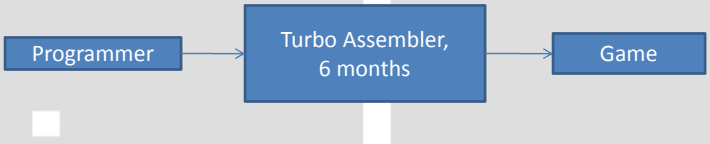
# Game Programming: The BIG Picture

Dan White
Studio Technical Director
Pipeworks
danw@pipeworks.com



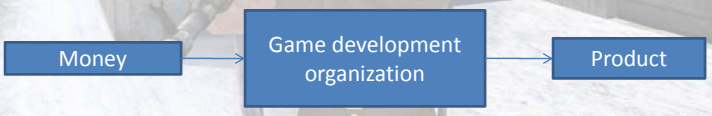
## The very old days…




25 years ago, a game might have 1 programmer, and maybe 1 artist

# View from the CEO's chair…

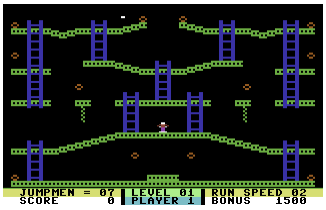
- Games are big business
  - Current AAA titles: $30 million budget, 2+ year time frame
  - Project completion date is very important
    - Particularly for licensed properties




This means we make games differently…

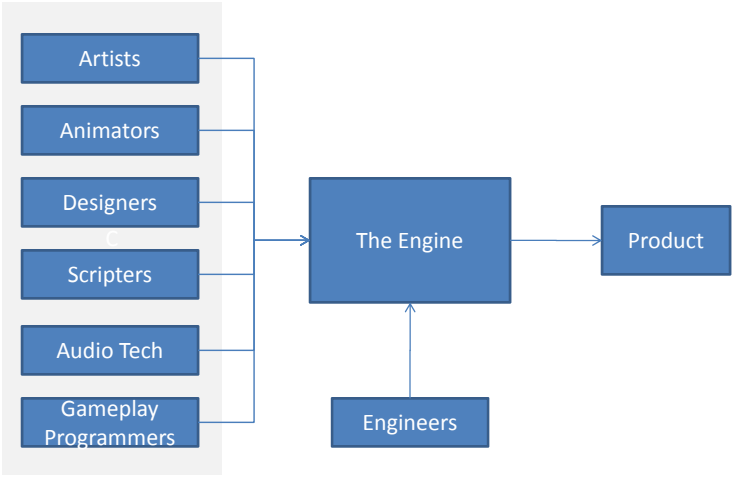
# When I first noticed change…

Jumpman
Atari 800
circa 1983:



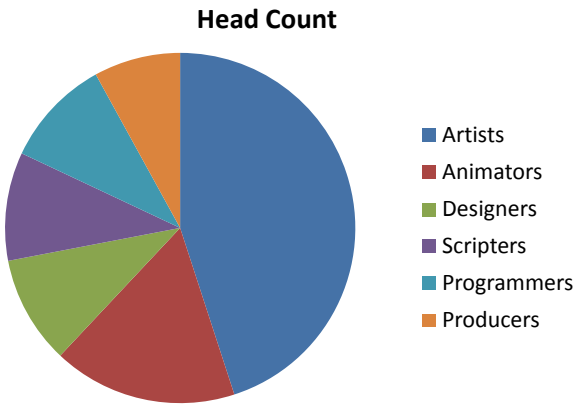

This game had an EDITOR!
At the time, this seemed revolutionary to me.

# A more detailed view of today…




Engineer = programmer = software developer

# Distribution of People




On large projects, programmers are a small part
Where is test? Forgotten as usual..

## The real task of engineers

- The main task of engineers in a commercial game company is to make tools and runtime to enable artists and designers to make games.
  - Saves money, but just as important increases predictability.
- This is how most industries work anyway…you don't need programmers to use Autocad.
- How to design and create the perfect engine is very much unsolved.
- Not to worry, we are decades away from losing the chance to be creative.

