12 Things You Didn’t Know You Could Do With MAME

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What is MAME?

- Never heard of it? See http://mamedev.org
- MAME = **M**ultiple **A**rcade **M**achine **E**mulator
- Emulates most arcade hardware in software
  - Simulates the CPUs, sound chips, and video h/w
  - Uses original ROMs and discs
  - Developer-focused (not super user friendly)
- Really two projects in one:
  - Reverse engineering arcade hardware
  - Designing a software architecture for emulation

What Can You Do With MAME?

- Most people tend to think of MAME as a means of running games
- Developers think in terms of using it as a tool to reverse engineer games

BUT…

- There's more to MAME thank you might think
- Plus, some people are really creative!

Look at the Source Code

(Yes, even if you're not a programmer!)

http://mamedev.org/source/mame/drivers

Key things to look for:

- Comments (in bright red at the link above)
- ADDRESS_MAP (describe memory layouts)
- ROM_LOAD (describes ROMs needed)

Look at the Source Code

```
/***************************************************************************

    Galaxian-derived hardware

    Galaxian is the root hardware for many, many systems developed in the
    1980-1982 timeframe. The basic design, which originated with Namco(?),
    was replicated, tweaked, bootlegged, and used numerous times.

    The basic hardware design comprises three sections on a single PCB:
    a CPU section, a sound section, and a video section.

    The CPU section is based around a Z80 (though there are modified
    designed that changed this to an S2650). The base galaxian hardware
    is designed to allow access to up to 16k of program ROM and 2k of
    working RAM.

    The sound section consists of three parts. The first part is
    a programmable 8-bit down counter that clocks a 4-bit counter which
    generates a primitive waveform whose shape is hardcoded but can be
    controlled by a pair of variable resistors. The second part is
    a set of three 555 timers which can be individually enabled and
    combined to produce square waves at fixed separated pitches. A
    fourth 555 timer is configured via a 4-bit frequency parameter to
    control the overall pitch of the other three. Finally, two single
    bit-triggered noise circuits are available. A 17-bit noise LFSR
    (which also generates stars for the video circuit) feeds into both
    circuits. A "HIT" line enables a simple on/off control of one
    filtered output, while a "FIRE" line triggers a fixed short duration
    pulse (controlled by another 555 timer) of modulated noise.
```

Look at the Source Code

```
1169  /* map derived from schematics */
1170  static ADDRESS_MAP_START( galaxian_map, ADDRESS_SPACE_PROGRAM, 8 )
1171      ADDRESS_MAP_UNMAP_HIGH
1172      AM_RANGE(0x0000, 0x3fff) AM_ROM
1173      AM_RANGE(0x4000, 0x43ff) AM_MIRROR(0x0400) AM_RAM
1174      AM_RANGE(0x5000, 0x53ff) AM_MIRROR(0x0400) AM_RAM_WRITE(galaxian_videoram_w) A
1175      AM_RANGE(0x5800, 0x58ff) AM_MIRROR(0x0700) AM_RAM_WRITE(galaxian_objram_w) AM_
1176      AM_RANGE(0x6000, 0x6000) AM_MIRROR(0x07ff) AM_READ_PORT("IN0")
1177      AM_RANGE(0x6000, 0x6001) AM_MIRROR(0x07f8) AM_WRITE(start_lamp_w)
1178      AM_RANGE(0x6002, 0x6002) AM_MIRROR(0x07f8) AM_WRITE(coin_lock_w)
1179      AM_RANGE(0x6003, 0x6003) AM_MIRROR(0x07f8) AM_WRITE(coin_count_0_w)
1180      AM_RANGE(0x6004, 0x6007) AM_MIRROR(0x07f8) AM_WRITE(galaxian_lfo_freq_w)
1181      AM_RANGE(0x6800, 0x6800) AM_MIRROR(0x07ff) AM_READ_PORT("IN1")
1182      AM_RANGE(0x6800, 0x6807) AM_MIRROR(0x07f8) AM_WRITE(galaxian_sound_w)
1183      AM_RANGE(0x7000, 0x7000) AM_MIRROR(0x07ff) AM_READ_PORT("IN2")
1184      AM_RANGE(0x7001, 0x7001) AM_MIRROR(0x07f8) AM_WRITE(irq_enable_w)
1185      AM_RANGE(0x7004, 0x7004) AM_MIRROR(0x07f8) AM_WRITE(galaxian_stars_enable_w)
1186      AM_RANGE(0x7006, 0x7006) AM_MIRROR(0x07f8) AM_WRITE(galaxian_flip_screen_x_w)
1187      AM_RANGE(0x7007, 0x7007) AM_MIRROR(0x07f8) AM_WRITE(galaxian_flip_screen_y_w)
1188      AM_RANGE(0x7800, 0x7800) AM_MIRROR(0x07ff) AM_WRITE(galaxian_pitch_w)
1189      AM_RANGE(0x7800, 0x7800) AM_MIRROR(0x07ff) AM_READ(watchdog_reset_r)
1190  ADDRESS_MAP_END
```

