# **Morrow computers**

(From Herb Johnson’s www.retrotechnology.com)

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**Morrow and Morrow history**

1. **George Morrow**

George Morrow produced a number of S-100 products throughout the S-100 era, first under the "Morrow's Micro-Stuff" brand name, then "Thinker Toys" or "ThinkerToys", and later as Morrow Designs. One early product was this very pretty OCTAL-based front panel, "The Keyed-up 8080". (Board loaned courtesy of James Prior.) His company Morrow Designs filed for bankruptcy in 1986; George Morrow passed away in early May 2003, age 69. An informative obituary was in the New York Times of May 8 2003, a Web search may find a copy as it was widely printed and distributed.

Regarding the NYT obituary: it is informative but incomplete regarding the role of the S-100 bus and George Morrow's S-100 products. It says Morrow produced S-100 "expansion products" cards for "personal computers...sold as kits"; followed by "a portable computer competing with the Osborne 1" and later a "industry standard" (i.e. IBM-PC compatible) portable called the Pivot. Morrow's efforts to standardize the S-100 bus were mentioned but described the S-100 as an "expansion card" bus.

In fact the S-100 computers of the mid-1970's were offered assembled or unassembled, the latter to keep costs down and delivery rapid - critical concerns for the small companies in the late 1970's who produced those earliest computers. The S-100 architecture was completely open; boards were not just expansions but DEFINED the entire computer. Morrow, like other early S-100 manufacturers, started with board products; then produced S-100 systems; and in the 1980's assembled single-board systems such as the Pivot. But in the late 1970's S-100 systems were a large, arguably dominant, segment of the personal and business microcomputing market; they were a strong presence through the mid-1980's. Many features of the 1981 IBM PC can be attributed to the need to compete with S-100 systems and to provide comparable support - including third-party card expansion, open hardware and full software documentation. Consequently George Morrow's products and quality of support; and his work with others to standardize and advance the S-100 bus into the [IEEE-696 standard](http://www.retrotechnology.com/herbs_stuff/s100bus.html), were critical for the future of S-100 systems. That set the course followed by the later "PC compatible" industry.

Unfortunately by the time the IEEE ratified the standard in 1983, much of the small computing world was moving to single-board computers and to the IBM PC architecture which was introduced in 1981. Morrow's company was no exception and it produced a series of single-board computers until the company closed its doors in 1986.

In April 2006 I stumbled over [this PC-history Web site](http://www.pc-history.org/cpm.htm) which has a chapter about George Morrow, a first-person account by Stan Veit written around year 2000. Since Veit's death the site has been maintained and preserved.

My only subsequent information about George Morrow's archives are the following. Sometime just after his passing, I learned that one of his sons has or had his collection of boards and documents. Sometime in early September of 2003, some S-100 boards were sold at a popular Web auction as "a piece of Personal Computing history from George Morrow's (1934-2003) personal collection." Checking that popular site again in 2006, I saw additional Morrow boards sold alledgedly from Morrow's collection. Checking again that site in 2007, I saw this note with an auction item which offers a summary history and confirms the status of at least part of Morrow's estate and archives.

*Here is another great item from George Morrow's personal collection!   
  
If you are viewing this auction, you are aware of the role that George Morrow (Morrow’s MicroStuff, Thinker Toys, Morrow Designs) played in the personal computing industry and the significance of some of these items. Between him and Bill Godbout of CompuPro, a friend, collaborator, customer, and sometimes business partner, they turned out a number of innovative products during the early years. Although their businesses were initially based on peripherals for the existing systems of the time like the IMSAI (IMS Associates) 8080 and the MITS (Micro Instrumentation Telemetry Systems) Altair 8800 machine, they did help develop the industry standards for the S-100 bus (IEEE-696), and eventually had enough products on the platform to build turn key systems. My father stayed in business as the world embraced the single board computers running CP/M (Morrow MicroDecision), and lasted through the early days of the IBM compatible machines (Morrow Pivot).*

1. **Morrow history**

In Nov 2006 I corresponded with Marc Kupper, a former Morrow staffer. With his permission, here's what he said about his Morrow experiences. My slight edits to his words are in []'. - Herb

> I worked at Morrow Designs in the late 1970s and early 1980s in

> R&D with my time split between debugging hardware (CPU boards,

> disk controllers, RAM boards, backplanes, the Decision-1 which

> was for CP/M and then Micronix and finally the MicroDecision),

> plus doing all of the device drivers and system testing software

> for those devices. We had a couple other guys that concentrated

> on Micronix plus two writers for the documentation.

> Morrow's Microstuff started in Berkeley but by the time I started

> they had moved to Central Ave. in Richmond. I forget if it was

> called Thinker Toys or had just been renamed to Morrow Designs.

> There was a lot of Thinker Toys related stuff around. In those

> days it was more of a family business with George's wife (Jean)

> running the admin/finance end of things, their boys getting

> underfoot, etc. I suspect we had about around 25 people with most

> of those in the factory.

