Early Home Computers and Video Games

Carnegie Mellon

COMPUTER CLUB

Talk Series
October 7, 2015

So, what are we going to discuss?

- How did computers end up getting used for entertainment?

- How did video games and computers end up in our homes?

- How did people use computers to communicate before the Internet was the big deal it is today?

Background

- For many of us (especially those born after the early 1990s), computers and video games are an accepted part of everyday life.

- But it wasn't always that way. Even 30 years ago, most families would not have owned a computer. Go back 40 years, and almost nobody would have.

- Similarly, 40 years ago your parents might have been able to play a few video games at an arcade that would have been mostly full of pinball machines and those iron crane things you never win anything out of, but having any kind of video game at home would have been quite uncommon.

Digital Equipment Corporation VAX 11/780, Circa 1977. Price $120,000-160,000 depending on options. People for scale.

The Beginning

- There are a few candidates for "First Video Game" but my pick would be *Tennis for Two* (1958).

- Created by William Higinbotham, a physicist at Brookhaven National Laboratory to entertain visitors.

- It used an analog 'computer' and an oscilloscope to display a side view of a tennis court that two players could play on.

  - Since the analog computer was designed for calculating missile trajectories, this game actually had surprisingly realistic physics.

Modern recreation of Tennis for Two on a period correct oscilloscope.

Tennis for Two

- *Tennis for Two* was dismantled a year later.

- It was largely forgotten until the late 1970s when people attempted to use it as prior art in a patent law case regarding video games.

  - However, it was ruled that *Tennis for Two* wasn't actually a 'video' game since the analog computer outputs weren't technically video.
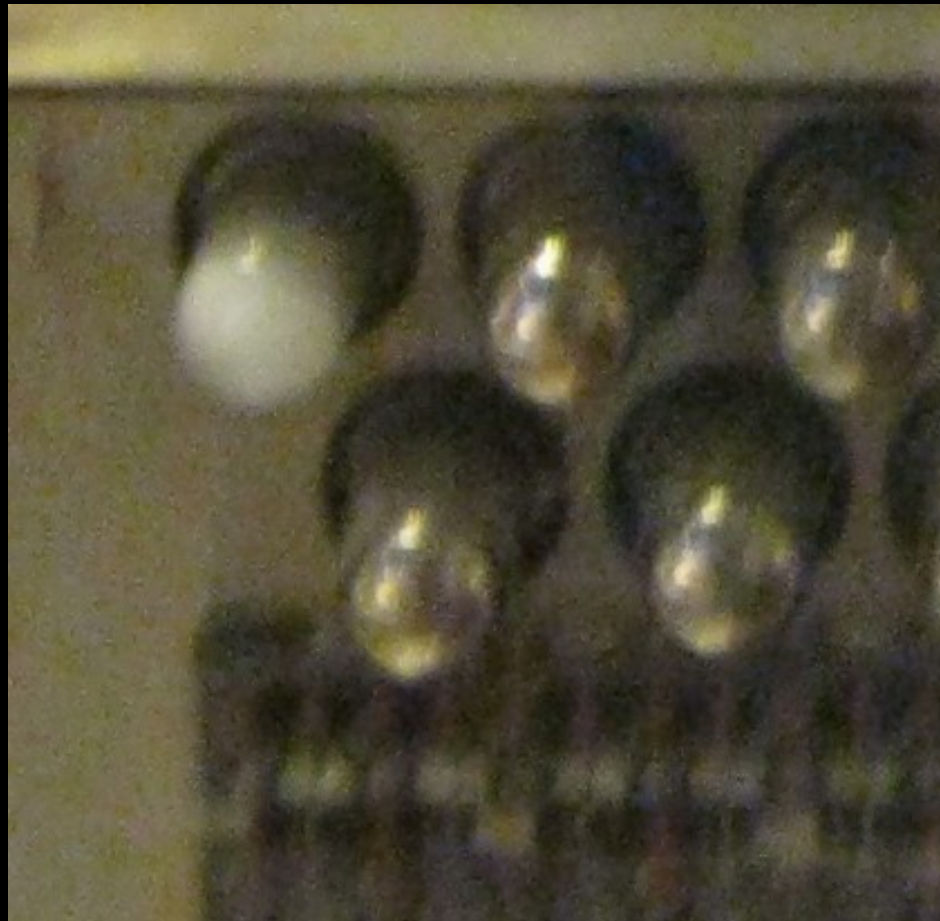
What about *digital* computers in games?

- Prior to the existence of (relatively) small solid-state computers, computer games mostly consisted of such fun things as:

  - Find the relay with the moth stuck in it.

  - Find the burned out vacuum tube.
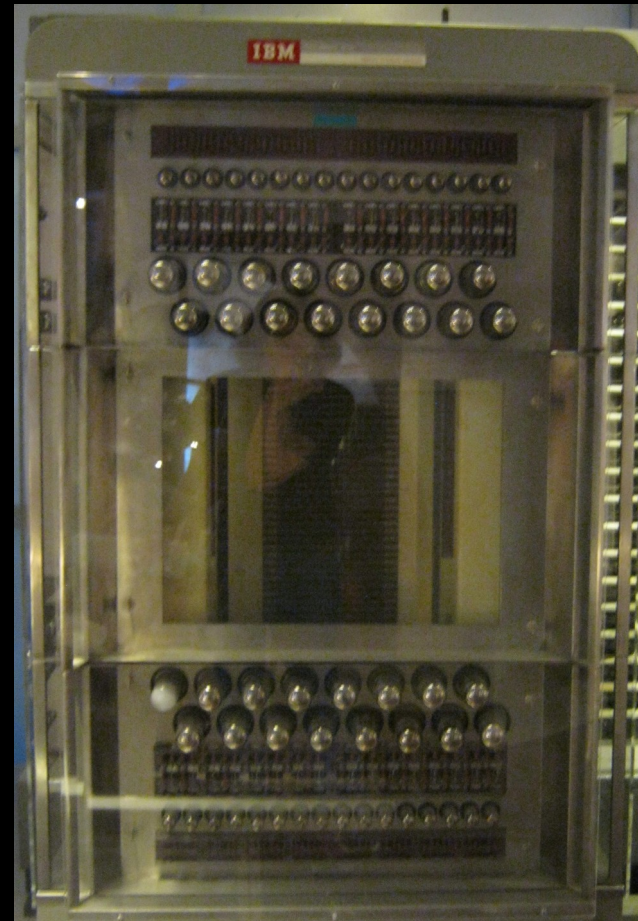
This rack of vacuum tubes is part of IBM's SAGE, a radar defense system (1958).

