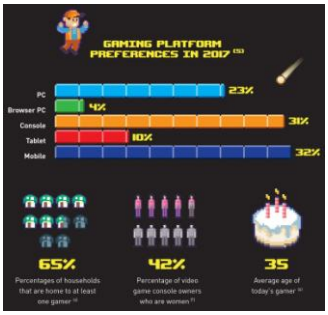
Xbox One - 2013

- large emphasis on internet-based features
- Ability to record and stream gameplay
- Ability to integrate with a set-top box to watch cable or satellite TV through the console
- An enhanced guide interface and Kinect-based voice control

PlayStation 4 - 2013

- AMD x86-64 Accelerated Processing Unit
- GPU can perform 1.843 teraflops
- The world's most powerful console
  - Big performance difference between the PS4 and Xbox One
- Sales: 19.9 million consoles

Gaming Platforms - 2017



https://www.forbes.com/sites/hnewman/2017/11/29/the-history-of-video-games-in-one-infographic/#584ed76a1a5c

PlayStation 5 - 2020

- Will be launched in late 2020 in North America, Europe, South America, Australia, and Japan

Video Games in Czechoslovakia

Hobby computing in Czechoslovakia

Adopted from Jaroslav Švelch Presentation CEEGS 2014, Brno

Hobby computing in Czechoslovakia .

- Vibrant hobbyist scene starts to emerge around 1982 affiliated with socialist organizations
  - Partially supported by the state through "computer clubs"
- Individual imports of Sinclair ZX Spectrum, Atari 8-bit – 10,000s in 1982 up until the total of around 200,000 in 1989
- Efficient systems of informal distribution working at the "speed of lightning"
- Around 200 homebrew games preserved from before 1990

Adopted from Jaroslav Švelch Presentation CEEGS 2014, Brno

Hobby computing in Czechoslovakia ..

- 1979: Federal Ministry of Electrotechnical Industry
- 1984: Long-term Complex Program of Electronization of Czechoslovak National Economy
- 1985: Long-term Complex Program of Electronization in Education
- Main interest
  - Educate future computer programmers and operators for the industry

Adopted from Jaroslav Švelch Presentation CEEGS 2014, Brno

Domestically produced micros

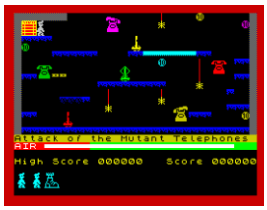
- School computers

- Low quality computers in schools cause "political damage"

Adopted from Jaroslav Švelch Presentation CEEGS 2014, Brno

Import from Western Society

- Around 1985 – informal distribution is in place, leads to influx of Western commercial games



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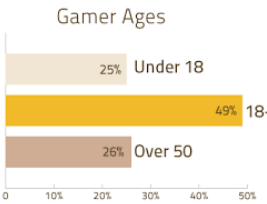
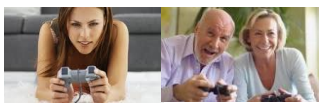
Video Games Audience

Video Games Audience

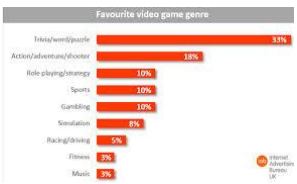
- 88% of households have some form of video game
- 70% of gamers are aged 18+
- The average gamer is aged 24 – 35 years
- Most gamers have been playing for approximately 11 years

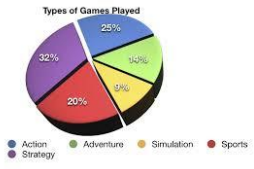
Typical Age Groups



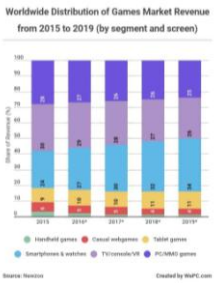


Types of Games Played



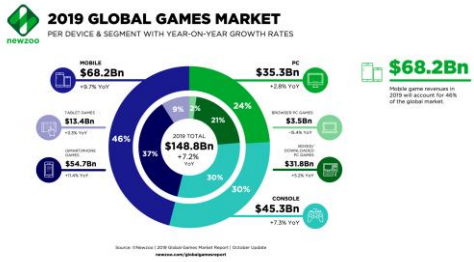


Video Game Market 2015-2019



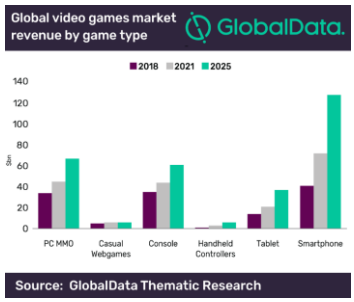
https://www.wepc.com/news/video-game-statistics/

Video Game Market 2019



https://gameworldobserver.com/2019/11/22/newzoo-video-games-market/

Video Game Market 2025



https://variety.com/2019/gaming/news/video-games-300-billion-industry-2025-report-1203202672/

Video Game Addiction

Why Play Games?