Look at the Source Code

```
2325  ROM_START( galaxian )
2326      ROM_REGION( 0x4000, "maincpu", 0 )
2327      ROM_LOAD( "galmidw.u",    0x0000, 0x0800, CRC(745e2d61) SHA1(e6
2328      ROM_LOAD( "galmidw.v",    0x0800, 0x0800, CRC(9c999a40) SHA1(02
2329      ROM_LOAD( "galmidw.w",    0x1000, 0x0800, CRC(b5894925) SHA1(00
2330      ROM_LOAD( "galmidw.y",    0x1800, 0x0800, CRC(6b3ca10b) SHA1(18
2331      ROM_LOAD( "7l",           0x2000, 0x0800, CRC(1b933207) SHA1(8b
2332
2333      ROM_REGION( 0x1000, "gfx1", ROMREGION_DISPOSE )
2334      ROM_LOAD( "1h.bin",       0x0000, 0x0800, CRC(39fb43a4) SHA1(47
2335      ROM_LOAD( "1k.bin",       0x0800, 0x0800, CRC(7e3f56a2) SHA1(a9
2336
2337      ROM_REGION( 0x0020, "proms", 0 )
2338      ROM_LOAD( "6l.bpr",       0x0000, 0x0020, CRC(c3ac9467) SHA1(f3
2339  ROM_END
```

Identify Your PCBs

(Yes, without dumping the whole thing!)

MAME's –romident option is your friend:

- Simply dump 1 or more ROMs
- More than 1? Place them in a directory or ZIP file
- From the command line run:

```
mame –romident <file|directory|zipfile>
```

- This will compare your ROMs against every ROM known to MAME (and that's a lot these days)

Identify Your PCBs

```
>mame -romident epr6844.ic123
epr6844.ic123       = epr-6844.ic123        Enduro Racer (YM2151, FD1089B 317-0013A)
                    = epr-6844.ic123        Enduro Racer (YM2203, FD1089B 317-0013A)
                    = epr-6844.ic123        Enduro Racer (bootleg set 2)
                    = epr-6844.ic123        Enduro Racer (bootleg set 1)
                    = epr-6844.ic123        Hang-On (Rev A)
                    = epr-6844.ic123        Hang-On
                    = epr-6844.ic123        Space Harrier (Rev A, 8751 315-5163A)
                    = epr-6844.ic123        Space Harrier (8751 315-5163)
                    = (BAD) 6844.rom              Super Hang-On (Hang-On upgrade, bootleg)

>mame -romident epr7629.ic84
epr7629.ic84        = epr-7629.ic84         Enduro Racer (YM2203, FD1089B 317-0013A)

>mame -romident ameridart1.zip
rom.u23             = u23.bin               AmeriDarts (set 2)
rom.u57             = u57.bin               AmeriDarts (set 2)
rom.u58             = u58.bin               AmeriDarts (set 2)
rom.u1              = u1.bin                AmeriDarts (set 2)

>_
```

Identify Your PCBs

romcmp (included with MAME) also helpful:

```
romcmp <directory|zipfile> [<dir2|zipfile2>]
```

```
>romcmp bking3
readme.txt                                      ignored (not a ROM)
23 files
3rd-a24-01.e7                                             1111xxxxxxx = 0xFF
3rd-a24-01.e8                                             1111xxxxxxx = 0xFF
3rd-dm-04.c2                                    FIXED BITS (0000000x)
3rd-a24-01.e7           3rd-a24-01.e8             IDENTICAL

>romcmp crgolfhi
crgolfhi.txt                                    ignored (not a ROM)
23 files
prom.s1                                         1ST AND 2ND HALF IDENTICAL
Copy of sub.r1a           sub.r1                   IDENTICAL

>romcmp empcity
18 files
2t.bin                                          BADADDR         x-xxxxxxxxxxxxx

>_
```

Backup & Repair Your Hard Disks

(Yes, you can recover your arcade hard disks!)