Not particularly fun, eh?

The vacuum tube in the top left of this picture has developed a leak, as indicated by the coating inside the glass being white instead of silvery. Sorry for the blurry photo, the part of the Computer History Museum where this lives is pretty dark, and flashes don't like glass.

Spacewar

- First video game to make use of a *digital* computer.

  – Also a Digital (as in DEC) computer, the PDP-1.

- Developed by students at MIT in 1962.

Dan Edwards (left) and Peter Samson playing Spacewar! on the PDP-1 Type 30 display.
Image Credit: Computer History Museum

Spacewar

- Two player game, displayed on one CRT.

- Each player controls a spaceship and attempts to destroy the other player's ship.

- Improvements to *Spacewar* and other PDP-1 projects represent the beginning of the "hacker culture" at MIT that would later spawn the Free Software movement.

Screenshot (probably a Polaroid) of Spacewar circa 1963. The dots are stars, the two larger objects are the two ships.
Image Credit: Computer History Museum

Spacewar

- The Computer History Museum has a restored PDP-1 running *Spacewar*.

  - Actually, they have the only 3 PDP-1s left in existence.

  - Hopefully at least one of those is stored in a place not prone to earthquakes.

- In 1971, Nolan Bushnell and Ted Dabney (later of Atari fame) created and commercialized a Spacewar clone.

 - It wasn't much of a success but was probably the first video arcade machine.

Steve Russell, main Spacewar developer, with the CHM's restored PDP-1.

Video Games at Home

- So far, we've seen a couple of early video games. They're cool, but very few people would have been lucky enough to play them.
  - Both were quite expensive (*Spacewar* far more so than *Tennis for Two*) and used uncommon and large hardware.
  - A ham radio experimenter may have owned an oscilloscope in the 1960s, but certainly not a computer (analog or digital).
- If video games were going to end up in the home, they'd need to be both smaller and cheaper.

Magnavox Odyssey

- First home video game console, developed from 1966 to 1968 but not released until 1972.

- Invented by Ralph H. Baer at Sanders Associates.

  - Baer also invented Milton Bradley's *Simon* game.

  - The Odyssey was originally intended to be a training device for the military, but was too primitive.

  - Sanders instead shopped it around to TV manufacturers as a toy.
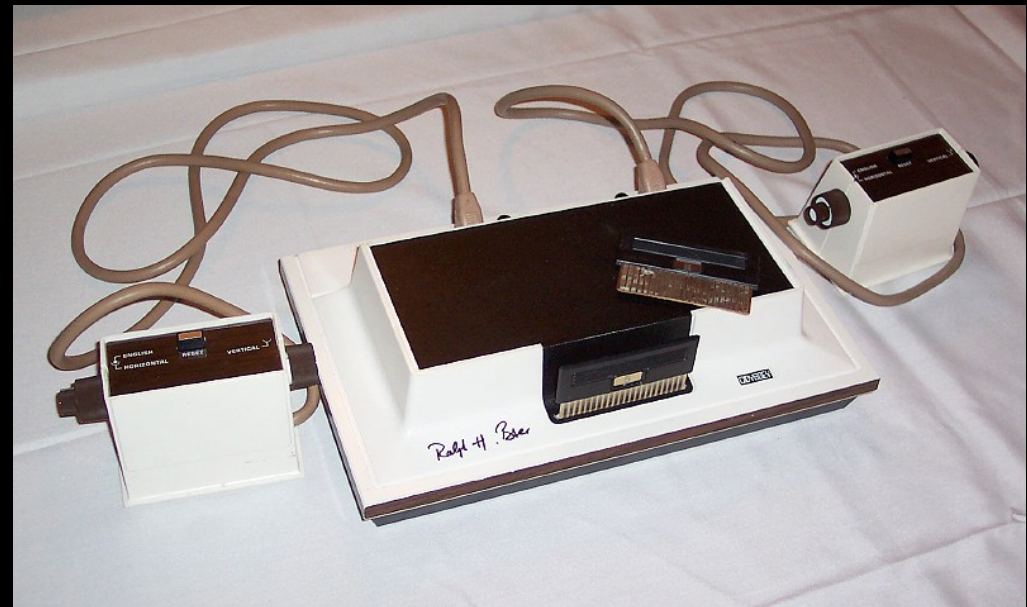
Magnavox Odyssey, with original controllers and game cartridge (also with Ralph Baer autograph).

Magnavox Odyssey

- It was digital, but implemented entirely in discrete diodes and transistors.

- It could only generate white dots and lines.
    - Because of this, it included plastic screen overlays, paper for keeping score, and board game accessories such as dice and play money.

- But it introduced the basics of a video game console:
    - Removable game cartridges
    - Plugged into a home TV set
    - Could be used for multiple games

- However, it was missing features like sound and the ability to keep score.

Accessories included with the Odyssey: Poker chips, dice, cards, play money, and game cartridges.

