

Introducing the X68000: Japan's 16-Bit Beast

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Japanese Home Computers Circa 1987

Unlike today where nearly all machines are boring x86 boxes, there were several wildly different options back then

- MSX
- NEC PC-88 and PC-98
- IBM PC Compatibles
- Fujitsu FM series
- Sharp X1
- Sega SC-3000
- Way too many to list here



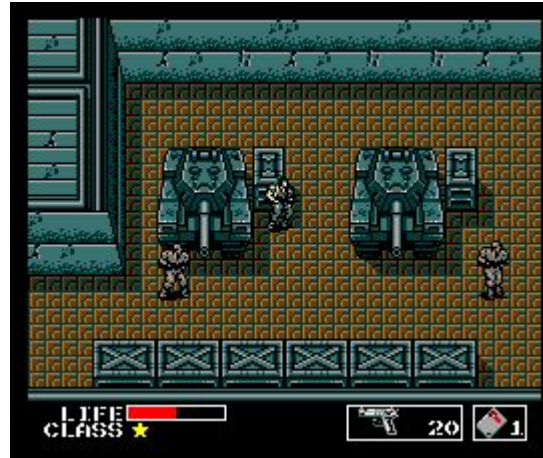
MSX: Dominant Japanese Computer Standard

- Created by Microsoft in 1983 in an attempt to standardize the PC market
- Manufacturers would implement their own machine within the MSX standard
- Z80 CPU at 3.58MHz
- also sold in Europe and the Middle East
- In 1987, current standard was MSX2/2+
 - \geq 64KB main RAM
 - \geq 128KB VRAM
 - AY-3-8910/YM2149 sound chip
 - 3 square waves and a noise generator
 - 512 color palette
 - 256 colors at 256x212 or 16 colors at 512x512



MSX2 Graphics

- Hardware only supports vertical scrolling
- To avoid this, games were often restricted to 1 screen



Nemesis 2: a Fairly Standard MSX2 game

https://www.youtube.com/watch?v=ZfZf8XpF7_o



Good Scrolling (REALLY hard to do)

<https://www.youtube.com/watch?v=gcZJ64PgtgA>



Sharp X1

- Not super popular, but also not unpopular by any means
- Technically inferior to MSX2
- Z80 CPU at 4MHz
- 8 colors
- 320x200 or 640x200 resolution
- AY-3-8910/YM2149 sound chip
- Optional YM2151 FM synth soundchip



X1 Twin

- Contains an X1 and a PC Engine/TurboGrafx-16
- Inspired X68000's design




Space Harrier on X1


<https://youtu.be/RUad5Vr0QsY?t=47s>



The Sharp X68000

- Sharp realized that there was space in the high end market not occupied by MSX
 - Aimed to design machine vastly more powerful than anything else on the market
 - Spent a lot of time creating tools and libraries to help game developers
 - Significantly more expensive than anything else on the market
 - ¥369,000 = \$6000 USD in today's money
 - No backwards compatibility with X1
 - Quite possibly the most powerful machine of the 16-bit era
 - Able to outperform machines released several years later (Genesis/SNES)
 - Huge homebrew following
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General Specs (original 1987 model)

