Lecture 2: History of Video Gaming Hardware: The 2-D Era

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Atari 2600 VCS (1977)

- ≈ 1 MHz MOS 6507
  - low-cost version of 6502
- 128 bytes RAM
- First ROM cartridges 2K, later 4K
- Discontinued 1992
- Retro releases now on the market!

Pics & info from Wikipedia
Atari 2600 Hardware Tricks

- Could put RAM on the cartridge
  - “Atari Super Chip”
  - 128 more bytes!
  - Jr. Pac-Man

- “Bank switching” to put more ROM on cartridge
  - Only 4K immediately addressable - game still has to operate within individual 4K chunks at a time
  - Mr. Do!’s Castle (8K), Road Runner (16K, 1989)
  - Fatal Run (only 32K game released, 1990)

Info & pics from AtariAge
Atari 2600 Hardware Tricks

• “M Network” games
  – Atari 2600 games produced by Mattel
  – Controversial decision within Mattel
  – Done by same group that designed the Intellivision: APh Technology Consulting

• Super Charger added 2K RAM
  – Originally planned as a hardware add-ons
  – Public didn’t seem to like add-ons, so built in separately into each cartridge
  – BurgerTime: Cleverness beats hardware!

www.intellivisionlives.com/bluesky/games/credits/atari2.shtml
• “Atari never intended to create a Chess game for the Atari 2600”

• “the original VCS box had a chess piece on it, and Atari was ultimately sued by someone in Florida due to the lack of an actual chess game”

• “Some time later Atari's engineers began working on a version of Chess for the 2600”
Atari 2600 - The Chess Story (2)

• “Although Video Chess ended up shipping as a 4K game, earlier versions of the game were larger...This prompted Atari to invent bank-switching ROMs which would be used in later titles that needed more than 4K...”

Quotes & pics from AtariAge page on Video Chess
Atari 2600 Graphics

- Custom “Television Interface Adapter” for handling graphics and sound
- No graphics buffer!
- “Playfield” scanline 40 blocks wide, two colors
- Atari 2600 games have intricate timing loop
  - For each scanline, program has 76 cycles to do whatever computations it needs to do to load a scanline’s worth of pixels into the TIA (“racing the beam”)
  - Have to do most the “game logic” during the vertical blanking period
- Two sprite “players”: 8-“pixel” wide chunks, twice resolution of playfield, could be two colors different than playfield
- Missiles: single-bit

Info from “Chris Crawford on Game Design”
Some details from Ian Bogost
Atari 2600 - Graphics Tricks

• Could change TIA registers to change colors
  – …from scan line to scan line
  – …if you were extremely careful with your timing, you could do it in the middle of a scan line!

• Multiplex a single sprite between multiple objects
  – Flickering ghosts in Pac-Mac man
    • Flicker varies depending on number of ghosts in play

• Programmers learned to exploit “undocumented features” in the hardware
  – Makes the Atari 2600 one of the hardest machines to emulate accurately
Rise of the third party developers

• Atari programmers unhappy
  – No credit
  – Salaried; little if any royalties

• Four top programmers split and form Activision (1979)
  – Responsible for over half of Atari’s titles
  – Promoted game creators along with games
  – Drew top talent
  – Didn’t pay royalties to Atari
    • Nintendo learned from this!
  – Atari sued
  – Settled in 1982

• Mattel and Coleco made the same mistakes in handling their programmers that Atari did!
Intellivision vs. Atari

- Plimpton Sports
  - [http://www.youtube.com/watch?v=lDza6eTXGEY](http://www.youtube.com/watch?v=lDza6eTXGEY)

- Major League Baseball
  - [http://www.youtube.com/watch?v=Y0KTjpaG3cg](http://www.youtube.com/watch?v=Y0KTjpaG3cg)

- Star Strike
  - [http://www.youtube.com/watch?v=VPB3H_a234s](http://www.youtube.com/watch?v=VPB3H_a234s)
Mattel Intellivision (1979)

- ≈1 MHz General Instrument CP1610 (16-bit!)
- 1352 bytes RAM:
  - 240x8 scratchpad memory
  - 352x16 system memory
    - 240 words for character buffer – what characters are where and what color
  - 512x8 graphics memory
    - Character patterns
- 7168 bytes ROM
  - 4096x10 (5120) executive ROM
  - 2048x8 graphics ROM

Photo and info from Wikipedia
Mattel Intellivision - Graphics

- 160x196, 16 colors
- 8 sprites
  - 8x8 or 8x16
  - Stretching: horizontal (1x, 2x) or vertical (1x, 2x, 4x, 8x)
  - Mirroring: horizontal and vertical
  - Collision detection: sprite to sprite, sprite to background, sprite to screen border
  - Priority: in front of or behind background
Mattel Intellivision - Retro

CLASSIC GAMING EXPO 2007 - JOIN US!
Written by Keith Robinson
Tuesday, 03 July 2007

A Message from IntellivisionLives.com

Make your plans to attend the Classic Gaming Expo 2007 at the Riviera Hotel on the Las Vegas Strip.