MAME's CHD format designed for hard disks

- chdman utility is included with MAME
- Easy to find USB-to-IDE adapters
- To create a hard disk image in Windows (CHD):

```
chdman –createhd \\.\physicaldriveX filename.chd
```

- To put a CHD back onto a hard disk:

```
chdman –extract filename.chd \\.\physicaldriveX
```

- Move to solid state (CF) via an IDE adapter

Backup & Repair Your Hard Disks

```
>diskpart

Microsoft DiskPart version 6.1.7266
Copyright (C) 1999-2008 Microsoft Corporation.
On computer: AARON-LAPTOP

DISKPART> list disk

  Disk ###  Status         Size     Free     Dyn  Gpt
  --------  -------------  -------  -------  ---  ---
  Disk 0    Online          111 GB      0 B
  Disk 1    Online          976 MB      0 B

DISKPART> exit

Leaving DiskPart...

>chdman -createhd \\.\physicaldrive1 test.chd
chdman - MAME Compressed Hunks of Data (CHD) manager 0.132u3 (Jul  9 2009)
Input file:   \\.\physicaldrive1
Output file:  test.chd
Input offset: 511
Cylinders:    124
Heads:        255
Sectors:      63
Bytes/sector: 512
Sectors/hunk: 8
Logical size: 1,019,934,720
Compression complete ... final ratio = 97%

>chdman -extract test.chd \\.\physicaldrive1
```

Cheat!

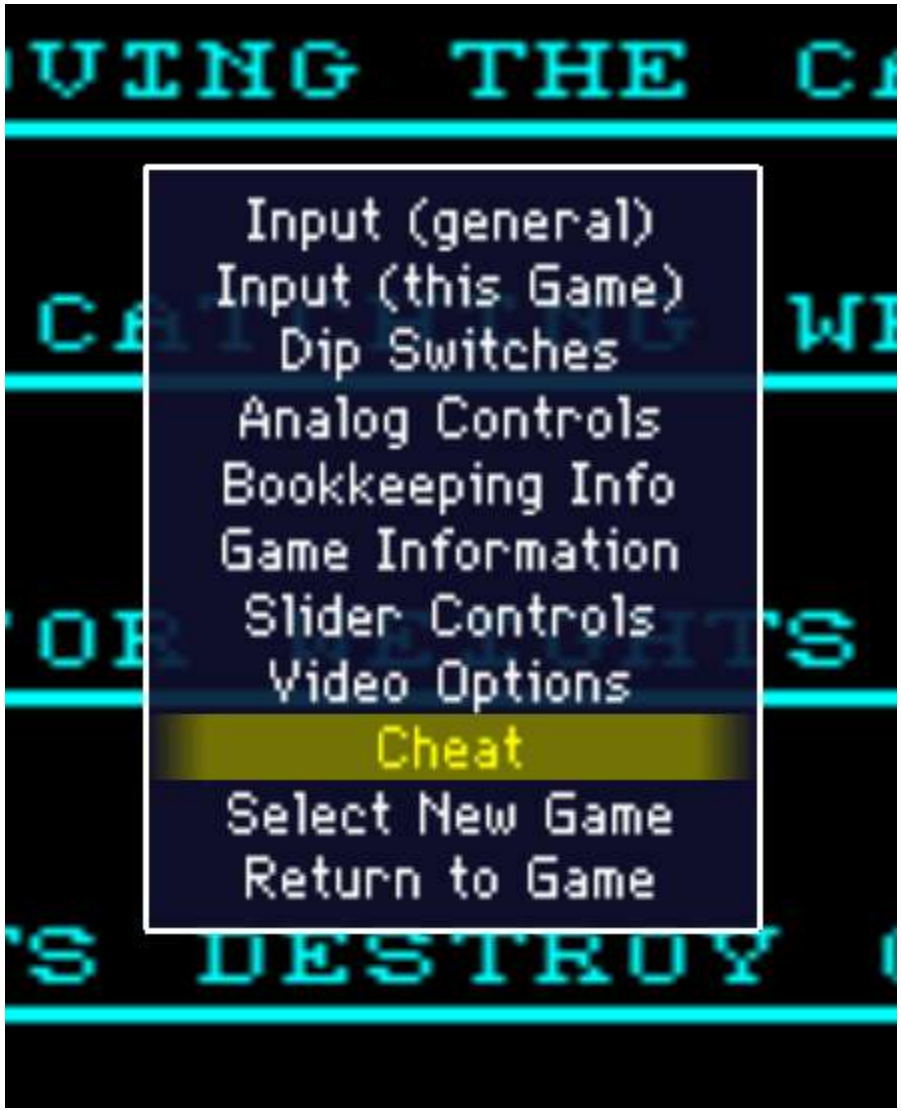
(Yes, you can beat the game with brute force!)