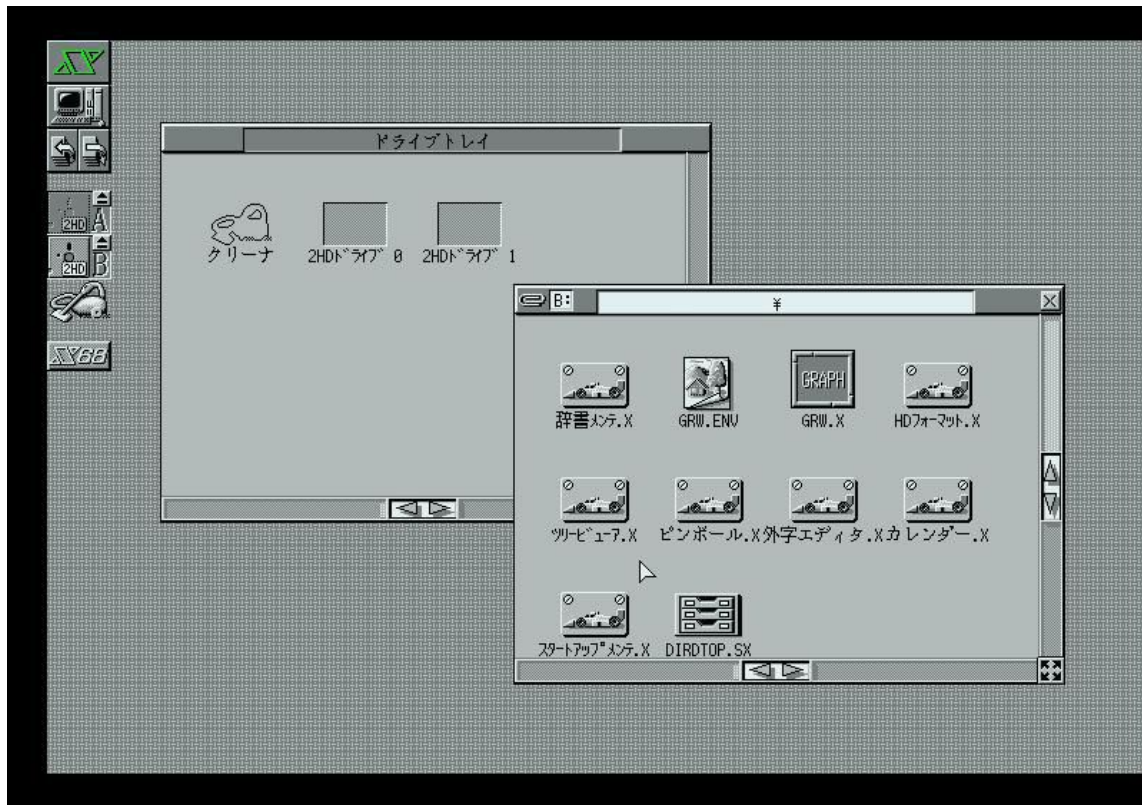
- Motorola 68000 at 10MHz
 - upgradable to a 68030 at 16MHz with an über-rare “xellent030” card
 - 1MB system RAM (upgradable to 12MB)
 - 1MB VRAM
 - 2 sound chips
 - YM2151FM Synth
 - Okidata MSM6258 ADPCM sampler
 - optional MIDI card
 - I/O: DB-25 serial, 2 expansion slots, 3D glasses controller, video genlock, external SASI
 - Dual 5.25” high density soft eject floppy drives (1.2MB per disk)
 - Dual tower case with expandable carry handle
 - Weight: enough to make shipping one here from Japan really expensive
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Cooler looking PC ever?



OSes

- Stock OS: Human68K
 - Boring MS DOS clone
- GUI: SX-Window
- 3rd party: KO-Window



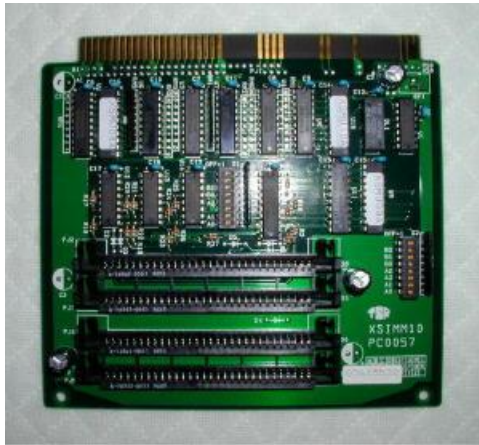
Peripherals: Because \$6000 Just Wasn't Enough

- tons of different upgrades available
- both first and third party options
- even some homebrew stuff
- most of these range from hard to find to unobtainium
 - some are rare enough that I couldn't actually find any pictures of them



CPU and Memory Upgrades

- Floating point units
- 68030/040/060 CPU accelerators
- XSIMM SIMM adaptor (the only way to max out an X68K's RAM)