>

> I believe we moved to San Leandro (McCormick street and about

> two miles from Godbout Electronics / CompuPro) in either late

> 1981 or early 1982 and it suddenly became a huge company (it

> seemed like over 100 people) with the factory changing from

> essentially a horse-n-buggy affair to a quite modern looking

> establishment with rows of part installation stations connected

> by conveyer belt roller things. I left in 1982.

> One name... to bring up is Howard Fullmer

> (of Parasitic Engineering) who had worked with George earlier.

> [He] came to work for Morrow Designs shortly after the move to San

> Leandro. I believe he was the director of R&D.

> Memories - George and I working through the night trying to get

> the DJ-DMA floppy disk controller board ready for Comdex (probably

> 1980). The board had a debug monitor that you could access via

> RS-232 and at one point it seemed the board had died completely

> with no output on the debug monitor. We spent an hour trying to

> figure out what had failed before someone noticed we had forgotten

> to plug the RS-232 cable back in. Crud - plug it in, verify that

> our last changes (now done an hour earlier) were all that were

> needed, and head home to pack for Comdex.

> One of George's specialties, and something he could talk endlessly on, was

> phase-lock-loop circuits.

> Some people complained about the octal keypad on the Keyed-up-8080, and the

> accompanying accordion-fold "cheat sheet" that had the 8080

> instruction set laid out in octal. It turns out the 8080

> instruction set breaks down very nicely in octal. George

> knew the entire instruction set inside/out meaning he'd

> write down the code and key it right in or for small things

> just key it in.

> The DJ-DMA (Disk Jockey DMA

> floppy disk controller) plus HD-DMA (MFM hard disk controller)

> have never been matched except possibly in controllers used by

> high end servers. What made these controllers unique is that

> they were like simple computers. You wrote "programs" for them

> in your local RAM and the controller would read and "execute"

> those programs for you via DMA and also read/write your sector

> data via DMA. Prior to these controllers you always needed sector

> interleaving to give the operating system (CP/M or Micronix) time

> to figure out what the next sector was. The DMA controllers were

> able to write or write a track in a single revolution. The DJ-

> DMA could also "uninterleave" a track on the fly in that if you

> used a diskette from another system that needed interleaving the

> DJ-DMA could still read or write a track in one revolution while

> it read/wrote the sector data from the appropriate place in the

> sector buffer. The HD-DMA also supported variable track sizes in

> that you can fit more sectors on the outer tracks....

> Proudest memories - I still believe the DJ-DMA, HD-DMA, and MPZ80

> were amazing. The MPZ80's memory mapping and "supervisor mode"

> did not get matched in the Intel world until the 80386 came out.

> The MPZ80 is pretty well documented and I suspect someone running

> a Z80 emulator should easily be able to add the MPZ80's memory

> mapping to [that] emulator.

Marc and I also discussed **Micronix**, the Morrow Z80 port of Unix. More information about the Micronix operating system is on [this Web page.](http://www.retrotechnology.com/herbs_stuff/mnix_micronix.html)

1. **Morrow Owner's Review magazine**

In 2006 Robert Parker of the Los Angeles (CA, USA) Morrow's User's Group sent the following note about the magazines I have in my list of Morrow documents:

*Those Morrow Owner's Review's are an interesting piece of history, but they were \*not\* produced by, or were they in anyway affilliated with, Morrow. A lady named Emma Paquin, a memeber or LAMUG (Los Angeles Morrow Users' Group), produced those as a "one lady show", to help other's learn about the machines. Pretty neat actually. Brian Leyton and I founded that group in 1981, and in it's "heydey" we had over 250 members. Met once a month, no dues of memberships fees of any kind (we passed a hat at the meetings to raise postage money to mail our newletters and meeting announcements), and usually 45-60 attendees each meeting. Great fun.*

*[LAMUG] was kinda unique, I think, in that we had all types of members, from JPL scientists to octogenarian retirees happily hacking away at the little machines. I remember doing an informal survey of the group at one point and found that the "average" age of our members was 57 - pretty unusual for microcomputer user groups of that time, and quite an educational and rewarding experience for me, a youngish "30 something" at the time.*

*Just an "historical note", Robert Parker*

**Morrow products**

**MPZ80**

A very interesting Morrow S-100 product is [the MPZ80](http://www.retrotechnology.com/herbs_stuff/s_mpz80.jpg) Z80 CPU card. It includes hardware for memory paging (24-bit addressing), memory management, and "traps" or interrupts when pages are inappropriately accessed. These features supported the Morrow "Micronix" operating system, which I'm told was a full port of Berkeley UNIX version 6. Here's the [ROM monitor hex code](http://www.retrotechnology.com/herbs_stuff/mpz80mon.hex) version 4.47 for that board revision 4. Image and hex code courtesy of Rich Camarda; he says the ROM starts at 0800H.

**Morrow ROMS**

We have a few Morrow MPZ80 ROM hex dumps, courtesy of Rich Camarda. Check [this page for them.](http://www.retrotechnology.com/herbs_stuff/proms.html) One is for Micronix, one for CP/M.

For a list of available Morrow docs look below.  
Again, here is how to [order S-100 stuff and email @ me](http://www.retrotechnology.com/herbs_stuff/mailto.html).  
For a [list of all S-100 docs](http://www.retrotechnology.com/herbs_stuff/s100.html#LISTS) click there.