http://cheat.retrogames.com/

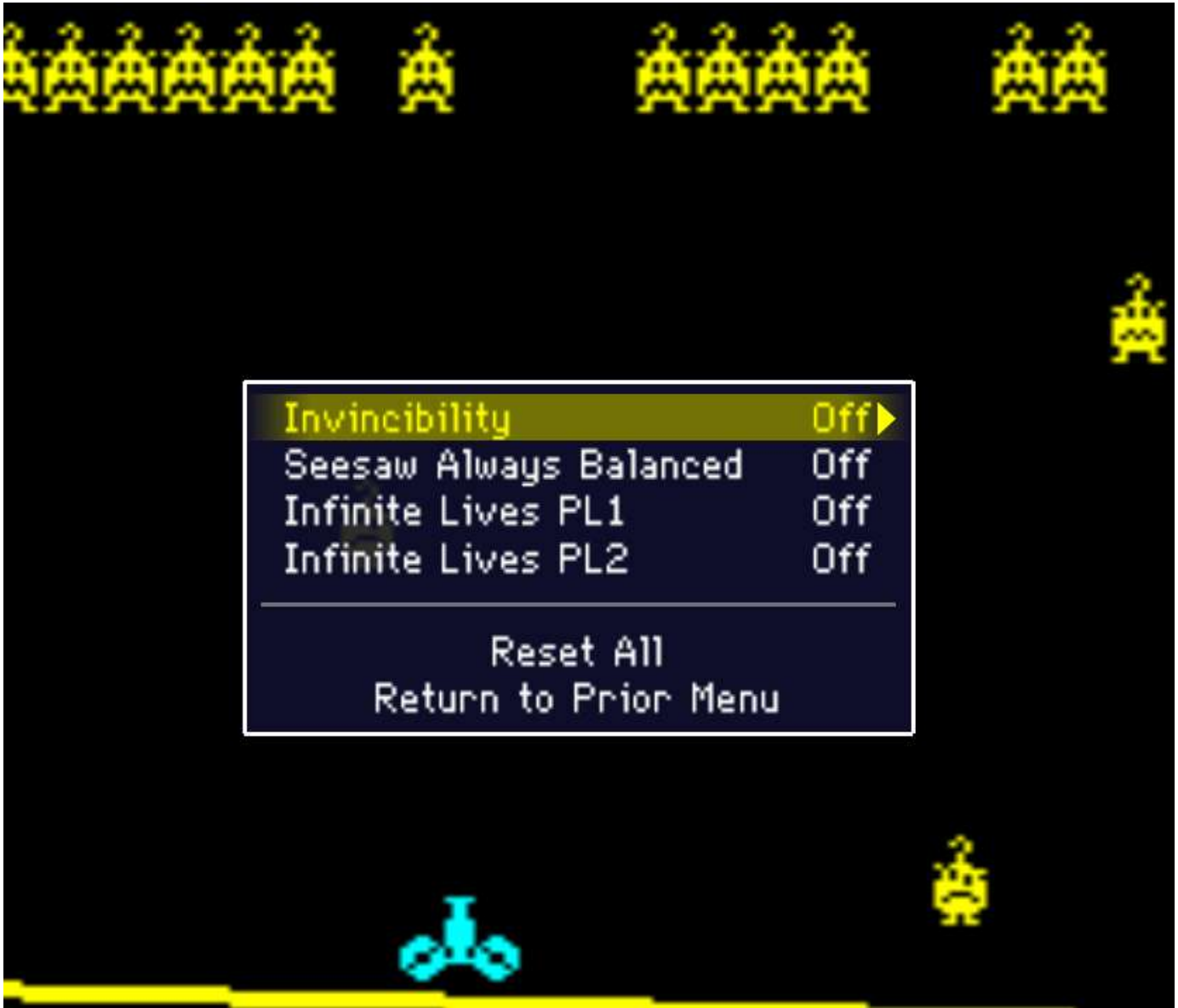
The MAME Cheat Engine:

- Need to be explicitly enabled (via –cheat option)
- Was recently rewritten and modernized
  - Now supports cheats in XML format
  - Now better integrated with the debugger
- Has a large group of people finding new cheats

Cheat


Input (general)
Input (this Game)
Dip Switches
Analog Controls
Bookkeeping Info
Game Information
Slider Controls
Video Options
Cheat
Select New Game
Return to Game

Cheat


Invincibility Off
Seesaw Always Balanced Off
Infinite Lives PL1 Off
Infinite Lives PL2 Off
Reset All
Return to Prior Menu

Fix Bugs in Old Games

(Yes, because they're just not hard enough!)