- Entertainment
  - Video games are identified by many people as a popular hobby/past time
- Storyline
  - Many games have a plot and like a reader of a novel
- Fantasy
  - Modern video games present life in imaginary worlds
- Interaction
  - Different ways of interacting, even exercising via games
- Learning
  - New trend in computer games, called Serious Games

What is Video Game Addiction?

- Addiction is defined as:
  - "A primary, chronic disease, characterized by impaired control over the use of a psychoactive substance and/or behavior."
- People who play games compulsively and avoid other responsibilities are video game addicts
- Video game addiction is not an addiction that is recognized in the diagnostic and statistical manual of mental disorders
  - However, it shares many of the symptoms of other addictions and is a rising concern

Symptoms of Video Game Addicts

- Playing video games for more than 3 hours per sitting
- Passing up activities that are normally enjoyed
- Neglecting work to play the game
- Getting restless or irritable if you can't play the game
- Trying unsuccessfully to limit or stop game playing

Advantages

- A way to release frustrations and anger
- Increase in imagination
- Enhancement of hand-eye coordination
- Maybe more...

Disadvantages

- Violence
- Neglecting responsibilities
- Putting loved ones to the side for the game
- Games have influenced many situations that have resulted in death
- Again maybe more...

Addiction Solutions

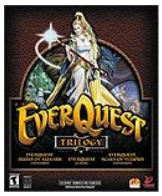
- Provide other activities
- Lessen the time spent playing games
- After school activities
- Sports
- Set a schedule

Dangers of Video Games

- Excessive game play can be fatal
- In Korea, where 30% of the population subscribes to online multiplayer games, one man died in 2005 after playing 50 hours (almost non-stop) StarCraft
- 3 Chinese died in 2007 after playing more than 50 hours, and 2 died in 2005

Dangers of Video Games .

- EverQuest is a 3D online game played by more than 400,000 people
- Games can lead to isolation and suicide
- Hudson Wooley, an epileptic who was playing 12-hours per day, eventually committed suicide



Game Genres

Game Genres

- Different types of video games exist, called genres
  - Each game belongs to one or more of these genres
- Games in the same genre can look different but share many properties
  - Similar design issues and problems
  - In some cases, similar gameplay mechanics

Game Genres .

- Action Games
- Adventure Games
- Strategy Games
- Role-Playing Games (RPGs)
- Simulation Games
- Sports Games
- Fighting Games
- God Games
- Casual Games
- Puzzle Games
- Online Games
- Online Virtual Environments
- Serious Games

Action Games

- Real-time games that require quick reactions to what is happening
- Opponents are computer generated or other human players
- Not much AI elements
  - Players are looking for fast-paced action
  - Some action games add adventure, strategic, or tactical elements

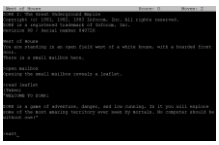
Action Games Types

- FPS games
  - i.e. Quake and Unreal Tournament
- Platform games
  - i.e. Mario and Sonic the Hedgehog
- Maze games
  - i.e. Pac-Man
- Shooters games
  - i.e. Space Invaders, Metal Slug, Gradius

Unreal 4 Video

Adventure Games

- Story-based games that rely upon puzzle solving to move the story along
- Types:
  - Text based (requiring a parser of some kind)
  - Graphical (point and click)
  - Hybrids
    - See next slide!



Zork I (Text Adventure)

Myst V: End of Ages (Graphical Adventure)

Adventure Games .

- Generally they have a large, complex world with many interesting characters and a good plot
- Usually not real-time games
  - Can take as much time as wanted to take a turn
  - Action-adventure hybrids can be real-time

Tomb Raider (Action-Adventure)

Strategy Games

- Players must manage a limited set of resources to achieve a pre-determined goal
  - Resource management entails deciding what units to create and how to deploy them
  - Trade offs in time, money, and raw materials
- Opponents can be computer generated, human players or both

Command and Conquer

Full Spectrum Warrior

Strategy Games .

