Graphics business

- ~$20M to develop a graphics chip
- Lucky to net ~$10 a chip
- Only game platforms have enough volume
  - Novelty supercedes fidelity
- PC’s offer many design win opportunities
  - But model and API velocity limit lifecycle
- Consoles live long and prosper
  - But only 2.5 design wins per cycle
Implementation of the ATI Flipper Chip

**Current consoles**

<table>
<thead>
<tr>
<th>PS2</th>
<th>Gamecube</th>
<th>Xbox</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mips + Vector Engine</td>
<td>PowerPC + Paired single</td>
<td>x86 + MMX/SSE</td>
</tr>
<tr>
<td>Render + Embedded FB</td>
<td>Geom, Render + Emb FB, Txtr</td>
<td>Geom, Render</td>
</tr>
<tr>
<td>Rdram</td>
<td>Mosys dram</td>
<td>DDR Sdram</td>
</tr>
</tbody>
</table>

**Graphics pipe**

- 1980 simulator
- 1990 workstation
- 2000 PC & console
- 2010 palm/pocket?
Implementation of the ATI Flipper Chip

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### Graphics Memory

- High resolution
- Low resolution
- Game PCs
- Consoles
- Low cost
- High performance

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### Graphics Programmability

- CPU
  - Less than compelling 3D
- 80’s bitslice, DSP, sundry
  - Lag in clock speed, software
- 90’s CPU plus simd coprocessor
  - Lag in memory throughput, addressing
- 00’s standalone simd coprocessor ('shader')
  - TBD
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Graphs image array processor

Hardwired pipeline

Database | Polygon sample | Image sample

address

arrays

Shader program

Short vector arithmetic

address
data

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Whither

- Generalization is likely
  - Addressing, branching, threading, virtual memory
- Cheap fast things devour big complex ones
  - Unit growth in pocket/palm entertainment
- But programmability can be scalable
  - Perhaps SOC CPU + simd + database/samplers
- And business overpowers technologies

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Global illumination is very useful
  - Simply enable shadows, reflection, refraction
Global illumination is very hard
  - Sort violates the pipe
  - So circulate lots of images, arrays
    - Novelty supercedes fidelity

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why

- De-evolutionary optimization
  - Direct to icon to symbol and back
- Evolutionary light prosthesis
  - Compensation for our visual asymmetry
- An instrument
  - Enable the top of the pyramid