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Children playing the Odyssey's Tennis game. The large wooden object with the oddly shaped display is a console television set.

This thing is boring...

- The Odyssey was a start, but honestly not that exciting even in the 1970s.

- But you couldn't really do more with 70s technology unless you made the box bigger.

- So that's exactly what happened.

  - One of the Odyssey games was essentially copied by a company called Atari, with improved graphics, score-keeping, and sound added, and then packaged inside a refrigerator sized cabinet.

PONG (11/1972)

- Was the first successful video arcade game.

- It was an obvious copy of earlier table tennis games.

- But it was a huge success.

  - Consumed less floor space than a pinball machine, but took in more quarters.

  - Gave Atari the money they needed to develop better arcade cabinets, as well as home video games such as the...

Atari 2600 (09/1977)

- Almost everyone has heard of it.

- Widely considered to be the first microprocessor based home console.

- But it actually isn't. That honor belongs to the...

Atari 2600, manufactured from 1978-1992

Fairchild Channel F (11/1976)

- It had half as much RAM as the 2600 (only 64 bytes) but it had an actual framebuffer.

- Fairchild (at the time a large IC manufacturer) left the game business in 1979.

- Another company bought the rights to the Channel F, but they weren't successful competing with Atari.

Back to the 2600

- Not the first, but until the 1983 video game crash, the most popular.

- The graphics and sound seem like a joke today, but for a home product in 1977 they were adequate.

Screenshot of *Pitfall* (1982) for the 2600. Think the graphics are cheesy? By 2600 standards, this is **good.**

Back to the 2600

- It was difficult to program for.

  - Instead of having to generate a frame at a time, 2600 games have to generate one line of video at a time.

  - Because of this (done to skimp on expensive RAM), 2600 games were usually written in painfully hand-tuned assembly language.

- But you could buy one anywhere.

  - Aggressively marketed in toy and department stores.

  - Rebranded by Sears as the *Tele-Games* console.

Screenshot of *Combat* (1977) for the 2600. This is more representative of typical 2600 graphics.

What's this thing?

- A large and inconvenient remote control?
- A controller for motorized TV antennas or satellite dishes?
- A two-handed printing calculator for really fast accountants?

Nope, it's a game console.

- RCA Studio II (01/1977)

  - Was a flop due to some bad design decisions that made it uncompetitive with the Channel F and 2600.

  - Black and white graphics at only 64x32 pixels.

  - Telephone keypad style controls built into the main unit.

  - One interesting note: It used RCA's own COSMAC 1802 CPU, which is still manufactured in a radiation-hardened version and used in satellites.
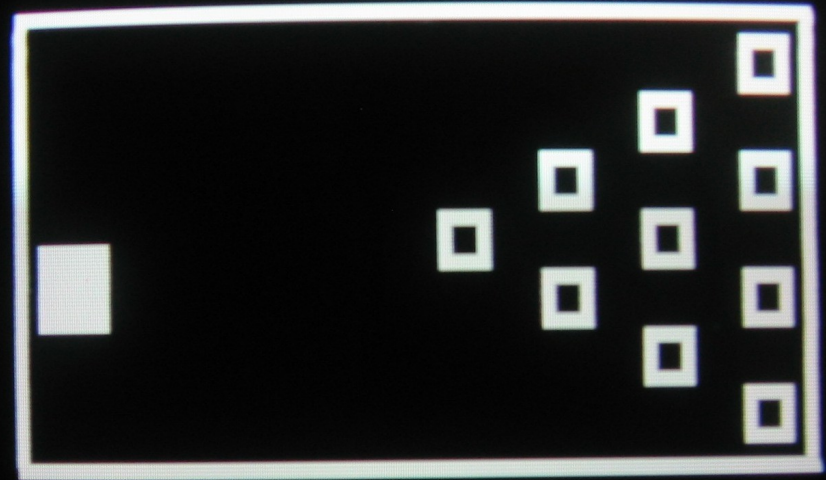
The Studio II's 'bowling' game. Better than Odyssey graphics, but not by much.

Other 2nd Generation Consoles

- Mattel Intellivision (1979)

  - Better hardware than the 2600, couldn't compete with the larger selection of games.

  - Used a 16 bit processor (GI CP1610) and the famous GI AY-3-8910 audio chip.

  - Mattel promised a "Keyboard Component" that would add a keyboard (and a lot of other stuff) to turn the Intellivision into a full-fledged computer, but this was never widely released, and got Mattel fined by the FTC for advertising a vaporware product that got people to buy their console over others.

Intellivision console showing *Minehunter* game. The rectangular area on the controller is a numeric keypad similar to the Studio II, but a joystick is also present.

Other 2nd Generation Consoles

- ColecoVision (1982)

  - Once again, better than the 2600, but not 'better enough' to beat Atari.

  - Had greatly improved video hardware and used a more powerful Zilog Z80 CPU.