## Actually it has been sort of solved

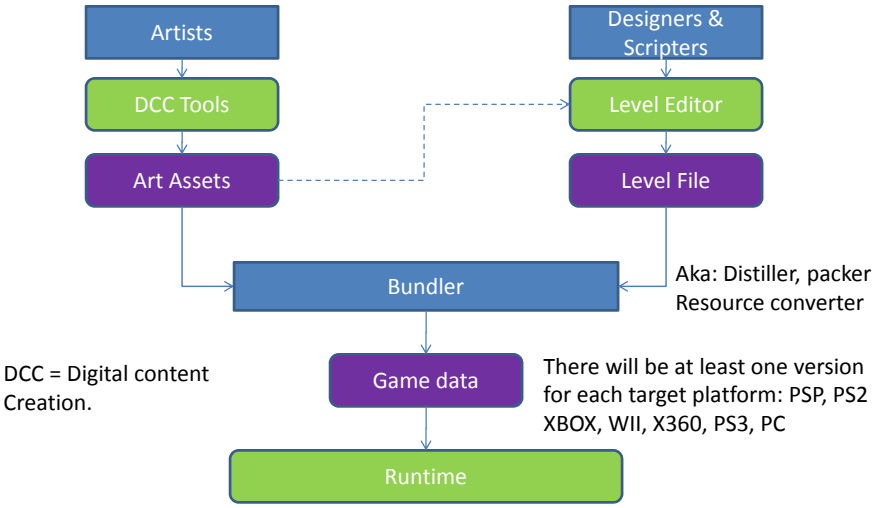
- Flash has taken over the market for 2D games.
- It's a huge success.
- Flash games can be made with only scripters.
- This is possible because:
  - Performance not an issue for 2D
  - 2D games are vastly simpler
- So successful that MS is making their own: Silverlight

# Adobe Flash CS4

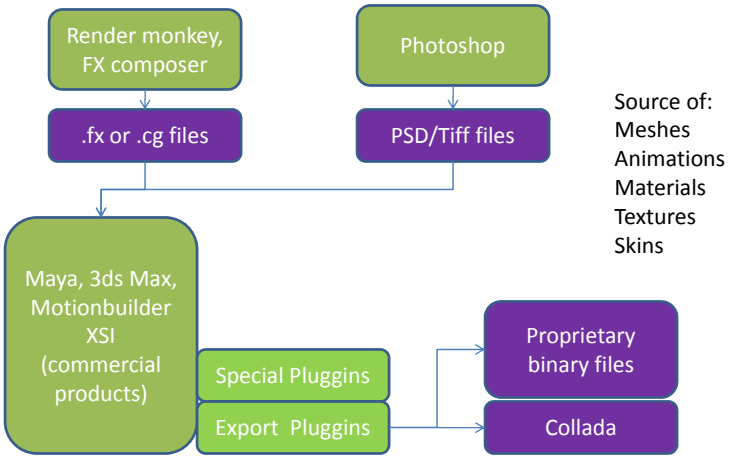

# Flash suggests form of the general solution

- Artists make assets
- Designers use the assets to make levels.
- The levels are packed to make game data.
- The runtime interprets & processes the game data.
- Sound familiar?
  - Source file →Compiled EXE
  - EXE run by an OS

