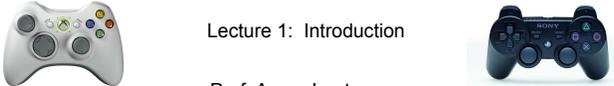


ECE4893A/CS4803MPG:
**MULTICORE AND GPU
 PROGRAMMING
 FOR VIDEO GAMES**



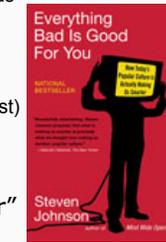
Lecture 1: Introduction

Prof. Aaron Lanterman
 School of Electrical and Computer Engineering
 Georgia Institute of Technology

Georgia Institute of Technology

Games are “serious business”

- Facts from www.esa.org:
 - \$7.4 billion revenues in 2006
 - Average player is 33 years old and has been playing for 12 years
 - 36% percent of American parents play computer
 - 80% percent of gamer parents play with their kids
- From Blizzard press release: World of Warcraft surpasses 10 million subscribers in January 2008
 - \$13 to \$15 monthly (for 2.5 million in U.S. at least)
 - **Do the math!!!**
- Stephen Johnson, “Everything Bad is Good for You: How Today’s Popular Culture Is Actually Making Us Smarter”



Screenshot from www.worldofwarcraft.com/burningcrusade/imageviewer.html?images/screenshots/65,241.

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Our MPG class fills an industry need

- “CPU/GPU programming skill is the biggest hole they have. They can’t find students who can do it well.” - Prof. Blair MacIntyre
- “The biggest challenge facing game companies right now is the problem of writing multithreaded code that fully supports the multiple-core architectures of the latest PCs and the next generation game consoles.” - Jeremy Reimer, “Valve goes multicore”
- “If a programming genius like John Carmack can be so befuddled by mysterious issues coming from multithreaded programming, what chance do mere mortals have?” - Jeremy Reimer, “Cross-platform game development and the next generation of consoles”

<http://arstechnica.com/articles/paedia/cpu/valve-multicore.ars>
<http://arstechnica.com/articles/paedia/hardware/crossplatform.ars>

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The realities of real-time

- The architectures we will look at are driven by real-time constraints
 - 60 frames per second
 - $1/60 \approx 16.7$ milliseconds
 - Average performance is irrelevant; **it’s the max that matters**
- In contrast, most scientific applications can be handled “offline”
 - Computers historically designed to work well in “batch mode”
- We may briefly discuss exploiting this kind of hardware for scientific applications
 - GPGPU movement
 - Sony’s folding@home

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This is NOT a course on game design, or...

- See CS4455: Video Game Design
 - Founded by Amy Bruckman in 1998
- See CS4731: Game AI for the real deal on AI
 - But we may dabble in AI just a little bit
- Also won't be talking about...
 - Handheld game devices
 - That may change in the future!
 - “Alternative” controllers
 - Networking issues (LAN parties, MMORPGs, etc.)
 - Prototyping, user testing
 - Societal impact of games
 - Gender and games
 - Business issues (organizational issues of large teams, etc.)
- May incidentally touch upon some of the above issues

This is only partially a graphics course

- No background in computer graphics required!
 - Make sure class is accessible to ECE majors
- We will review a minimal amount of necessary background
 - Geometric transformations, backface culling, clipping, rasterization, lighting, texture mapping, etc.
- Emphasis will be on real-time graphics
- We won't be talking about things like...
 - Perception
 - Global illumination: ray tracing, radiosity, photon mapping
 - Although people are experimenting with putting such algorithms on GPUs!
 - Advanced animation techniques: inverse kinematics
- See CS3451/CS6491: Computer Graphics, CS4496/CS7496: Computer Animation, CS4475: Computational Photography, CS4480 Digital Video Special FX

This is WILL be a course on...

- Emphasis will be on games that simulate and depict “realistic” animated 3-D environments
 - Algorithms
 - Architectures
 - Programming paradigms
- Practical target platforms
 - Xbox 360
 - Playstation 3
 - Windows PCs with NVIDIA or ATI graphics cards
 - ...and maybe taste of Playstation 2
- Future target platforms
 - Intel's Larabee
- What about the Wii?

Then vs. Now

- In the early days of computer games, the “designer” and the “programmer” were often one and the same
- Nowadays there are usually separate positions of “producer,” “lead designer,” “lead artist,” “lead programmer,” etc.