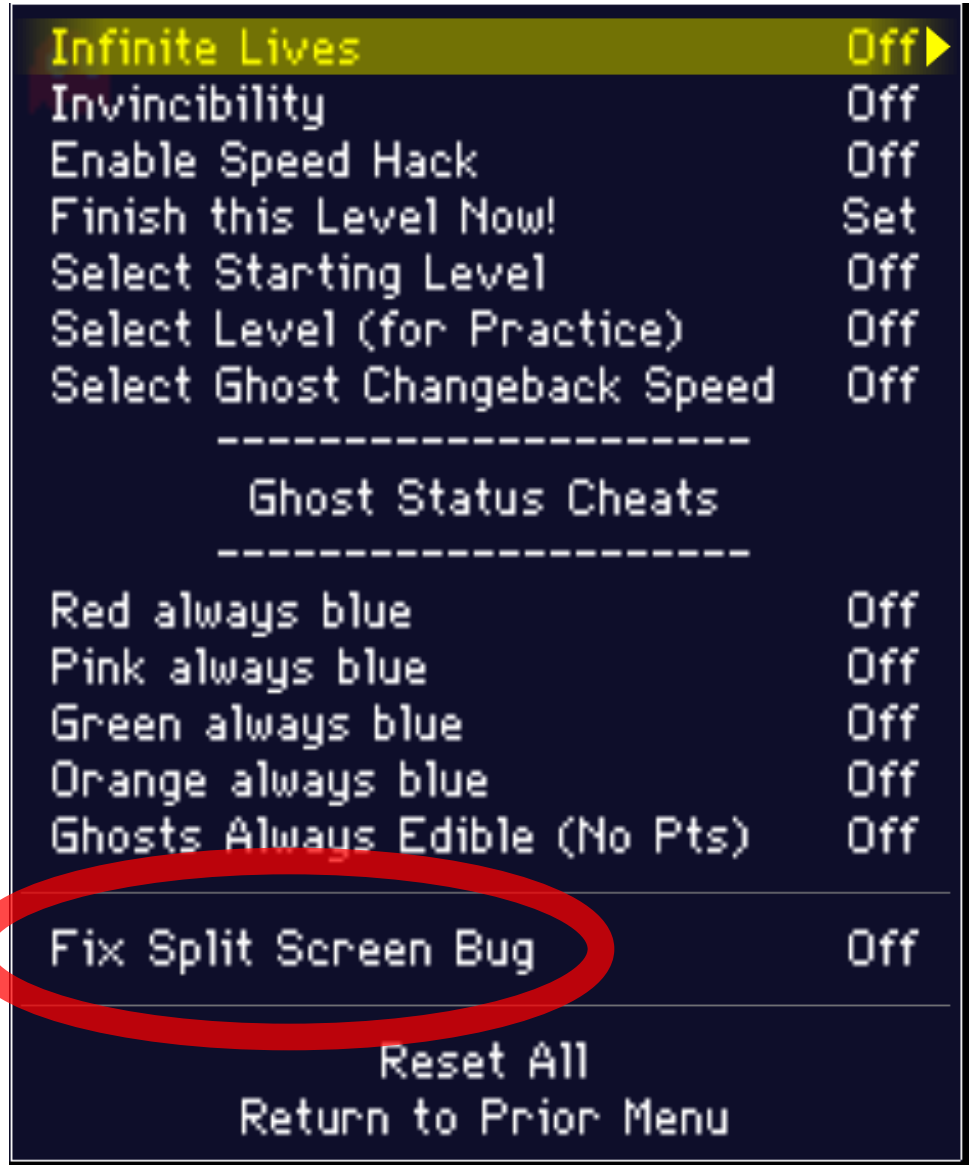
http://donhodges.com/

Using only MAME's built-in debugger, reverse engineering, and logic, Don has fixed:

- Kill screens in Donkey Kong, Dig-Dug, and more
- Pac-Man split screen (level 256)
- Galaga playable demo

Even created cheats for some of them….

Fix Bugs in Old Games



Record and Play Back Your Game

(Yes, you can show off your moves!)
http://replay.marpirc.net

MAME supports built in input recording

- To record from the command line:

```
mame <game> –record <filename>.inp
```

- And to play it back:

```
mame –playback <filename>.inp
```

Key to remember:

- Emulation must not have changed timings or input
- Format changed a little while back (built-in compression)
- Not sufficient for Twin Galaxies

Record and Play Back Your Game

(But wait, there's more!)

MAME also supports recording in several formats

- To record an AVI/MNG/WAV:

```
mame <game> –aviwrite <filename>.avi
mame <game> -mngwrite <filename>.mng
mame <game> -wavwrite <filename>.wav
```

- To take an in-game snapshot press F12 (configurable)

You can control the size of snapshots and movies via the –snapsize and –snapview options.

- By default, it is the native screen size

Record and Play Back Your Game

(But wait, there's more!)