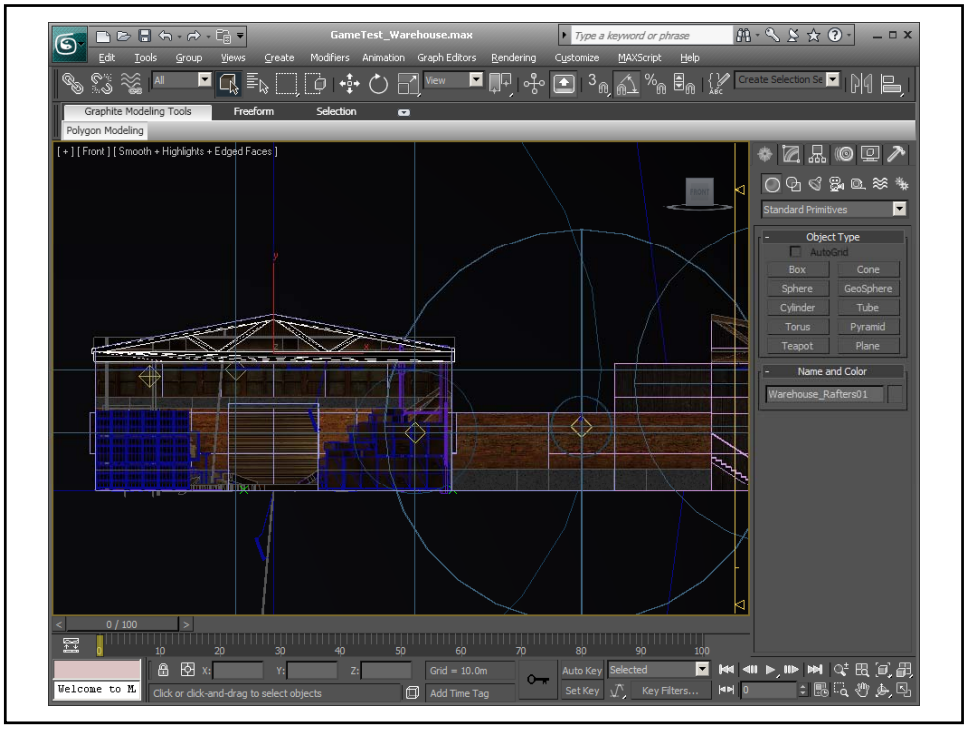
# A slightly more detailed view…




# The art pipeline…




Originally targeted at film.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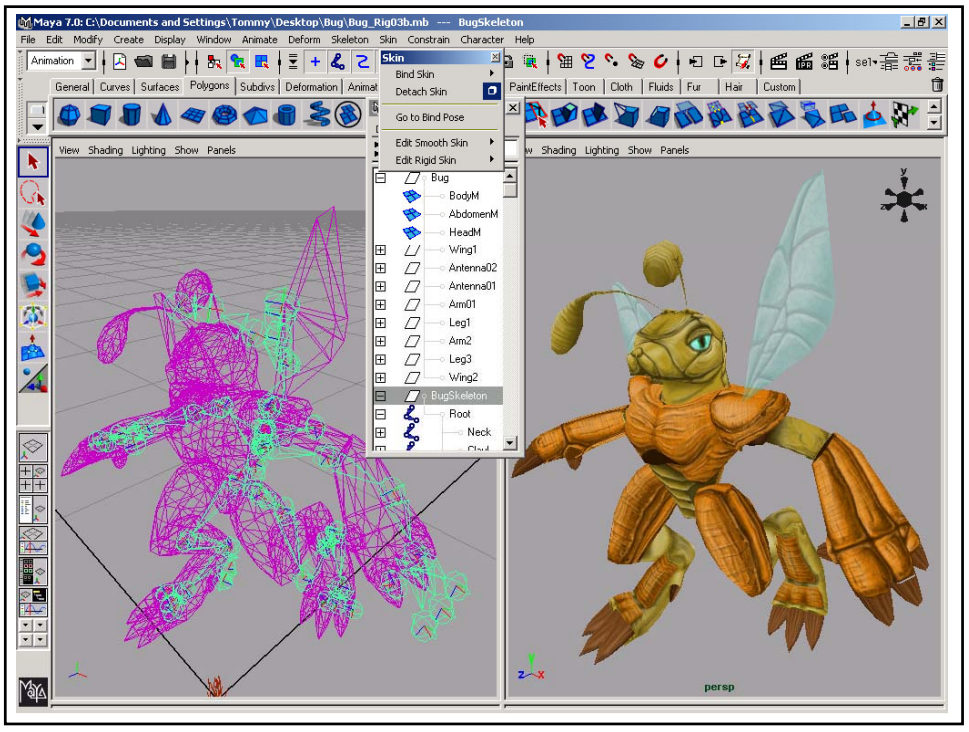