  - Optional expansion module made it compatible with 2600 games.
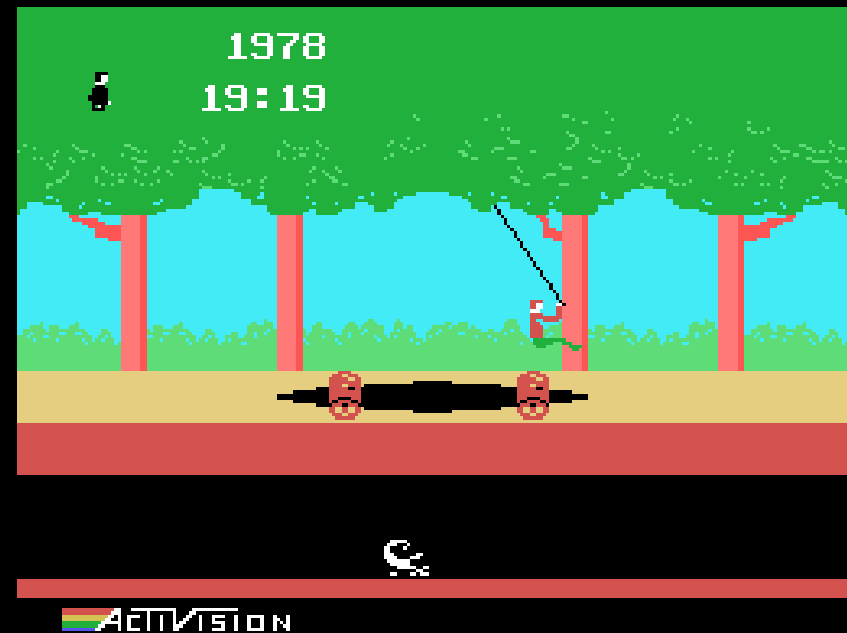
ColecoVision version of *Pitfall*. Same game as on the 2600 but with much nicer graphics.

Other 2nd Generation Consoles

- Magnavox Odyssey^2 (1978)

  - Had nothing in common with the original Odyssey, was a microprocessor based console using an Intel 8048.

  - Unlike the Intellivision, it actually came with a keyboard, and Magnavox even released a few basic programming cartridges.

  - Known as the *Philips Videopac G7000* in Europe, and was far more successful there.

Odyssey^2 console with joysticks. Note the full QWERTY keyboard (even if it is an awful membrane keyboard).

Other 2nd Generation Consoles

- Vectrex
    - Never very popular, not a lot of games released.
    - But very cool because it used vector graphics, previously the domain of arcade cabinets.
    - If you've attended one of our Saturday meetings in the past month, you've probably seen one of these.
    - Computer Club members have written one demo for this platform and are planning to do another. If you'd like to be involved, talk to Ford Seidel.

Vectrex version of *Pole Position* (1983)

Finishing up consoles (for now)

- By the early 1980s, home video games were getting to be pretty popular.

- Many companies made consoles, many wrote games, and a new game release would draw a lot of hype.

    - Especially if it was a tie-in with a popular movie or TV show, or a clone of a popular arcade game.

    - Of course, if the game was really really awful, customers might get angry.

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E.T. for the Atari 2600 (1982)

Pac-Man for the Atari 2600 (1980)

1983 Video Game Crash

- In 1983, the US market for console games collapsed.

- Why? There are a few big causes:
    - Market Saturation – Lots of incompatible consoles.
    - The promise of easy money encouraged developers to quickly turn out lousy games.
    - As well as hyped up but unimpressive games from market leaders like Atari.

Unsold E.T. Cartridges recovered from a New Mexico landfill in April 2014

1983 Video Game Crash

- On top of that, home computers were far more capable, and not much more expensive.

- In 1983, an Atari 2600 cost $129.

- By June 1983, the list price for a Commodore 64 was $300, and some stores would sell them for as low as $200.

  - It was better for gaming than the 2600, and could be used as a real computer too.

Mail-order computer advertisement from July 1983.

Aftermath of the Crash

- The US game console market largely disintegrated.

  – Atari went bankrupt.

  – Coleco would have went bankrupt if not for Cabbage Patch dolls.

  – Milton Bradley, Mattel, and other toy companies got out of the video game business, as did television manufacturer Emerson.

- To many, it seemed that dedicated game consoles were dead, having been completely supplanted by home computers.

  – And it seemed that might be the case until October 1985, when the Nintendo company of Japan released the *Nintendo Entertainment System*, a modified version of their Japan-only *Famicom* (1983).

  – If you want to learn more about Nintendo, and how they succeeded in bringing console games back to the US, attend next week's talk, *History of Video Games: Nintendo*.

Home Computers

- Cheap microprocessors made it possible to build home computers.
  - In 1975, MOS Technology's 6502 could be bought in quantity 1 for only $25.
  - Compare to $300 for a similarly capable Motorola 6800 or Signetics 2650.
- But in the beginning, they weren't very user-friendly.
  - Most early home computers were sold in kit form.
  - And once you got the thing put together, you had to program it by inputting binary data with toggle switches.

Home Computers

- In the late 70s, this would change.

- Companies such as Apple and Commodore sold fully assembled computers that you could plug into your TV.

  - Most of these early machines used the aforementioned 6502 CPU.

  - The next most common 8 bit CPU was Zilog's Z80 (Sinclair/Amstrad in the UK, Osborne, Kaypro, etc. in the US).

- In addition to gaming, home computers could be used for real work, learning to program, etc.

Commodore PET, circa 1977

The Apple II (1977)

- Used the 6502 processor.

- Clever hardware design gave it color video output.

- Extremely common in schools from the late 1970s through the 1990s due to reliability and a huge library of educational software.

    - When I graduated high school (2007), the adjacent elementary school still had Apple IIs in the Kindergarten and 1st grade classrooms.

One of my Apple][e's, pictured with Disk II 5.25" drive and Apple color monitor.

The Apple II (1977)

- The Good:
  - Very expandable due to design and open documentation.
  - Disk drive was fast, small, and required no external power.
- The Bad:
  - Expensive for what it was.
  - Graphics capability not that great (no dedicated hardware for sprites, etc., color used NTSC signal trickery).
  - Sound capability very limited (just a 1 channel 'clicker' that took a lot of CPU cycles to produce any terribly interesting sound.

The Commodore 64 (1982)

- Am I skipping over some stuff? Yes.

  - The PET (1977), was a hastily designed and unimpressive Apple II competitor.

  - The VIC-20 (1980), intended to be cheap, was a much better machine than the PET.