Keys to remember about making movies:

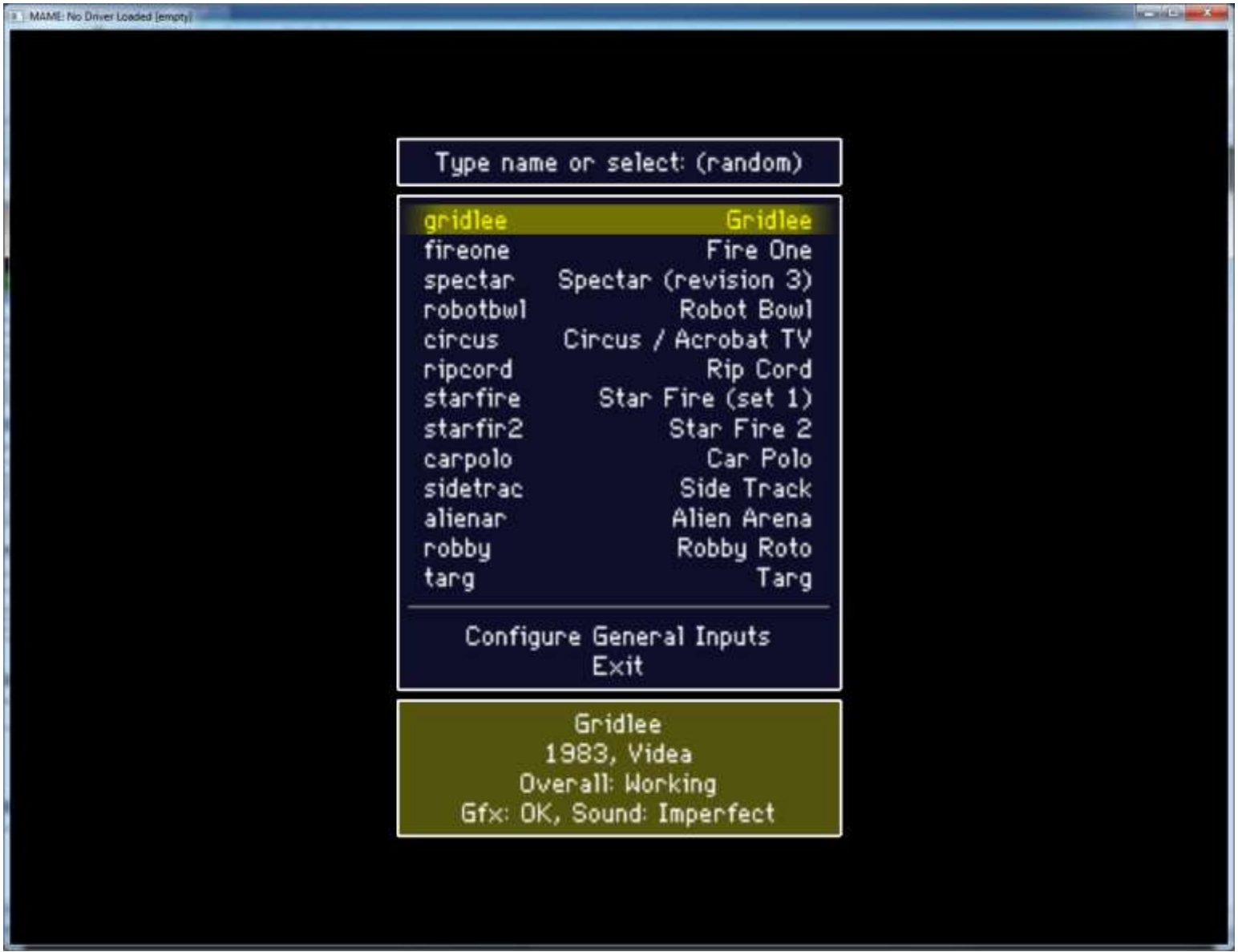
- AVIs are uncompressed, huge, and slow to create
  - You will need to post-process them for compression
  - Tip: record to an INP, then make AVI from playback
- MNGs are compressed, a bit less huge, but no sound
- If your game changes resolutions, specify a snapsize