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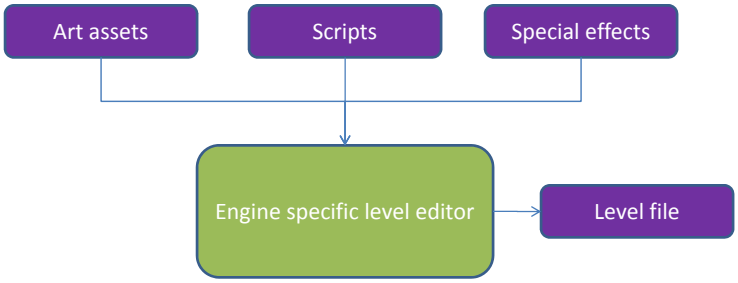
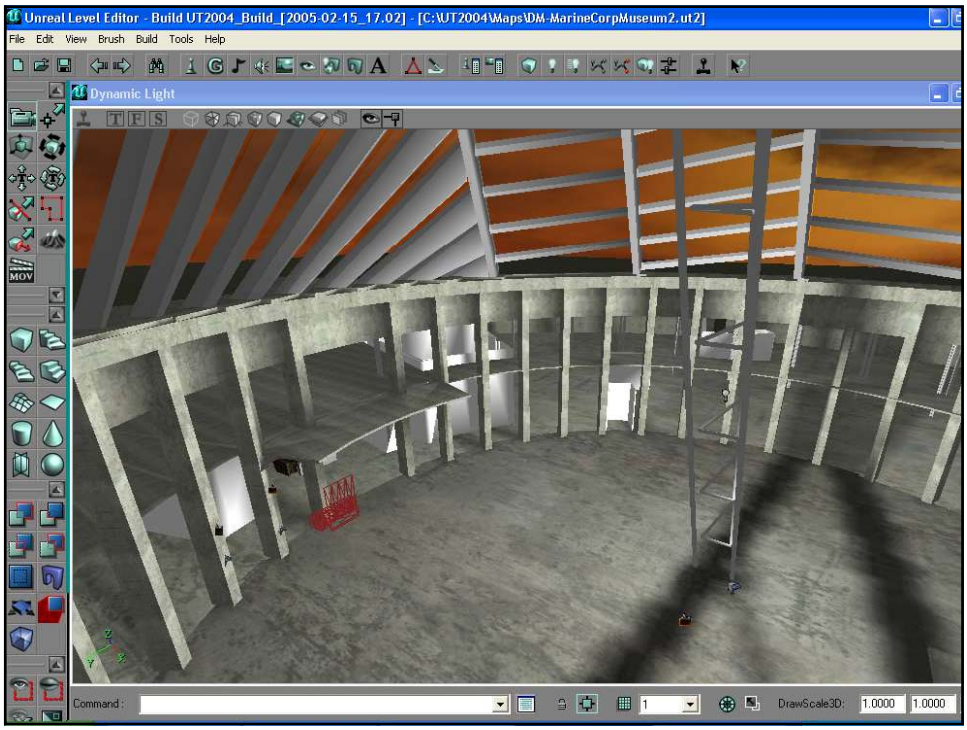
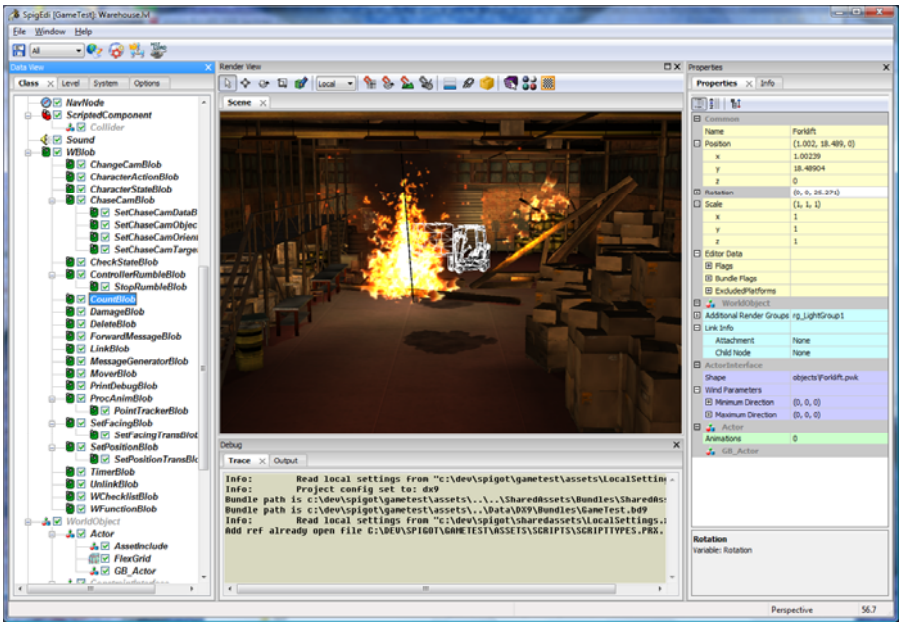
# The level editing pipeline…




