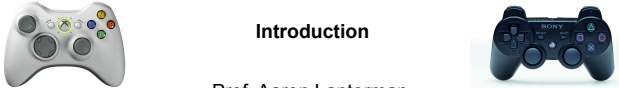



ECE4893A/CS4803MPG:
**MULTICORE AND GPU
 PROGRAMMING
 FOR VIDEO GAMES**



Introduction

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



Games are “serious business” (1)

- 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!!!**

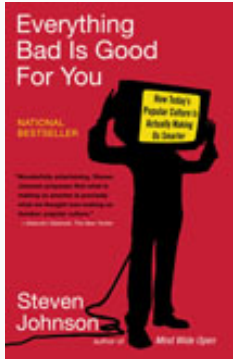


Screenshot from www.worldofwarcraft.com/burningcrusade/imageviewer.html?images/screenshots/65,241.




Games are “serious business” (2)

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.



Our MPG class fills an industry need (1)

“CPU/GPU programming skill is the biggest hole they have. They can't find students who can do it well.”

- Prof. Blair MacIntyre




Our MPG class fills an industry need (2)

“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”



<http://arstechnica.com/articles/paedia/cpu/valve-multicore.ars>
Picture from Wikipedia

Our MPG class fills an industry need (3)

“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”



From www.eurogamer.net/articles/i_johncarmack_doomrpg

<http://arstechnica.com/articles/paedia/hardware/crossplatform.ars>

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 minimum that matters**
- In contrast, most scientific applications can be handled “offline”
 - Computers historically designed to work well in “batch mode”

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



Only partially a graphics course (1)

- 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

Only partially a graphics course (2)

- We won't be talking about things like...
 - Perception
 - Global illumination: ray tracing, radiosity, photon mapping
 - Although people are 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
- 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.

Theme 1

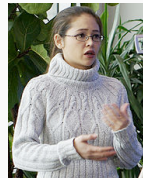
- Hardware features influence game design
- If the Atari 400 gives you 4 sprites, you'll naturally find something to do with those 4 sprites
- If a Playstation 3 can push a gazillion polygons, developers feel obligated to provide a gazillion polygons
 - Driving budgets through the roof
 - 100 person 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

Commercial game industry is brutal

- Nov. 2004: "EA Spouse" post (ea-spouse.livejournal.com) lead to \$14.9 million award for unpaid overtime



Erin Hoffman

- Some companies get hundreds of resumes per week per listing (www.gamasutra.com/features/20050711/mcshaffry_01.shtml)

Photo from Wikipedia

Think "outside the box"

- Computer engineering
 - Gaming drives technological developments
 - 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 indie developers (1)

- On-line distribution takes manufacturing costs out of the equation
- “Brick & mortar” stores have limited shelf space
- Services like Amazon, Netflix, etc. can exploit “the long tail”
- Why are we still shipping boxes mostly full of air?



Photos from <http://cribbster.wordpress.com/2009/01/27/>

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Many opportunities for indie developers (2)

- Greg Costikyan's Manifesto! Games
- Jeff Vogel of Spiderweb Software
 - Old-school RPGs
 - Exile, Nethergate, Avernum, Geneforge
 - www.spiderwebsoftware.org
 - Makes house payments, feeds kids



From www.costik.com



From www.spidweb.com/misc/jvogel.html

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Consoles hostile territory for indie devs (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**

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Consoles hostile territory for indie devs (2)

- Nintendo NES “pioneered” business model
 - Typically sell 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
- New: XNA Community Games!

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“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”

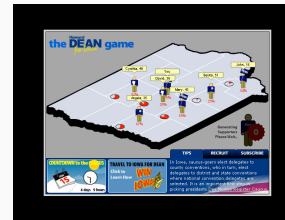
Screenshots from www.gamasutra.com/features/20051102/carless_01b.shtml
www.businessweek.com/innovate/content/apr/2006/id20060410_051875.htm
www.persuasivegames.com



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“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)



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



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America’s Army

- Training, advertising, or propaganda?
- U.S. government spent \$7 million, but free to play
- Made with Unreal Tournament engine



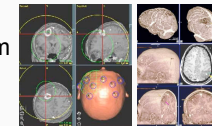
Pics from Wikipedia
 Info from Ian Bogost, “Persuasive Games”



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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>



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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

http://www.youtube.com/watch?v=iaVj_Q0dkCc

Machinima – filmmaking with game engines



Michael Nitsche (LCC)

Rooster Teeth's Red vs. Blue
From www.spectrum.ieee.org/computing/hardware/machinimas-movie-moguls

