Fusion

TESTED TO EXTREMES!

Simon Goodwin puts *Fusion* head to head with *ShapeShifter*, and awaits the release of energy...

Around the mid eighties two new micros took radical steps away from the command-dominated mainstream of CP/M and MSDOS. Macintosh and Amiga computers have grown and converged since, but both machines still represent unique, brilliant and enduring ways to make a computer useful.

Expanded Amigas can emulate Macs with ease – a fine Shareware emulator, *ShapeShifter*, is freely available and can be registered for $40. But now its dominance is threatened by a new commercial release. The eagerly awaited *Fusion* emulator hopes to supplant it, whilst also providing excellent support for older hardware emulators, Emplant and A-Max.

WHY MAC?

Macs are easy to use and there's lots of good – if pricey – software for them around. Old versions are bargains, as you don't need recently-added PPC code anyway. Macs run global champions like *Excel*, *NetScape*, *PhotoShop*, *Quark XPress* and *Word*. Games include *Doom* and *Duke Nukem*, which are not (currently) available on Amigas lacking Mac emulation.

Like Amigas, Macs are based on Motorola processors so programs should run at full speed, unlike software on PC emulators which are crippled by the need to translate every instruction as they run. Macs and Amigas are both good, and very different. So if you can have an Amiga AND a Mac – why not!

Current Amiga graphics boards and processors outperform 68k-based Macs, and with *Fusion*, PowerMac emulation is in the works for putative Power Amigas.

HARDWARE CONCERNS

Again like the Amiga, the Mac has a healthy proportion of its system code ready to run in pre-programmed ROM (Read Only Memory) chips. This must be available to the Amiga – with due deference to copyright laws – before the emulators will run. You also need the Mac system files, normally supplied by Apple on CD or HD floppy, which are the equivalent of Amiga Workbench disks – but more so.

Most modern Macs and emulators run 32-bit system files, known as version 7. The original 7.0 release works with *ShapeShifter* but not *Fusion*, which requires at least version 7.1 and prefers 7.5 or 7.6 – intermediate versions were not released. A third digit signifies minor changes, eg, 7.5.3.

> **"** Macs are easy to use and there's lots of good – if pricey – software for them around. **"**

FUSION

Fusion's Mac screen in a Workbench window is clever but sluggish.
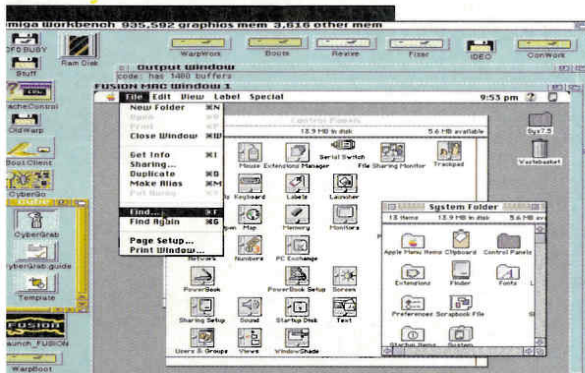
The new release, 8.0, occupies almost 100Mb of CD space and will currently only work with *Fusion*.

A-Max, designed for 16-bit systems, runs Versions 4 to 6, all limited to 24-bit addressing like the A1000, A500 and CorroII Amigas. Emplant and A-Max Corro boards can run system 6 or 7.

ROMS

Emplant demanded a 256k ROM image, keeping things simple for the emulator patches but making it obsolescent – 256k Mac ROM sets are rare in the 1990s, and unsupported since System 7.6. *Fusion* and *ShapeShifter* handle ROM sizes from 256k up. Most

68030 systems have 512k ROMs, with megabyte ROMs supporting the copyback cache in the fastest 68k Macs. 2Mb PowerBook and PowerMac PPC ROMs are useless on current Amigas – until you actually have a PowerPC based Amiga to emulate with.

A-Max and Emplant ROM sockets let you plug chips from a real Mac into your Amiga, and copy the code to an Amiga file. *ShapeShifter* introduced a different approach, later followed by *Fusion*. You need access to a working Mac, but don't need to take it apart to extract the chips.