**Morrow S-100 docs list**

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Price and other information can be found [in this notice.](http://www.retrotechnology.com/herbs_stuff/mailto.html)   
To return to the document index [click here.](http://www.retrotechnology.com/herbs_stuff/s100.html)  
Also see my [Godbout and Compupro documentation](http://www.retrotechnology.com/herbs_stuff/d_comp.html).

Morrow documentation

Morrow Micronix version 1.6 manual: well over 300 pages. Similar to old Unix manuals

with chapters on startup and installation, user guide, commands, etc. etc.

Some references to hardware but no schematics or specifics. Ask for details and

copies of sections.

Keyed Up 8080 (single board 8080), schematics, source code. 60 pgs

Morrow 8080 (front panel) User's Manual, 64 pgs

MPZ80 CPU Tech Ref Manual, rev 1 Apr 82, 84 pgs

Morrow DJ-1 floppy manual, 69 pgs

Disk Jockey 2/DIO (floppy) Manual, w/BIOS listings, 114 pgs

Disk Jockey 2D (floppy) model B User's Manual, w/sources, 102 pgs

Disk Jockey 2D (floppy) model B rev 2 User's Manual, w/sources, 102 pgs

Disk Jockey 2D (floppy) rev 4 User's Manual, w/sources, 90 pgs

DJ DMA Floppy Disk Controller Tech Ref Manual, rev 1 1982, BIOS listings, 66 pgs

HDC-DMA Hard Disk Controller Ref Manual, 48 pgs

Disk Jockey HDCA (Hard Disk) Controller Ref Manual, w/BIOS list, 94 pgs

Morrow Discus M10, M26 (10MB or 26 MB hard drive) manual, 28 pgs

Morrow Discus M26 (26 MB hard drive) manual, 48 pgs

Switchboard User's manual, 30 pgs

Mult/IO I/O Controller Tech Ref Manual, w/source, 126 pgs

Wunderbus I/O Controller (not motherboard) Tech Ref Manual, w/ sources, 96 pgs

Wunderbus S-100 motherboard - hand drawn schematic and layout, 2 pages.

MMSP2 MultiPurpose Interface: cassette/ser/par, [proc tech] 50 pgs

includes COPE (Cassette OPeration Executive) source listing

"How to stop a microprocessor", discussion, 6 pages

Morrow SynchroFresh VIII 8K memory, 1977, schematics only, 3 pgs

MM256K DRAM Tech Ref Manual, 28 pgs

MM65K Memory Board Users Manual, 32 X M58725P RAM, 26 pgs

SuperRam Users Manual, 16K memory. 30 pgs

two 4 X 4 arrays of 2114 RAM; has 74154 chip (24/28 pin);

board says "SuperRam" in large white text

three DIP switches on top edge of board.

ThinkerToys SuperRam 16k-A User's Manual, 24 pgs

two 4 X 4 arrays of 4044 RAM;

board says "SuperRam 16" in small text

three DIP switches on top edge of board.

ThinkerToys SuperRam 16K - manual not available

one 4 X 8 array of 2114 RAM; 74154 chip;

board says "SuperRam 16K" (?) in small white text

"Thinker Toys" in larger white text.

three sets of DIP switches near top edge,

three more sets of DIP switches on board

ThinkerToys SuperRAM 32K, 32K board - manual not available

two 4 X 4 arrays of MM5257 (4044?) static RAM;

Board says "SUPERRAM 32" in large white letters,

Has ONE DIP switch of 8 switches, near top edge.

MDT 60 Video Display Terminal Users Manual, 54 pgs

MDT20 Terminal Ref Manual, 52 pgs

MDT70 Terminal Ref Manual, 62 pgs

Spite software present: Guide to Products and Services, Morrow

Nov 1985. Price and ad booklet, 36 pgs

1. **Morrow related magazines**

Morrow Owner's Review - MicroDecision and Pivot support magazines

snapshots of George Morrow's company and early 1980's computing

see the "history" above for more info on these magazines

Vol 1 #1, April 84; 48 pgs (2) (notes on Morrow company, interview)

Vol 1 #2, June 84; 48 pgs (2) (PIVOT, facility tour, Morrow talk on tape)

Vol 1 #3, Aug 84; 48 pgs (2)

Vol 1 #4, Oct 84; 48 pgs (2)

Vol 1 #5, Dec 84; 60 pgs (George M. Compuserve interview)

Vol 2 #1, Dec 84; 60 pgs (2)

Vol 2 #2, Feb 85; 42 pgs (2)

Vol 2 #3, Apr 85; 42 pgs (2)

vol 2 #4, Aug 85; 60 pgs

vol 2 #5, Oct 85; 60 pgs (Pivot II and Zenith Z-171 deal)

vol 2 #6, Dec 85; 60 pgs (end of MicroDecision production)

Vol 3 #1, Feb 86; 50 pgs

Vol 3 #2, apr 86; 50 pgs (Morrow Corp. files Ch. 11 in March)

vol 3 #3, jun 86; 60 pgs

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