- Object placement & properties
- Setup lights
- Create light/shadow maps
- Script binding (connect triggers and so forth)
- Script testing
- Create camera paths & cinematic sequences.
- In some cases…creating of the static world geometry (now out of fashion)



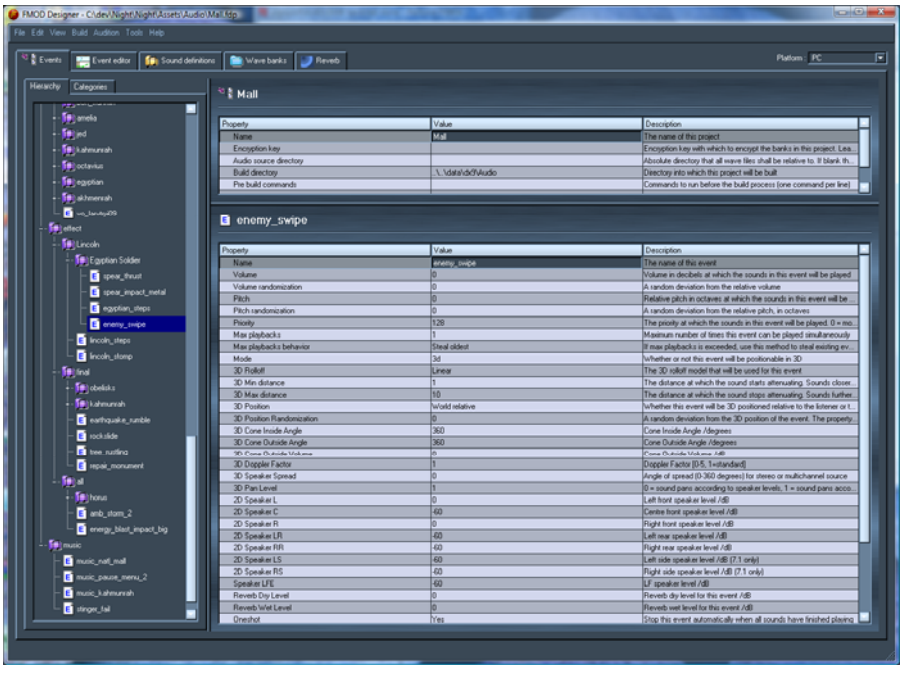


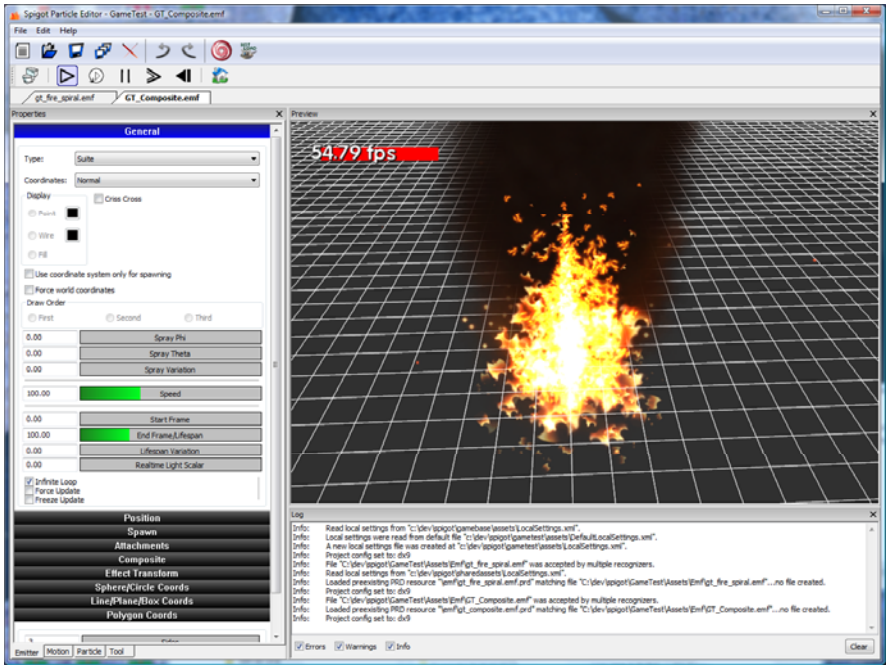
## How to design a level editor is still unsettled…

- Some engines use the DCC as the level editor
- Some approaches have a special build of the game that is also the level editor.
- In some cases, the level editor also does the bundling.