A Mac program, (supplied with both), copies the system ROM contents to disk, for transfer to the Amiga. If you don't have *CrossMac*, this file can then be copied over on a PC format disk (or disks).

Version 1 of *Fusion* was incompatible with some of the claimed 143 Mac ROM variants; version 2 is more tolerant, but still not perfect and – typically – lacks any list of what will, and will not, work. Generally, you shouldn't have a problem using a ROM image from a standard

machine, like a Quadra, Centris or an older machine like the MacIIcx.

IN AND OUT

Real Apple Macs have serial ports, SCSI, optional Ethernet, and their own low-cost network called AppleTalk. Apple connectors are often peculiar and hard

KREK WAITER'S PEAK MAC*

A handy lexicon of Amiga and MacSpeak

Mac	Amiga
Control Panels	Preferences
Desktop	Workbench
Dialog box	Requestor
Extension	Commodities
Folders	Drawers
Initialise	Format
Preferences	EnvArchive
QuickTime	CDXL

*pronounce in Bristol accent

HIT THE BUFFERS

Emulated drives can appear to the Amiga as partitions or HardFiles. These are slower than dedicated partitions, but much easier to copy, backup and move because the Amiga regards them as large but otherwise normal files.

Access lags because the system cannot move directly to a given block. It must read the file sequentially to get to any position, because the blocks could be scrambled or 'fragmented' across the disk. The larger the HardFile, the longer this takes.

The 'cure' is to dedicate a partition, or add buffers. The standard block size is 512 bytes, when one block in every 73 contains a 'map' recording the location of that part of the file. This map must be re-read unless there's a spare 'buffer' to hold it in memory, so you normally need about one buffer per 36k for fast access to a large file, and over 1000 buffers (512k) for a 40Mb 'hard drive'.

Fast File System 3.1 (v40.1 or later) lets you use bigger blocks. This can make a terrific difference. First back up the partition, as changing the block size zaps the original contents. Then run *HDToolbox* (in sys:tools), selecting a drive and partition. Choose 'advanced options' then 'change...' to see the file system characteristics, and choose bigger blocks; values from 1k to 32k are allowed. Select OK, adjust the preset number of Buffers (bottom left) and OK again to exit.

You don't necessarily need Kickstart 3.1, as the file system Add/Update option lets you put a later version, overriding ROM code, in the startup area of your drive. Amiga International's web site has an 'experimental' v43 *Fast File System*, supporting bigger blocks, enormous drives, and ATAPI CDs.

The table shows how this works in practice, with boot times in seconds for a given block size and buffer count. The test system used *ShapeShifter 3.1*, Mac OS 7.0, a 50Mb hard file and an 800 by 600 chunky *CyberGraphX* display; PCx, Fusion and PC Task deliver very similar results.

Doubling the block size quadruples the space each buffer can control (twice as many blocks, each twice as big) and boosts transfer speed as the disk interface takes bigger gulps. There's a 'right number' of buffers for a given size of file. An extra 90 half k buffers don't help at all, while 120 two k buffers are enough for hard files over 100Mb long!

Tiny files waste some disk space as they always occupy a whole number of blocks, and tired old programs like *AmiBack* may be confused, but the RAM versus time trade-off is massively improved. 60k or 240k deliver ten times the speed if you use 2k blocks instead of four times as many half k buffers.