- Can be either turn-based or real-time
  - Turn-based strategies give you time to think and implement decisions at your own pace.
  - Real-time strategies (RTSs) have all opponents thinking and acting at the same time with no turns

Civilization

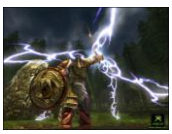
Rome: Total War

Role-Playing Games (RPGs)

- The gamer generally directs a group of heroes on a series of quests
  - Huge world with unfolding story
  - Players micromanage their characters
  - The game characters tend to grow in strength and abilities
  - Combat is typically an important element
    - That is how experience, money and strength are accumulated
- Fantasy RPGs feature complex magical systems and diverse races of characters

Role-Playing Games Examples

Final Fantasy X



Fable

Star Wars KOTOR II

Paper Mario: The Thousand Year Door

Simulation Games

- Simulation games attempt to emulate real world operating conditions with great detail
  - The more serious, the more important accuracy is
  - Great time and effort may be required to learn all of the intricacies of the game

Airport Firefighter Simulator, Excalibur

Gran Turismo 4

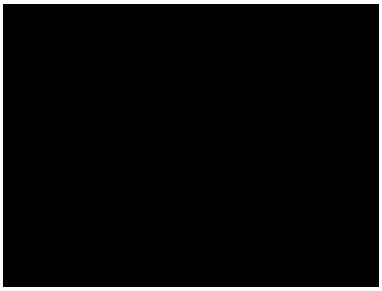
Simulation Games .

- Most simulate some kind of complex machinery
  - i.e. Racing games, flight simulators, etc
- Not all simulations are so serious
  - Simplified to allow players to play more easily
  - Such games are called arcade simulations

Microsoft Flight Simulator

Microsoft Mobile Arcades

Simulation Video



http://www.excalibur-publishing.com/games/airport-firefighter-simulator/

Sports Games

- Players participate in a sporting event
  - Can take player, owner, manager or coaching roles
  - Can be a single match, series, entire season or life-time of the team or franchise

Basketball , EA Sports

FIFA, EA Sports

Sports Games .

- Transferring real game to video game
- Must accurately and realistically reproduce the rules and strategies of the sport
  - Arcade versions with relaxed rules or reduced realism can also be entertaining

Baseball arcade

Olympic games, arcade

Fighting Games

- Players control avatars and attack opponents and defend from attacks
- Players expect a set of basic attacks and counters to start
  - More complex combinations over time

Mortal Kombat , Deadly Alliance

Virtual Fighter 4

Fighting Games .

- Most fights last only a few minutes, but there may be many rounds in a complete bout
- Games are generally viewed from the side
  - Newer versions have 3D elements and multiple view angles and camera positions

Tekken 4

Dead or Alive 4

God Games

- Games that do not have a real goal
  - Also called software toys
- Encourage players to fool around with them to see what happens
  - No wrong way to play the game
  - Open-ended games with few or no preset winning conditions


The Sims 2

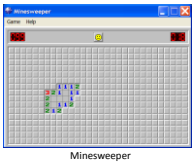

Rollercoaster Tycoon

Casual Games

- Casual games are easy-to-play
- Players familiar with the rules of the game
- Players drop into and out of these games quickly
- Short session games with little or no learning curve

Casual Games Types

- Adaptations of traditional games like chess, hearts, and solitaire
- Television games like Wheel of Fortune and Who Wants to Be a Millionaire?
- Simple games like Minesweeper


Minesweeper


Solitaire

Puzzle Games

- Puzzle games exist purely for the intellectual challenge of problem solving
- Puzzles can be real-time or non real-time
  - Real-time puzzles have some timing elements and contain some action
  - There are little or no time constraints in non real-time puzzles

Sudoku


Rubik's Puzzle

Tetris Video

Online Games

- Online games include any of the preceding genres but allows for multiplayer network play
- Some can accommodate only 2-4 players, but others can taken dozens, hundreds, or possibly thousands of players


Everquest II


World of Warcraft

Online Virtual Environments

- New ways of exploring web-based applications
  - Evolution of telecommunication technologies, web-services and software engineering
- Great range of online virtual environments
  - More than 100 different ones

Online Virtual Environment Video

Serious Games

- Game: "a physical or mental contest, played according to specific rules, with the goal of amusing or rewarding the participant."
- Video Game: "a mental contest, played with a computer according to certain rules for amusement, recreation, or winning a stake."
- Serious Game: "a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives."

Mike Zyda "From Visual Simulation to Virtual Reality to Games", IEEE Computer, 2005

Serious Games Video

Video Games Components

Video Games Components

- Computer Graphics
- Physics Simulation
- Artificial Intelligence
- Human-computer interaction
- Many more
  - i.e. Modeling, Audio, Arts, etc.