I’ll be there in the IntellivisionLives.com booth! Come by and say hello.

This is the tenth annual event and we are moving to a new location. The Classic Gaming Expo takes place at the Riviera Hotel, so plan to be there!

Play on the Intellivision, Intellivision 2, Intellivision Lives!, PlayStation 2, and many more.

Merchandise

Gaming News

IGN Complete
Mattel Intellivision - Modern Homebrew Scene

spatula-city.org/~im14u2c/intv

jzIntv

spatula-city.org/~im14u2c/intv/4-tris

sdk-1600.spatula-city.org

Homebrew programming contest:
spatula-city.org/~im14u2c/intv/contest-2007

spatula-city.org/~im14u2c/intv/4-tris
Example Intellivision code

CALL RSGGB ; Reset good guy bullets.

CALL FILLZERO.lp ; \nDECLE 25 ; |- nuke any remaining bad guys
DECLE BGMPTBL ; /

CALL FILLZERO.lp ; \nDECLE 10 ; |- and their sprites
DECLE SPAT ; /

; ; Draw the crater strip in selected color scheme. ; ;
MVI COURSE, R1 ; \nANDI #7, R1 ; 
SLR R1, 1 ; |_ Adjust color for course
ADDI #CRATCLR, R1 ; |
ADD@ R1, R0 ; /
MOVR R0, R2 ;
ADDI #7*8, R2 ; City/crater ending card #

Source code for Space Patrol
From spatula-city.org/~im14u2c/intv/spteaser
Atari Homebrew Scene

From www.bogost.com and www.quernhorst.de/atari/rf.html
ColecoVision (1982)

- ≈3.6 MHz Zilog Z-80A (8-bit)
- 1KB scratch RAM
- 16 KB of separate VRAM (not directly CPU addressable)
- Cartridges 8/16/24/32K
- Expansion Module #1 allowed user to play Atari 2600 games
  - Atari sued, but lost since EM #1 used off-the-shelf hardware
- Bundled with Donkey Kong - “killer app”
- 6 million sold
- Discontinued 1984
- Coleco also produced games for Atari 2600 and Intellivision

Info from Wikipedia

http://www.youtube.com/v/5GpptJusOjM
ColecoVision - Graphics

- Video Processor: Texas Instruments TMS9928A
  - Variants used in MSX, Texas Instruments TI-99/4A
- 256x192, 15 colors
- 32 sprites (but only 4 per line)
- First console that could seriously compete with stand-alone arcade machines

Info & screenshots from Wikipedia

- Smurf: Rescue in Gargamel’s Castle
- War Room
Apple ][ series (1977)

- ≈1 MHz MOS 6502
- 16K to 48K of RAM (64K with “Language Card”)
- Expansion slots
- VisiCalc (first spreadsheet) - killer app
- Spurred IBM to make the IBM PC
- Hi-res graphics: 280x192, 5 colors (sort of)
  - Page flipping, Pre-shifted shapes

Exodus: Ultima III screenshot from Moby Games
Other pics and info from Wikipedia
Atari HCS 400/800 (1979)

- ≈1 MHz MOS 6502
- 16K to 48K of RAM
- Star Raiders - “killer app”
  - Created by engineer who designed POKEY (the I/O and sound chip)
  - Written to show off the machine’s capabilities
  - 3-D math!!! Remember, no divide instructions….
Atari HCS 400/800 - Graphics

- Extremely flexible graphics system
- Amenable to all kinds of 2600-style tricks, although now with a much more powerful basic capabilities
  - Reprogramming color table for each scan line
  - Vertical smooth scrolling easy
  - Smooth scrolling horizontally via custom character set patterns

Info from “Chris Crawford on Game Design”
Screenshots from Wikipedia
Atari 5200 (1982)

- Sort of a Atari 400/800 without a keyboard
- Not totally compatible
- Had trouble with new analog joysticks  
  - Hard to center
- Atari paid more attention to 2600 line
- Discontinued in 1984

Rescue on Fractalus!