	1/2k blocks		2k blocks	
Buffers	**RAM used**	**Boot time**	**RAM used**	**Boot time**
30	15k	324s	60k	26s
120	60k	324s	240k	18s
480	240k	182s	960k	17s
1920	960k	26s	3840k	17s

Table: Big blocks boost hardfile speed dramatically.
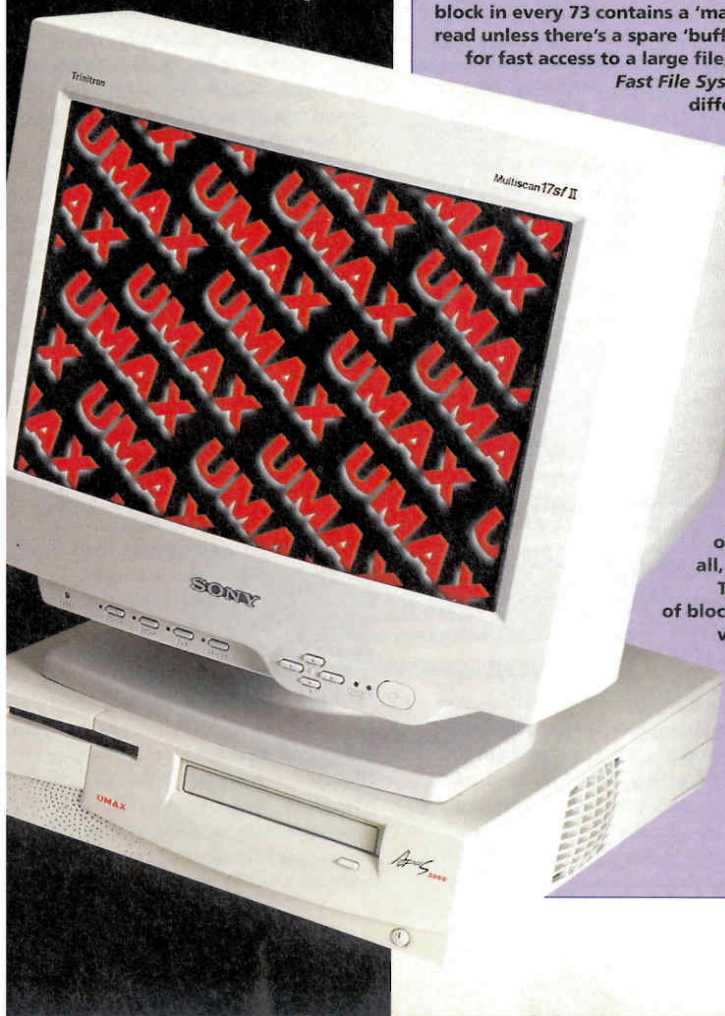
ON THE AFCD

There's a treasury of Mac-emulation related utilities on *AFCD20* including:

AMax – Supra hard disk driver, flicker reducer and ROM accelerator.
BootFile – a cut-down Mac system 7.0 to get you started in *ShapeShifter*.
FAQs – A-Max, Emplant, *Fusion*, Mac and *ShapeShifter* answers.
Emplant – diagnostics, icons, screen and CD drivers for Jim Drew's debut.
Emulators – Amiga (really!), Apple][, Atari, Beeb, Spectrum, TRS-80 etc.
MacJoy – for Amiga joystick and CD32 joypad support to Mac emulators.
MacTools – transfer and convert files between Amiga and Mac.
MacView – A vintage Amiga application to display *MacPaint* pictures.
ShapeShifter – Christian Bauer's Shareware Mac 2 emulator and PD extras.

A-Max – four cheap chips, two ROM sockets, and an easily snapped Mac floppy socket!

Emplant hardware comes with reassuring diagnostic software (above). The Emplant card; (below) AppleTalk, SCSI-I and ROM sockets for Zorro.
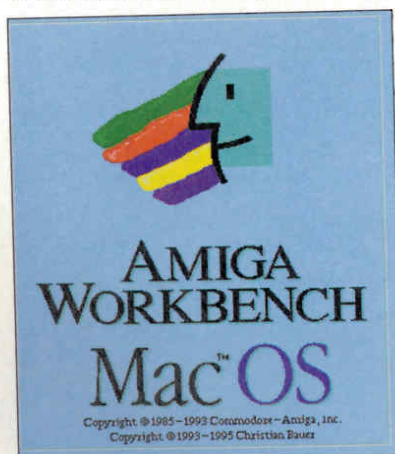

to find (those tedious miniature DIN sockets). Both *ShapeShifter* and *Fusion* are capable of using the standard Amiga ports as their Mac equivalents, but you will still need connectors and convertors to attach them to genuine Mac hardware.