# Other tools

- Special Fx editor
  - Particle systems very important for look and feel.
  - Edit and tweak particle systems
  - Can be really fun to work with & neglected academically
- Sound editor
  - Take sound samples (from Sound Forge or whatever) and create runtime sound-effects by applying patches, filters etc.
- Asset management
  - This is a huge problem with > 10^5 files

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Use coordinate system only for spawning
Force world coordinates
Draw Order
First
Second
Third
Spray Phi
Spray Theta
Spray Variation
Speed
Start Frame
End Frame/Lifespan
Lifespan Variation
Realtime Light Scalar
Infinite Loop
Force Update
Freeze Update
Position
Spawn
Attachments
Composite
Effect Transform
Sphere/Circle Coords
Line/Plane/Box Coords
Polygon Coords
Emitter
Motion
Particle
Tool
Preview
54.79 fps
Log
Errors
Warnings
Info
Clear


Recurring Theme
• Editor
• Previewer
• Runtime
• As usual, the UI (editor) takes most of the work.

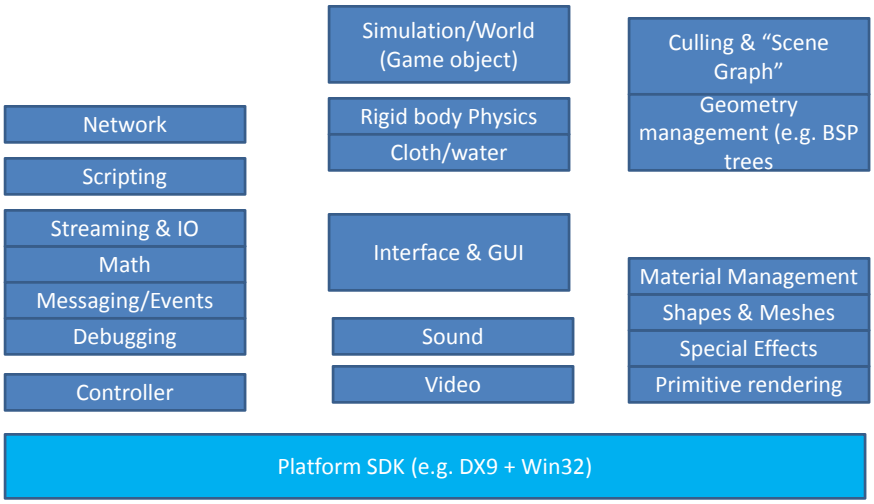
## On to the Bundler…

- The bundler does the final conversion of assets to a platform specific format.
- Stripify & build meshes
- Convert texture formats
- Compress everything that can be compressed.
- Layout binary data for streaming.
- Handles endian swapping.
- Build large data structures (e.g. BSP or kD trees)
- Do every possible preprocess operation!
  - Among other advantages, finds errors early.

## Runtime

- Game runtime is a real-time simulation
  - Predictable performance is important
    - Amortization is not the answer
  - Resources are limited, memory is generally scarce (relative to the PC)
  - Hardware has poor memory bandwidth.