Ditch Your Front-End

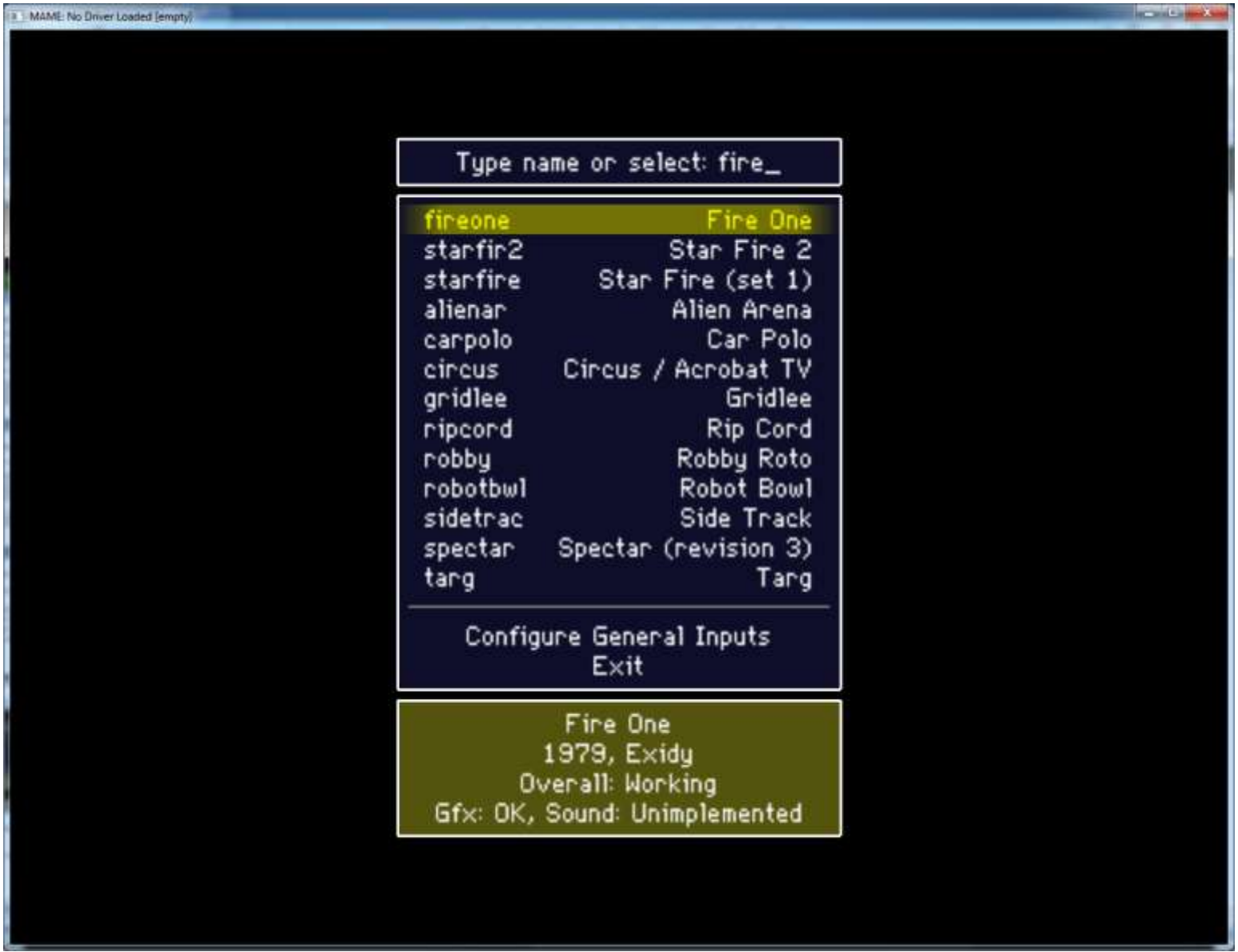
(Yes, slightly more user-friendly!)

- In the old days, MAME would just error if you double-clicked it or specified no game to run
- Today, you actually get a mini front-end
  - Picks random list by default
  - As you type, recomputes list of best matches
  - When you quit, you can select a new game

Ditch Your Front-End



Ditch Your Front-End



Create a Database

(Yes, MAME is a database of arcade history!)
http://maws.mameworld.info/maws

Internally MAME has standard information about:

- ROMs and other media
- CPUs, sound chips, and clock speeds
- Controls, inputs, and DIP switches
- Video displays
- Game manufacturers and years

All accessible via the –listxml option

Drive Real Arcade Hardware

(Yes, you can make it real!)
http://www.byoac.com

MAME can be made to work in a real cabinet:

- Not an official goal of the project, however!
- Can wire up real arcade controls
- Can connect real arcade monitors
- Can put it all in a real wood box
- Several companies produce the necessary adapters
- But don’t abuse this – remember this is just for fun!

Incorporate Game Art

(Yes, the artwork was part of the allure!)
http://mrdo.mameworld.info/mame_artwork.html

MAME supports bezels, overlays, and backdrops

- All are optional, and individually selectable
- High-quality scaling to your screen resolution
- Community-wide effort to get nice, high resolution scans (see above link)
- All artwork is stored losslessly
- No cabinet or marquee art yet (3D models anyone?)

Incorporate Game Art

Incorporate Game Art

Turn Your LCD into a CRT

(Yes, you can sort of simulate old school!)