Computer Graphics

- Computer Graphics is ubiquitous:
  - Visual system is most important sense:
    - High bandwidth
    - Natural communication
  - During the past few years, fast developments:
    - Hardware
    - Software

From Past to Future

- Over the past 60 years we have gone from this

- To this…

Historical Perspective

- 1950: MIT Whirlwind (CRT)
- 1955: Sage, Radar with CRT and light pen
- 1960: Spiel 'Spacewar' on PDP-11
- 1963: Ivan Sutherland's 'Sketchpad' (CAD)
- 1963: Steven Coons, Coons patches
- 1969: ACM Siggraph founded
- 1968: Tektronix storage tube ($5-10.000)
- 1968: Evans&Sutherland (flight simulators) founded
- 1970ies: First software standards, raster displays

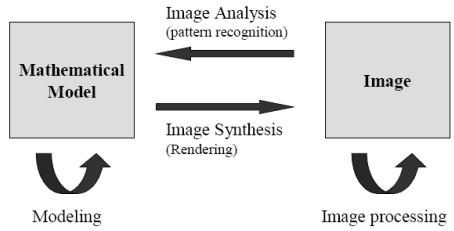
Historical Perspective .

- 1971: Gourand shading
- 1974: Z-buffer
- 1975: Phong model
- 1979: Eurographics founded
- 1980: Whitted: Ray tracing
- 1981: Apollo Workstation, IBM PC
- 1982: Software standard GKS, Silicon Graphics (SGI) founded
- 1984: X Window System
- 1984: First Silicon Graphics Workstations (IRIS GL)

Historical Perspective ..

- Cindy Goral: Radiosity
- 1988: Graphics standard PHIGS
- Until mid/end of 1990s: Dominance of SGI in the high end
  - HW: RealityEngine, InfiniteReality, RealityMonster, ...
  - SW: OpenGL, OpenInventor, Performer, Digital Media Libs, ...
- End of 1990s: Low- to mid range taken over by „PCs" (Nvidia, ATI, ...)
  - HW: Fast development cycles, Graphics-on-a-chip, ...
  - SW: Direct 3D & OpenGL, computer games
- 2000s: Ubiquitous computer graphics
  - Advanced games engines
  - Mobile computer graphics

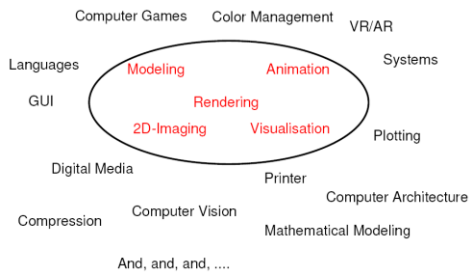
Method of Operation



Supporting Disciplines

- Physics, Mathematics and other Natural Sciences
  - Models and Techniques
  - Numerical Analysis
- Engineering
  - Hardware and Software Systems
  - Input and Output Devices
  - Infrastructure and integration into existing environment
- Art, Psychology, Medicine, ...
  - Story-Telling
  - Design and Composition
  - Perception
- ..and of course Computer Science

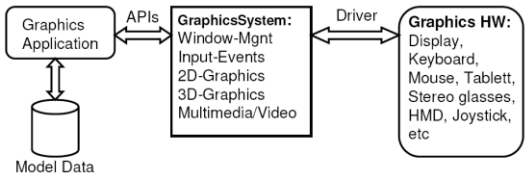
What is Computer Graphics



Some Applications

- Computer Aided Design (CAD)
- Computer Aided Geometric Design (CAGD)
- Entertainment (i.e. games)
- Geographic Information Systems (GIS)
- Visualization (Scientific Visualization, Information Visualization)
- Medical Visualization
- Navigation and Wayfinding
- Archaeology and Cultural heritage
- Many more…

Components of Graphics



3D Rendering Hardware

- Geometric representation
  - Triangles, volumes
- Viewing
  - Transformation
- Hidden surface removal
  - z-buffer
- Lighting and illumination
  - Gouraud shading
- Realism
  - Texture mapping
- Special effects
  - Transparency, antialiasing, etc

Graphics Digital Libraries

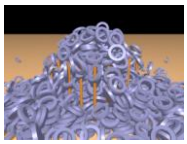
- ACM
  - http://dl.acm.org/
- IEEE
  - http://ieeexplore.ieee.org/Xplore/home.jsp
- EUROGRAPHICS
  - https://diglib.eg.org/

But Why Physics?

- Physics is exploding in the games development industry
- It is a powerful tool for producing great-looking games
- It is the only tool for making games look realistic
- Companies are increasingly seeking programmers whose physics skills are strong

Physics is Fun!

- Physics modeling can be fun
- A simple model can create effects that the programmer never dreamed possible
- A nice physical model of a fire will work and look beautifully even if you wave your move your hand over it!