Two recurring themes

- Theme 1: Hardware features influence game design
 - If the Atari 400 gives you 4 sprites, you'll naturally find something to do with those 4 sprites
 - If a Playstation 3 can push a gazillion polygons, developers feel obligated to provide a gazillion polygons
 - Driving budgets through the roof
 - 100 person teams - 30 programmers, 70 artists
 - Trend not sustainable!
 - With all the emphasis on 3-D realism, could great games like Ms. Pac-Man or Balance of Power be made today?
- Theme 2: Sufficient cleverness can sometimes overcome hardware limitations

Taking a broad view of "video games"

- Commercial game industry is brutal
 - Nov. 2004: "EA Spouse" post (ea-spouse.livejournal.com)
 - Some companies get hundreds of resumes per week per listing (www.gamasutra.com/features/20050711/mcshaffry_01.shtml)
- Think "outside the box" a bit
 - Computer engineering
 - Nothing is driving technological develop as fast as gaming
 - Gaming experience gives future computer engineers insight
 - Maybe you'll work for NVIDIA or ATI?
 - Maybe you'll work for Intel, AMD, or IBM?
 - Maybe you'll help design the Playstation 4 or Xbox 720?
 - "Game" programming/design: think beyond the commercial industry
 - Scientific potential of GPGPU
 - Even if you never program any "games," **multicore is the future**
- That all said - we'd be totally thrilled if you got a job at Insomniac, Bungie, Blizzard, Activision, LucasArts, etc.

Many opportunities for independent developers

- On-line distribution
 - Takes manufacturing costs out of the equation
 - "Brick & mortar" stores have limited shelf space - on-line services like Amazon, Netflix, etc. can exploit "the long tail"
 - Why are we still shipping boxes mostly full of air?
- Greg Costikyan's Manifesto! Games
- Jeff Vogel of Spiderweb Software has been crafting "old-school" 2-D and isometric RPGs as his full-time job for over a decade
 - Exile, Nethergate, Avernum, Geneforge
 - www.spiderwebsoftware.org
 - Makes house payments, feeds kids

Consoles hostile territory for indie developers (1)

- To sell games on a console, you still must pass the gatekeepers at Sony, Microsoft, and Nintendo
- Code must be "digitally signed" to run
 - Piracy concerns
 - Consoles supposed to provide safe environment
 - Unlike PC users who are used to dealing with viruses, spyware, crashing programs
 - Manufacturers worried about "untrustworthy" code screwing up people's consoles
 - Want to ensure a uniform, "quality" experience
- **They have more lawyers than you**

Consoles hostile territory for indie developers (2)

- Nintendo NES “pioneered” business model
 - Typical ell consoles at a loss
 - Charge royalty on units **manufactured**, not units sold
- For indie developers, online distribution (Xbox Live Arcade, Playstation Network, WiiWare, etc.) seems like the least risky option

“Serious Games”

- Games for “training” and “education”
 - First responders: “Hazmat: Hotzone”
 - Medicine: “Pulse!!”
 - Business: “Stone City” for Cold Creamery



- Ian Bogost (LCC) doesn't like the term “serious games”

Screenshot from www.gamasutra.com/features/20051102/carless_01b.shtml
www.businessweek.com/innovate/content/apr/2006/id20060410_051875.htm
www.persuasivegames.com

“Persuasive Games” & “Games for Change”

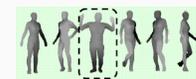
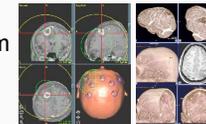
- Expand the “Serious Games” notion to include broader categories like “advertising,” (advergame), “propaganda,” “subversion”
- The Howard Dean for Iowa game
- Disaffected! (not authorized by Kinkos)
- America's Army - training, advertising or propaganda?
 - U.S. government spent \$7 million, but free to play
 - made with Unreal Tournament engine



Pics from Wikipedia & www.persuasivegames.com
 Info from Ian Bogost, “Persuasive Games”

Other real-time applications

- Graphics
 - MRI in the operating room
- Processing
 - Machine vision
 - Toshiba demos: real-time face tracking, markerless motion capture, hand gesture user interface
 - Data compression/decompression
 - New Toshiba HDTVs will use Cell processors
 - Radar signal processing
 - 7 SPE Cells -> PS3s; 8 SPE Cells->Mercury Computing blades



Images from sti.cc.gatech.edu/Slides/Masubuchi-070618.pdf
 and <http://www.radiology.uiowa.edu/NEWS/Haller-PDF.pdf>

Movie magic

- Hollywood
 - Final ray-traced renderings usually done off-line using “render farms”
 - Continually improving real-time graphics lets moviemakers more easily experiment via “pre-viz”
 - Both on CGI-intensive sequences and live-action sequences
- “Machinima”
 - Fans making films using game engines



thesims2.ea.com/sims2_userdata/16/303316/movie_myimmortal.wmv

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