- The C64 was Commodore's first big success.

  - At release, a C64 could be bought for less than $600, less than half what a similar Apple II would cost.

  - This was largely due to vertical integration. Commodore owned MOS Technology, maker of the 6502 CPU that powered the C64 (and most of its competitors), and while the initial cost of developing the custom video and audio chips was high, they could be produced cheaply and made the motherboard and case much smaller.

The Commodore 64 (1982)

- The Good:

  - Cheaper than an Apple II.

  - Much better graphics/sound.

  - Easy to get – aggressively marketed in department and toy stores.

- The Bad:

  - No internal expansion slots.

  - Floppy drive slow, and as large as the computer itself (as well as being heavier).

  - Cheap build quality: Keyboards somewhat flimsy, bulky external power brick, etc.

Commodore 64, pictured with color monitor and model 1541 floppy drive.

The IBM PC

- Originally released in 1981.

- IBM's attempt to enter the microcomputer market.

- 16 bit (on an 8 bit bus).

- Graphics choices consisted of monochrome text only (like a 1977 Commodore PET) or IBM's unimpressive "CGA" featuring colors more suited to pie charts than video games.

- Stock sound was just one voice of square wave.

- OS was *PC-DOS*, a CP/M knockoff from Microsoft.

IBM Model 5150 PC from 1981

The IBM PC

- The Good:
  - Open architecture
  - Expandability
  - Free IBM logo included for business legitimacy.
  - Less expensive but mostly compatible clones existed.
- The Bad:
  - More expensive than even an Apple II – In 1981 $1,565 got you 16K of RAM, CGA graphics, and no floppy drives.
  - Mostly incompatible with the rest of the home computer world.
  - Lackluster graphics and sound.
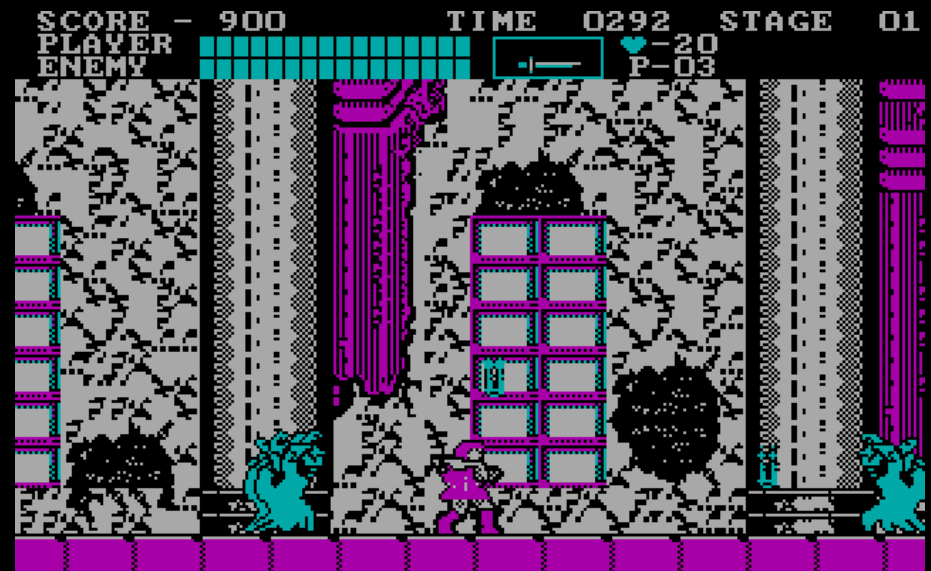
Castlevania in 4 color IBM CGA.

Early home GUIs

- Machines like the Commodore 64 and IBM PC were a huge step up in usability from kit computers like the Altair.

- But command lines still tend to scare newbies.

- The idea of interacting with computers graphically dated back to at least the late 60s with Douglas Englebart's NLS (On-Line System).

- Xerox PARC had a fully working system, but it was quite expensive and Xerox management was more interested in selling toner cartridges than changing how the world used computers.

- Attempts to commercialize GUIs had been made, but none were very successful:

  - CMU startup Three Rivers Computer's PERQ (1980) cost approximately $20,000, was the size of a mini fridge, and wasn't very successful (It's estimated that only around 5,000 were ever made).

  - Apple Computer's Lisa (1983), sold for around $10,000 and wasn't very successful, but the lessons learned from the Lisa project resulted in...

The Macintosh

- Released in January 1984, the Macintosh was the first commercially successful computer with a GUI.

- It used the Motorola 68000 CPU, running at 8 MHz (almost twice the speed of the IBM PC's 8088).

- It had 128 kilobytes of RAM, which sounds like a lot for this era, but on a 16 bit machine with a GUI and 400KB floppy disks it was a bit limited.