Modern Computer Games

- Modern computer games are about creating a virtual world
- The virtual world can behave in any way that the programmer decides
- However, if we want players to understand and engage with our games, virtual worlds must model the physical world accurately

How Much Physics is Required?

- To answer the question think about the games you have played
- What happens in those games?
  - Movement, explosions, collision detection, many more…
- These days you can not seem to have a game without collision detection

Some Basic Things

- 3D Objects
- 3D Scenes
- Movement
- Rigid objects
- Rotation
- Friction
- Air and water resistance
- Gravity
- Collisions and explosions
- Springy things
- Waves

3D Objects

- Creating a software model of a 3D object is not an easy task
  - However we can use tools to simulate 3D objects
- Graphics APIs like OpenGL, DirectX extend the hardware support for simulating 3D objects

3D Scenes

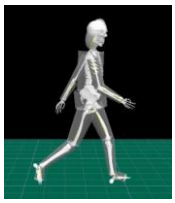
- Modeling an entire scene in 3D is just an extension of the techniques used to model a 3D object
  - But more interactions take place!

Movement

- Modern games have a lot of movement
  - Walk, jump, run or pick-up objects
- Making movement happen in a way that looks realistic can be achieved using a number of techniques

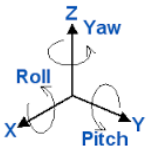
Rigid Objects

- A spinning space station is an example of a rigid object in motion
- Rigid bodies seem to be easy but not so trivial if you implement them first time



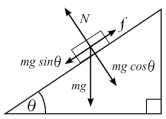
Rotation

- 3D objects can move forward or backward, left or right, and up or down
  - However they can also rotate as they move
- Modeling rotation increases the number of forces that a game has to apply on the object
- Rotation can stabilise or destabilise an object as it moves



Friction

- In the real world, most objects eventually come to a stop due to friction
- Modeling friction is a very common task in modern games
  - Icy or slippery surfaces
- But many games get it wrong!

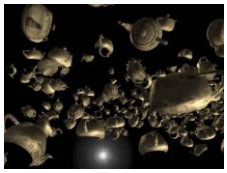


Air and Water Resistance

- Many games ignore air resistance completely but not water resistance
  - Air resistance is not becoming an important issue
- Modeling water resistance involves more than slowing movement down
  - Water also moves

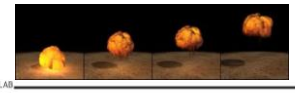
Gravity

- Gravity affects everything
  - Can not get away from it, even in space!
- A modern game must model the effects of gravity in all situations
  - Not always so easy



Collisions and Explosions

- What is a game without special effects
- It is impossible to simulate all aspects of a collision and explosion
  - Physics are too complex but does not matter
- If we model the physics of the larger forces and interaction of objects in collisions and explosions we can make it look right



Springy Things

- In physics, springy things includes non-rigid elements such as hair and cloth
- Think what it takes to model the movement of a virtual girl while running

Waves

- Dealing with water is more than just resistance and currents
  - It also involves waves
- Old games simulated waves by moving the camera up and down
  - Not acceptable any more in modern 3D games

What about Maths?

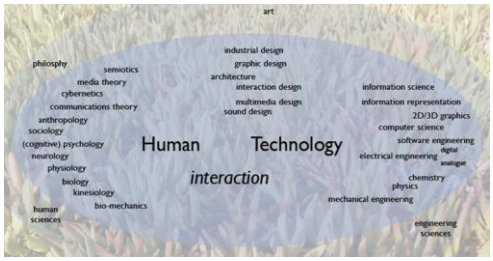
- Physics requires maths
  - Vectors
  - Matrices
  - Triangles and Planes
  - Derivatives
  - Imaginary numbers
  - And many more..

Artificial Intelligence

Artificial Intelligence Video

Human-Computer Interaction

Human Technology Interaction



Flavors of Game Developers

- Game Designers decide on the format and behavior of the game
- Artists design models, textures, animations and otherwise are responsible for the look of the game
- Level Designers create the spaces in which the game takes place
- Audio Designers are responsible for all the sounds used in the game
- Programmers write code, to put it all together, and tools, to make everyone else's job simpler
- And others
  - Production, management, marketing, quality assurance

IEEE CoG 2020

- Evolved from
  - Computational Intelligence and Games (CIG)
  - Virtual Worlds and Games for Serious Applications (VS-GAMES)
- Bring together leading researchers and practitioners from academia and industry in the field of games, to discuss recent advances and explore future directions

http://ieee-cog.org/2020/

Questions