Photo and info from Wikipedia
Commodore 64 (1982)

- \( \approx 1 \) MHz MOS 6510 (close relative of 6502)
- 64K RAM
- Discontinued 1984
  - Followed up by many variations
- Classic sound chip: SID
- Launch price: $595

Photo and info from Wikipedia
Commodore 64 - Graphics

• MOS VIC-II graphics chip
• 16 colors
• Display modes:
  – 320x200 (2 unique colors in each 8x8 pixel block)
  – 160x200 (3 unique colors + 1 common color in each 4x8 pixel block)
• 8 sprites, 24x21 pixels (12x21 in multicolor mode)
• Smooth scrolling
• Raster interrupts
The Video Game Crash of 1984 (1)

- Partially arose from a cascade effect of Atari’s hubris
- E.T. rushed to market in only 5 weeks to hit stores in time for holiday season
  - http://www.youtube.com/v/VakiwDmJ-II
  - Widely considered Worst Game Ever
  - Atari paid $20-25 million for the rights
  - 1.5 million sold
    - 8th best selling Atari cartridge of all time
  - 4 million manufactured
- Rushed, weak port of Pac-Man
  - 12 million manufactured
  - Only 10 million Ataris in homes at the time
    - Atari assumed people would buy 2600s to play Pac-Man
  - 7 million sold
  - Ms. Pac-Man port & homebrew Pac-Mans are better

Photo and info from Wikipedia
The Video Game Crash of 1984 (2)

- Millions of cartridges of E.T. and Pac-Man encased in concrete and secretly dumped in landfill

- In 1982, Atari CEO Ray Kassar sells off 5,000 of his Warner (Atari’s parent company) stock just before a low earnings report drops Warner stock by 40%
  - SEC investigated for insider trading
  - Settled, returned profits
  - Later cleared by SEC
  - Forced to resign in 1983

Info from Wikipedia
Nintendo NES (1985 U.S. release)

• ≈1.8 MHz 6502 core, with DMA controller and sound hardware on-die (Ricoh)
• Called “Famicom” in most of Asia (1983 in Japan)
• Bundled with Super Mario Bros. - “killer app”
• Launch price: $200; final bundle: $50
• Discontinued in 1995
• 62 million sold
• Competition:
  – Sega SG-1000 (1985 Japan)
  – Renamed Sega Master System (1986 U.S.)
    • Didn’t catch on in the U.S.
  – Atari 7800 - last gasp, bombed

Pics and info from Wikipedia
Nintendo NES - Graphics

- Ricoh-made “Picture Processing Unit”
  - \(\approx 5.4\) MHz, RP2C02
- 256x240 resolution
- 64 sprites (8x8 or 8x16 for all), 8 per scanline
- Tile patterns
- 25 colors per scanline:
  - 1 background
  - 4 sets of 3 tile colors
  - 4 sets of 3 sprite colors

Photo and info from wikipedia
Sega vs. Nintendo

• Blast Processing
  – http://www.youtube.com/v/K03fQKkN7VI

• Genesis Does what Nintendon’t
  – http://www.youtube.com/v/k7nsBoqJ6s8
Sega Genesis (1989)

- ≈7 MHz Motorola 68000
- ≈3.5 MHz Zilog Z80
  - Sound coprocessor
  - Backward compatibility with Sega Master System
- 64K main RAM for 68000
- 64K video RAM (not directly accessible)
- 8K secondary RAM for Z80
- 8K audio RAM
- ROM cartridges up to 4M
  - Can use bank switching for larger games
- Released as “Sega Mega Drive” in Japan (1988)
- 29 million sold

Photo and info from Wikipedia
Sega Genesis - Video

• “Video Display Processor” – descendent of the TMS9928 family used in Colecovision (but not designed by TI)
• 320x224 resolution (complicated)
• 4 planes (2 scrolling playfields, 1 sprite plane, 1 ‘window’ plane)
• Up to 64 sprites
• 61 on-screen colors

• Nintendo’s answer, the Super NES, came later
  – 49 million sold
  – Slower CPU, but nice graphics & audio chips

Most info from Wikipedia
TMS9928 note from Joe Zbiciak
IBM PC compatibles

• Original IBM PC (1981)
  – ≈4.8 MHz 8088
  – 16K to 640K
  – CGA (640x200 B&W, 320x200 4-color, 160x100 16-color w/tricks)

• IBM PC AT (1984)
  – 6 MHz 80286, later 8 MHz
  – 256K to 16M
  – EGA (640x350 16-color from a palette of 64)

• VGA (1987)
  – Palette of 262,18 colors
  – 640x480, 16-colors
  – 320x200, 64-colors (Wolfenstein 3-D)
  – 320x240, 64-colors (Doom)

• Killer app: Lotus 123

Photo and info from Wikipedia
Some details by Joe Zbiciak
Doom (1993)

- Followed in footsteps of Wolfenstein 3-D (1992)
- Released as shareware!
  - Downloaded by 10 million people in two years
- Cleverness over hardware

Images and info from Wikipedia