The Macintosh

- It was (relatively) cheap at $2,495, thanks to clever hardware design (and skimping on expensive RAM).
  - Compare to $9,995 for a Lisa.
  - Or $75,000 for a Xerox Star.
  - However, it was still far more expensive than your average home computer, or even an IBM PC.
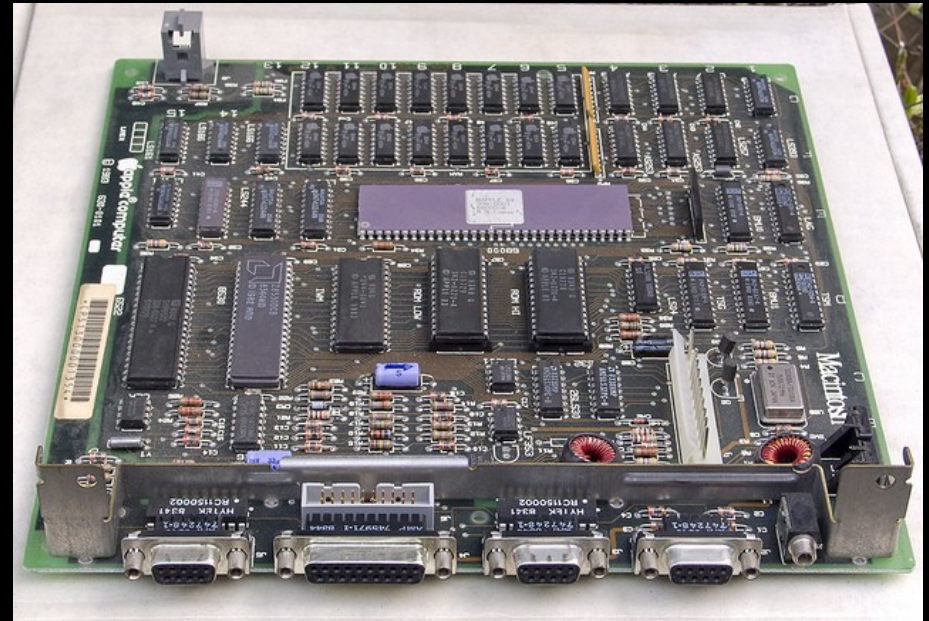
Macintosh 128k logic board. The large purple and gold IC is the Motorola MC68000 CPU (in 64 pin DIP package).

The Macintosh

- What made the Macintosh successful?

    - Attention to user interface design made it easy to use.

        - The use of a single mouse button, while somewhat limiting, led to less confusion for new users.

        - Apple encouraged consistent program behavior (menu layout, etc.) which made the Macintosh easy to learn.

    - Apple encouraged third party software development through good documentation and affordable development tools.

        - Having learned their lesson from the Lisa, Apple actually wanted third parties to code for the Mac.

        - Fun fact, Microsoft Word and Excel (as we know them today) were both originally developed for the Macintosh.
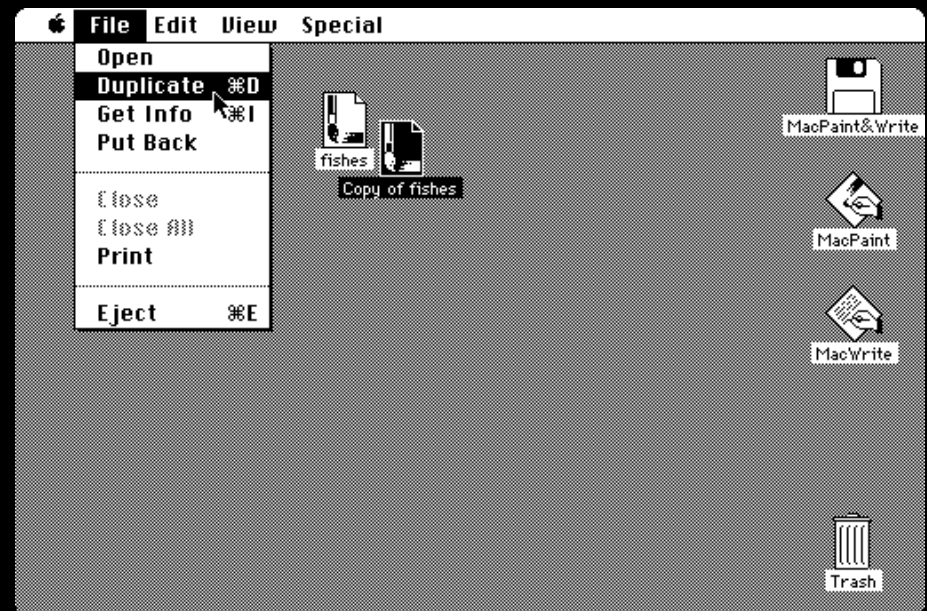
The Macintosh

- What were some of the downsides of the early Mac?

  - 128 KB of RAM really wasn't enough. Apple quickly released a 512 KB model, but it cost another $300.

  - Despite having a very polished user interface, the Mac's OS was very primitive under the hood.

    - No multitasking (other than Desk Accessories) until 1987.

    - Unintelligent memory management. This wasn't fixed until 2001 with the release of the UNIX-based Mac OS X.

  - No color and no expandability until the release of the Mac II in 1987.

Macintosh II with color display. Circa 1987.

The Amiga

- The Commodore Amiga was a slightly less well-known early GUI based home computer.

  - Used the same Motorola 68000 CPU as the Macintosh, but added some more advanced supporting hardware to make a more powerful machine.

  - A custom-designed chipset allowed the Amiga to generate color video and relatively advanced graphics, making the Amiga a common choice for TV graphics design in the 1980s and early 90s, as well as making it a popular machine in the Demoscene.

Amiga A1000, circa 1985

The Amiga

- The Amiga Workbench (Commodore's OS for the machine) featured a GUI similar to the Macintosh OS, but in color.

- Graphics weren't quite as high-resolution initially, but that was the sacrifice that had to be made to get a color GUI in 1985 unless you wanted a computer that cost more than a new car.