MAME's artwork system supports overlays

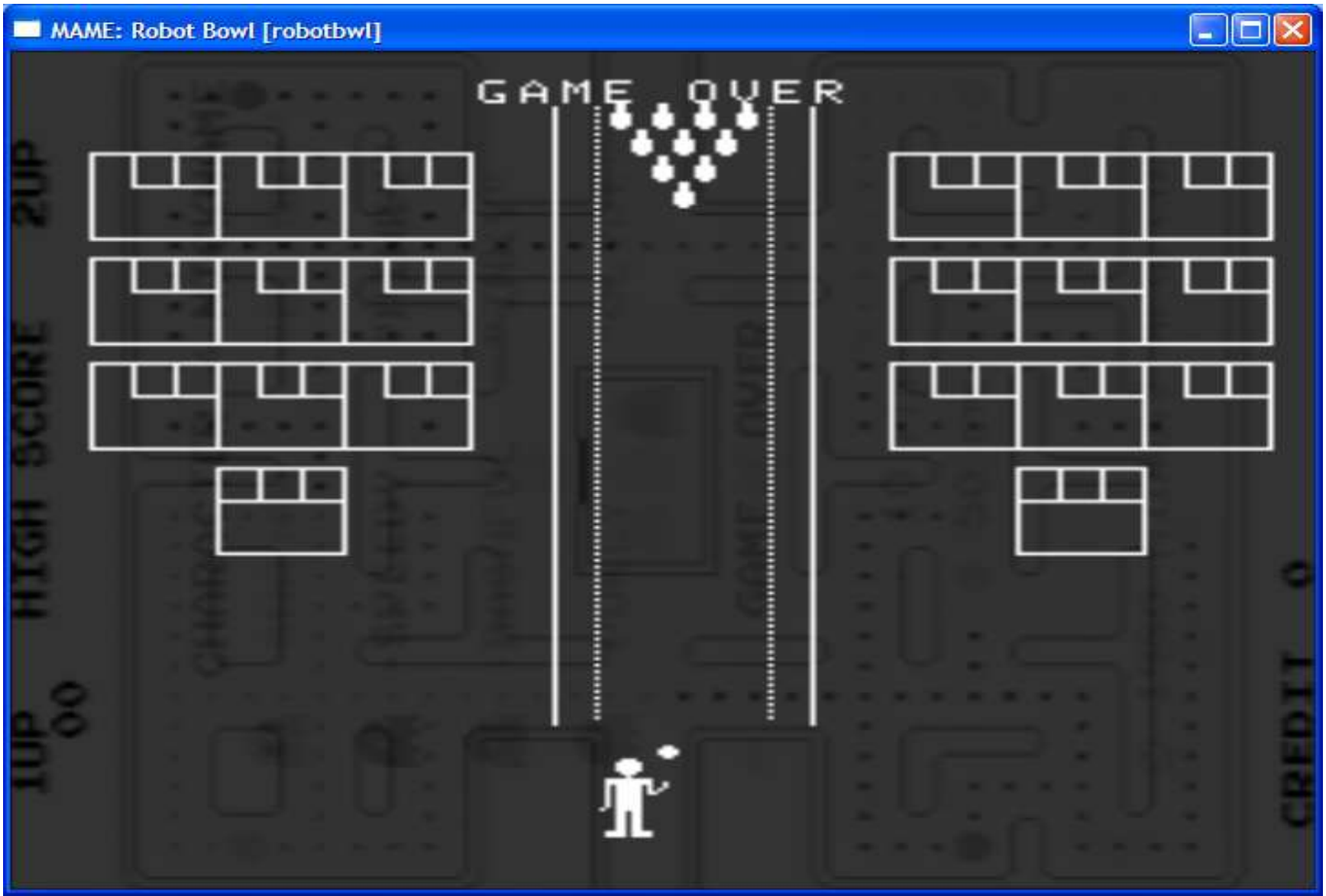
- Small repeated patterns overlaid on screen areas
- Relies on high-res LCD versus low-res game
- Lowers the overall brightness a bit
- Several good ones included with MAME

Try this at home:

```
mame <game> –effect aperture1x2rb   (for low res displays)
mame <game> -effect aperture2x4rb   (for high res displays)
```

Turn Your LCD into a CRT

Turn Your LCD into a CRT



Turn Your LCD into a CRT

Play Free Games

(Yes, I know we said that wasn't the goal…)

http://mamedev.org/roms

Some companies have done the right thing!

- Many early Exidy ROMs available
- Several developers who own the rights have given us permission to redistribute their games
- Gaelco released World Rally for free
  - http://www.gaelco.com/english/pages/hablando/frhablan.htm

The 12 Things You Now Know

1. Look at the source
2. Identify your PCBs
3. Repair your hard disks
4. Cheat!
5. Fix original bugs
6. Record & play back
7. Ditch your front-end
8. Create a database
9. Drive real hardware
10. Incorporate game art
11. Simulate an old CRT
12. Play free games

Some Additional Things You Can Do

- Run MAME on almost any platform (SDLMAME)
- Fast-forward through the boring parts (Ins key)
- Use nicer fonts in the MAME UI
  - http://mrdo.mameworld.info/mame_artwork_supp.html
- Choose your own crosshairs for gun games
  - Same site
- Save/restore in some games (automatically)

Q&A