# Runtime…some important systems



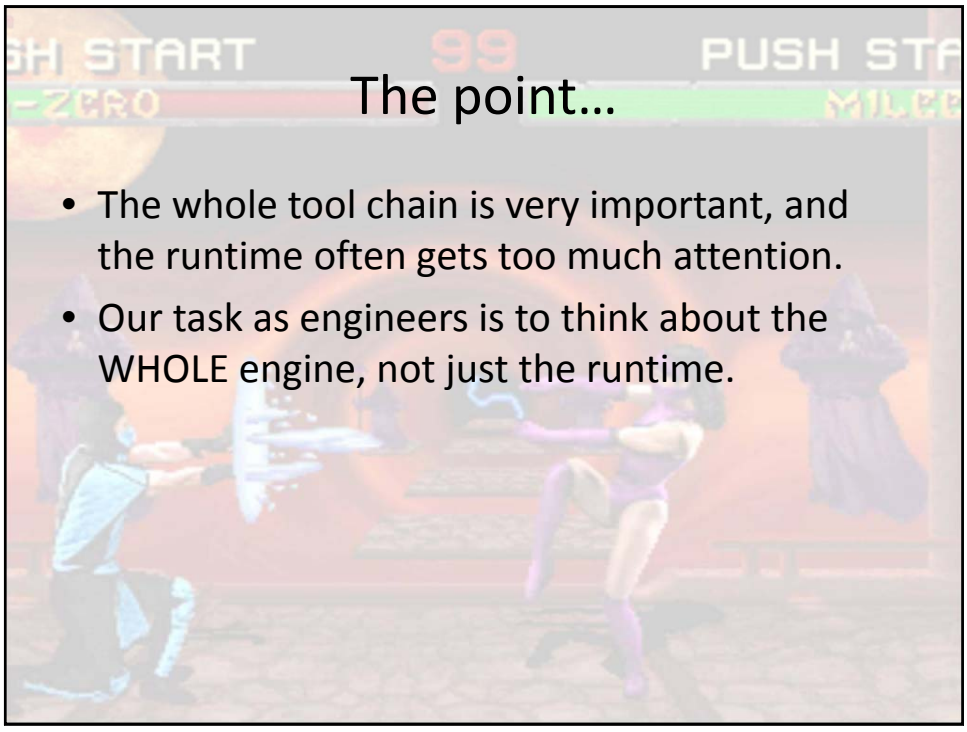

Perhaps 80% is cross platform.

# Runtime design issues

- Grouping of libraries varies, but functionality is common.
- Biggest unsolved question in runtime design is how to achieve threading.
  - Or, on PS3 how to use the SPE's
- Note that I have broken the engine down much farther that the tools side. Many of the components exist there as well.

# Perspective

- The tools complexity, by line count, will be multiples of the runtime side (at least for a single platform).
- The engineers use the runtime, but all the content people use the tools.
  - Training time on tools is much higher, cause more people are involved.
  - Productivity payoff is much higher for the same reason.
- Runtime changes with platform and fads, but tools can remain forever.
- A lot of what makes a runtime "good" is performance, but the payoff to the user may be low.
  - 2x increase in poly count is often barely noticeable
- We have already reached the sweet spot for most game features:
  - 4 enemies to 8 → big difference
  - 64 enemies to 128 → small difference
- **Iteration makes games good, and the tool chain allows iteration.**




# The point…

- The whole tool chain is very important, and the runtime often gets too much attention.
- Our task as engineers is to think about the WHOLE engine, not just the runtime.

## Issues with engine-centric development

- You can make a game without tools, but you can't make a game without runtime.
  - Just like you can make a game without artists, but no without programmers.
- For financial and technical reasons, you have to make the engine in stages.
- Its very easy to screw up. The world is filled with failed engine initiatives.
- Making an engine genre agnostic is very hard…potentially impossible.
  - Genres: FPS, RTS, RPG, fighting, puzzle, driving and the all-important 3rd persona action adventure
- In the end, users don't give a darn…they want a fun game.

## Are you excited yet!

- Engine design and implementation is utterly fascinating (at least for me).
- It touches more disciplines that almost any other software development area.
- Entry is through scripting/game programming, which is fun anyway.

## The price of admission…

- Most of game & engine programming is just solid CS.
- However, there are areas which are typically missing from a CS program.
  - Mathematical modeling, vector math
  - Simulation & physics
  - Graphics, particularly special effects
  - Low level (not TCP based) networking
- This is why I'm so excited about this class!
- Some CS areas are less important:
  - Web anything
  - Databases
  - This is changing…

## High-level unsolved problems

- Should materials be edited inside DCC tools?
- How should art assets be exported from DCC tools?
- How much game logic should be in script, vs.. the engine?
- Is there a visual programming solution for scripting?
- How to have a data-driven design and still get predictable performance?
- What language should tools be written in? C++, C#, Java, Python?
- How should cut-scenes be created?
- At what level should network replication occur?

# Lower-level problems…

- Engine structure for multiple cores/threads
- Class organization for a complex simulation
- Realistic human animation
- Destructible stuff
- Hair, Fire, Water, Smoke (Fur is mostly under control)
- Lighting
- Shadows
- Convincing & predictable AI
- Non-creepy human rendering
- Non-interior environments: Foliage, urban scenes