- The Amiga OS also implemented preemptive multitasking, which the Macintosh wouldn't get for years.
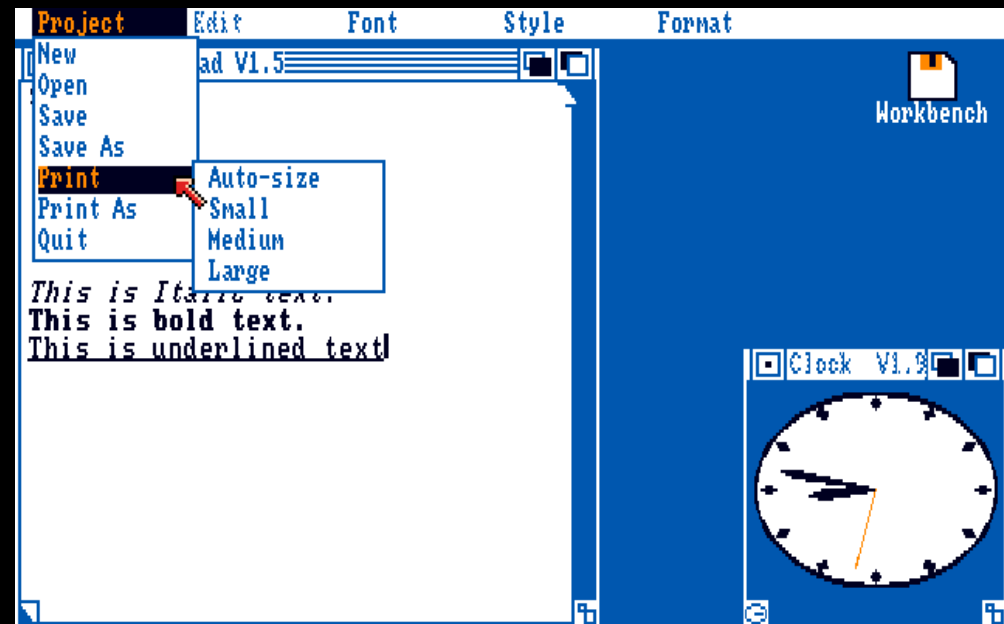
A screenshot of Amiga Workbench 1.0

The Amiga

- Amiga hardware and software gradually became more powerful.

  - Processors were upgraded from the Motorola 68000 to the faster 68020, and later the 68030 and 040.

  - The OS's graphics became more polished.

- However, the Amiga suffered due to heavy competition from Windows and Macintosh, as well as Commodore going bankrupt.

- But on the other hand, even now the Amiga still has a very dedicated fan base.
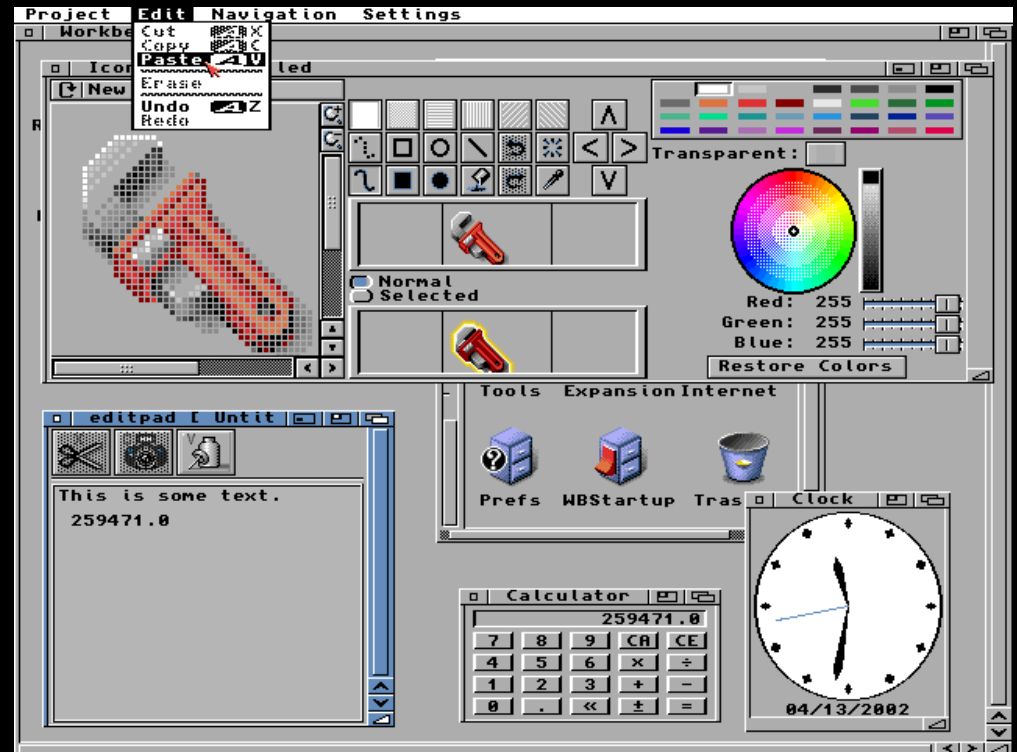
A screenshot of Amiga OS 3.5

GUIs on the IBM PC

- Windows was announced in 1983, but not released until 1985.

  - Windows 1 and 2 were mostly ignored or seen as a novelty..

  - By version 3.0 (1990), Windows had evolved to the point of actually being usable and useful. Microsoft's own business software such as Word and Excel, as well as some popular third-party Macintosh software was ported to it.