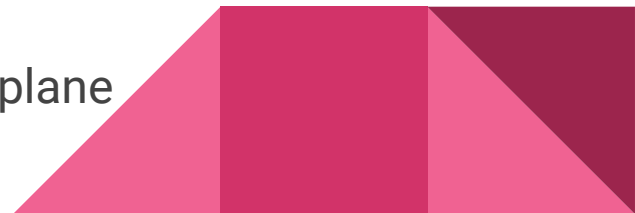
Multimedia Expansions

- 8 channel PCM sound card (“Mercury Unit”/PCM-8)
- MIDI board: connect your standard PC MIDI card to the X68K
 - popular choices include Roland MT-32 and SC-55
- TS-6BGA graphics accelerator
 - 16.7 million colors
 - CD quality audio
 - not a 3D accelerator



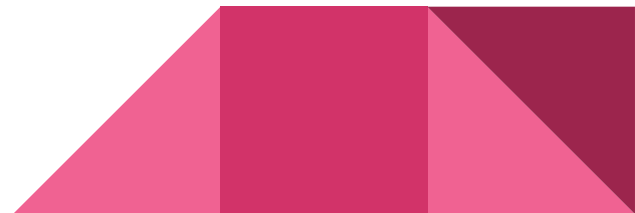
Video Hardware: An in-depth look

- 1MB VRAM split into two 512KB sections
 - TVRAM = high resolution 1024x1024 text display layer at 4bpp (16 colors)
 - each bit in a separate “plane”, hard to do color
 - GVRAM = 512x512 or 256x256 bitmap graphics display
 - several modes (selectable 256x256 or 512x512 resolution)
 - 4 16-color planes
 - 2 256-color planes
 - 1 65536-color plane
- 128 sprites, each 16x16, with 16 colors
- sprite controller can also generate tilemap background plane



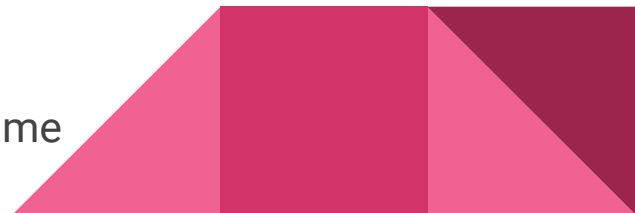
Sound Hardware

- YM2151
 - 8 channels of 4 operator FM Synthesis
 - same chip used in most arcade boards at the time
- OKI MSM6258
 - 1 channel of 4-bit ADPCM at one of several predefined sample rates
 - decent quality



Also Released in 1987: The Amiga 500

- Classic Amiga
 - \$699 on launch = \$1500 in today's dollars
 - 7.16MHz Motorola 68000
 - 512KB RAM shared between CPU and graphics
 - Several video modes
 - 1 layer with 32 colors on screen
 - 2 layers with 16 colors on screen
 - 736x483 at 4bpp or 368x483 at 6bpp (extra bit halves brightness)
 - 8 sprites (16 px wide, arbitrary height)
 - 4 channels of DMA-driven PCM audio
 - Blitter
 - "Copper" state machine to control video hardware mid-frame



Enough Numbers, Let's Look at Some Games!



Nemesis 2 on X68000

<https://youtu.be/S3C6UYVcHjg?t=4m59s>



Space Harrier on X68000

<https://www.youtube.com/watch?v=nhymlDtiZmQ>



Yeah, those look nice, but what can it REALLY do?

- “超連射68K” (Cho Ren Sha = Ultra Fire) (1995)
- Produced by 2 people
 - Music by Ruzarin “Loser” Kashiwagi
 - EVERYTHING ELSE by Koichi “Famibe no Yosshin” Yoshida
- 512 sprites on screen at once thanks to crazy sprite multiplexing hackery
- FM synth soundtrack and sampled sound effects
- Coded almost entirely in C (Assembly is the norm)
- X68K and Windows versions available for free from the author’s website



Backup Video

https://www.youtube.com/watch?v=y mf_e0Y4iZA



I'm not impressed unless it can do 3D

- "Geograph Seal" (1994)
- Developed by Exact (Excellent Applications Create Team)
- Yes, that's the real title, and yes, that's the official acronym
- Realtime filled 3D polygons without any hardware acceleration
- Precursor to "Jumping Flash" on PS1, also developed by Exact



Video Clip

<https://www.youtube.com/watch?v=pNYLREOG52k>



So, you've just made the most powerful PC on the market. Now what?