- Other GUIs were released for the PC, but none had much success.
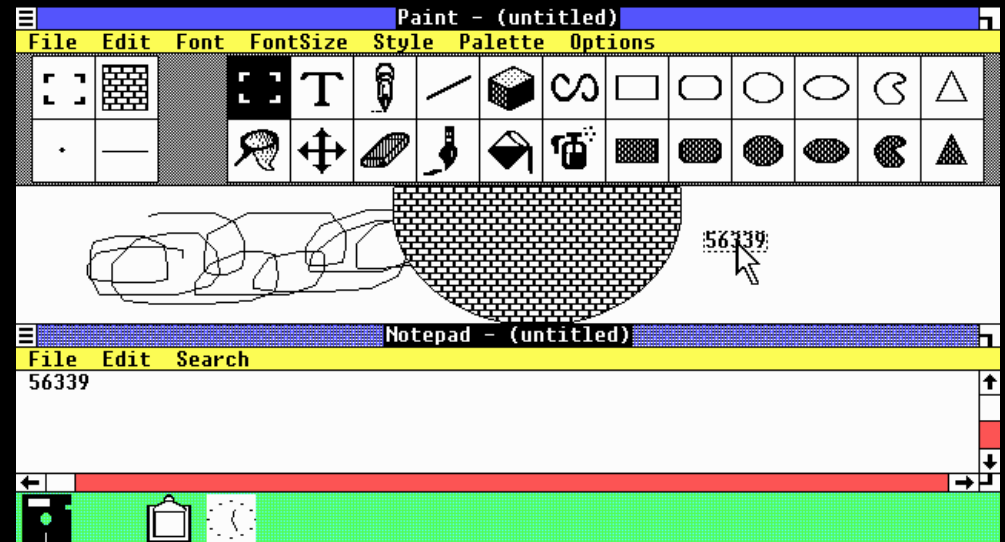
Windows 1.01, released in 1985.
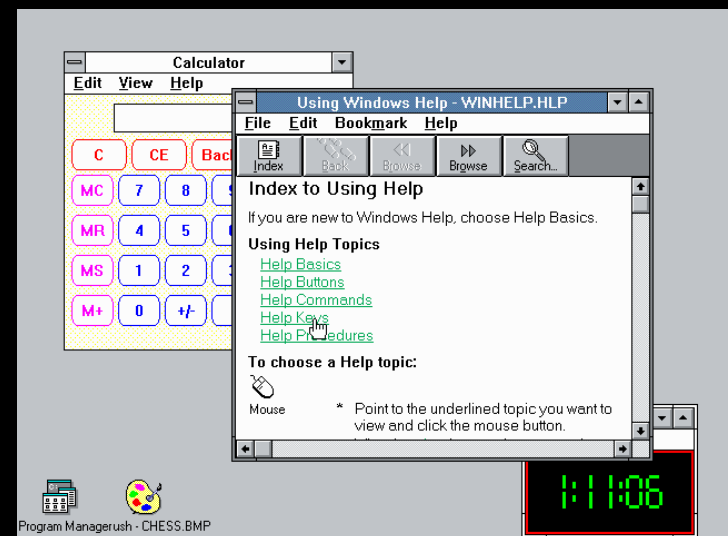
Windows 3.0, released in 1990.

Computers for Communications

- Most of you probably don't remember a time without the Internet.

- The foundations of the modern Internet started with ARPAnet (1969), however average people (and even most businesses) would not have had access to that.

- But users of home computers did still use their computers for communication, mostly via dial-up *modems*, which converted data into audible tones to send over ordinary phone lines.

Acoustic Coupler modem attached to a Western Electric model 500 rotary-dial telephone.

Bulletin Board Systems

- BBSes were a lot like modern day Internet forums, although the number of people who could be connected at once were limited by how many phone lines the BBS operator had, and how powerful their computer was.

- Many BBS features, such as public message boards, the ability to upload/download files, person-to-person chat, and network gaming are still common today.

Commodore 64 connected to a BBS via modem and acoustic coupler.

More about BBSes

- People would mostly call into local BBSes as long-distance calling was expensive.

- But what if you wanted to connect to people on the other side of the country (or maybe the world) without spending a fortune on long distance?

This was one option, but if you got caught with it (and the cops recognized what it was), bad things would happen.

On-Line Services

- Prior to the commercial Internet, companies such as CompuServe, America On-Line, and GEnie operated commercial On-Line Services.
  - Multiple dial-in numbers meant you were more likely to have a local number to call, but the services charged hourly rates that were often as expensive if not more than a long distance call.
  - In 1981, CompuServe access cost $5 an hour but only during 'non-peak' hours – 6 PM to 5 AM weekdays, and on weekends. During 'peak' hours, the hourly fee was a whopping $22.50.
  - For comparison, a gallon of gasoline cost on average $1.38.
  - These services were pretty similar to a BBS, just on a larger scale.
  - However, you'd be less likely to find certain common BBS fodder such as warez (pirated software) or advice about illicit activities.
  - However, commercial content such as news, stock quotes, and even early forms of online shopping were available.

Quantum Link, the predecessor to AOL, running on a Commodore 64.

Wide-Area Communication On the Cheap

- Calling a local BBS could be economical. It would be nice if we could exchange messages between BBSes such that most/all of the calls made were local.

- That's exactly what technologies like *FidoNet* did.

  - *FidoNet* was originally invented as a way for some friends who ran BBSes to quickly exchange messages between each other.

  - It grew into a fairly large inter-BBS communication network.

  - The basic idea: You would call into a local BBS, leave a message, file, etc. for somebody on a remote one, and that message would be stored.

  - At some point, usually in the middle of the night when calls were less expensive and phones were less likely to be in use, the BBS would call the remote system, send over any messages it had for users on that system, and receive any that users on that system had for it.

  - Later on, this was enhanced to allow multiple hops, reducing costly long distance calls as well as phonecalls in general.

Other Dial-In Services

- If you lived in a relatively tech-savvy area, other dial-in services might be accessible to you:
  - Local newspapers
  - Library card catalogs
- University students and other affiliates may have been able to dial into their university's computer system.
  - If you were really lucky, maybe your university even had an Internet connection that would let you access services like Usenet and IRC.

Want to learn more?

- Attend this weekend's Retro PETting Zoo
  - Saturday October 10 from 11:30 AM to 2:30 PM in GHC 6121
  - See some of the platforms we discussed here in action: Apple II, Commodore 64, Vectrex, Atari 2600, Amiga, Vectrex, and more.
- Attend Demosplash 2015
  - Friday November 6 – Saturday November 7 in GHC Rashid Auditorium.