- In the years following 1987, Sharp made minimal improvements to the X68000
- All models except original were available in normal and "HD" (hard drive) versions
 - 1988:
 - ACE: board layout difference, 20MB HD
 - 1989:
 - EXPERT: 2MB RAM now standard, 40MB HD
 - this is the model CMUCC owns
 - original cost: ¥466,000 = ~\$7500 in today's money
 - PRO: basically an x68000 with more addon slots in a standard PC case
 - only 1MB RAM

Surely they improved things, right???

- 1990:

- EXPERT II: board layout revision, 40MB HD
- PRO II: just a PRO with a board revision, still only 1MB RAM stock
- SUPER: SASI replaced with SCSI, 80MB HD

1991:

- XVI: CPU upgraded to 16MHz (10MHz mode available for compatibility)

1992:

- Compact XVI: smaller form factor with 3.5" floppies
 - no HD variant available



Surely they didn't expect a modest CPU boost to keep a 5 year old machine current...

1993:

- X68030: 68030 CPU at 25MHz, 4MB RAM
 - mediocre backwards compatibility with games
- X68030 Compact: like the XVI compact but with the X68030's specs

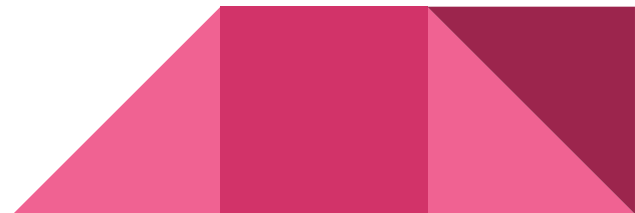


The Whole Family



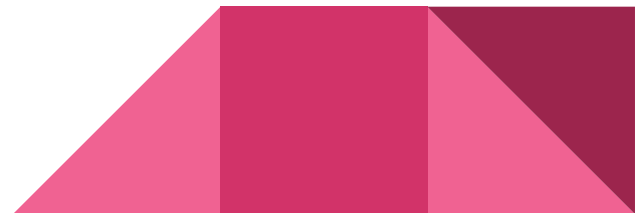
The downfall of the X68000

- Sharp went 6 years without upgrading the video or audio hardware
- by 1993, you could buy a decent PC with nice graphics and sound
- Moral of the story: just because your computer was better than your competitors' products 6 years ago doesn't mean it's still better now
- Sharp quietly discontinued the X68000 line
 - planned PowerPC model canceled

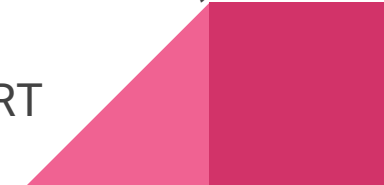


It's 2016: Let's Write Code for This Thing!

- There's a ton of documentation for this machine, but it's all in Japanese
- a programmer going under the pseudonym "lydux" released a full GCC toolchain, newlib implementation, and dos call wrappers for the X68K, documented in English
 - also from lydux: a version of GDB that can debug your X68K over serial
- Tons of music composition tools, sound drivers, graphics editors, and other stuff have all been released for free on the internet
- If you're interested in developing for the X68K, talk to us :)



Wow, I want one!

- The X68000 has the ability to break your wallet very quickly
 - most games need 2MB of RAM, so you want a later model
 - rare and expensive
 - heavy = expensive shipping from Japan
 - everything is proprietary, so prepare to put up serious cash for accessories
 - even the keyboard and mouse are expensive
 - Horrible power supply caps = low chance of it working out of the box
 - Some sellers will replace the caps, but these usually go for more money
 - 30 year old mechanical hard drives are unreliable
 - SCSI2SD is an excellent replacement (even works on SASI models)
 - EVERYTHING IS IN JAPANESE
 - Doesn't play nicely with LCDs, so you probably want a nice CRT
 - the "lcdfix" driver isn't compatible with many games
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Any Questions?