Floppy drives were originally non-standard, in 400k and 800k capacities with variable-speed 'zone' recording which made most of the data inaccessible to standard 300 RPM Amiga DD drives. Later models have

> **You can run a useful Amiga system in 6Mb RAM with a 40Mb HD, a Mac with that spec would barely start up.**

1.44Mb superdrives, compatible with normal HD floppies but also capable of accessing the weird old format, and double (720k) or HD PC floppies.
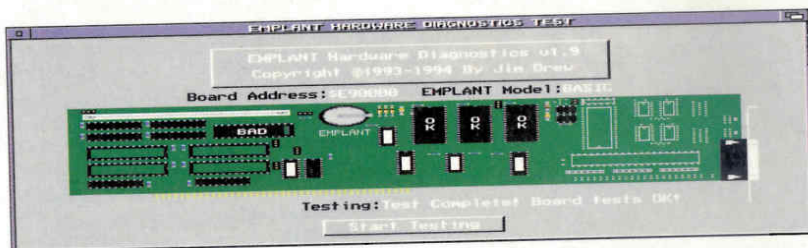
Macs are peculiar in many ways. There's only one mouse button, no command line, and you must explicitly 'shut down' your system to avoid loss of data. Disks should not be ejected unless

Mac emulation need not stop you using Amiga software simultaneously.

you've moved them into the 'trashcan' first. Real Mac drives enforce this rule mechanically; on an Amiga you break it at your peril.

Fusion and *ShapeShifter* allow Mac devices to be mounted and used as Amiga drives while the emulation is running. You can also cut and paste text – but not graphics – directly between systems. Printing may be tricky as Mac system software only supports Apple's proprietary printers. There are free, third party, drivers for Epson and Deskjet printers, and commercial rivals. You can use 'desktop printing' to generate postscript files to print from the Amiga with *Post* or *GhostScript*.

SoftFPU – a Mac Shareware program – emulates a 68882 chip so programs using FPU code will work on machines without floating point hardware – albeit much slower than they were designed to run. Mac software is far hungrier for resources than Amiga equivalents – you can run a useful Amiga system in 6Mb RAM with a 40Mb hard drive, but a Mac with that specification would barely start up.

ShapeShifter supports most Ethernet adaptors, and *Fusion* definitely works with the Hydra Systems card, but in spite of much testing and prompting, failed to work with our Ariadne boards (although the author told us that other people had got the Ariadne to work). SCSI ZIP drives or CD-R discs are perhaps the ideal way to transfer data,

but floppies and serial links are also possible. *AF102* documented the standard Amiga and Mac serial connections. As usual, add-on hardware boosts your options. *Fusion* also supports older emulator hardware.

A-MAX
A-Max boards fit a Zorro slot or Amiga floppy port, with sockets for Mac system ROMs. The original model had an interface for a non-standard 800k Mac drive – one simple TTL chip, with three more to get around the bizarre installation of 16-bit ROMs in a serial disk socket. A-Max II+ and A-Max 4 (for Zorro) add more ports and can read old Mac disks in an Amiga drive.

EMPLANT
The 'basic' Emplant is a mostly empty board with timer and interface chips and DIP and SIMM sockets for Mac ROMs. It can be extended to 'deluxe specification' with a Mac-style SCSI-1 controller, AppleTalk network interface and a change of the copyright-control PAL (Programmed Logic Array). Emplant software requires this board – *Fusion* uses it, if present.

CATWEASEL
Fusion can access Mac disks via the Catweasel controller, faster than Amiga HD drives and supporting cheap PC-types. Catweasel itself lacks WB support for Mac disks, but works well alongside *Fusion* and *ShapeShifter 3.7* or later.

MAC FILE FORMATS
Mac Files are divided into forks – rather than keep separate icon and program files, as on the Amiga, most files have a 'data fork' and a 'resource fork'. Resource forks contain code, tooltypes, locale information and pointers to applications that created the data.
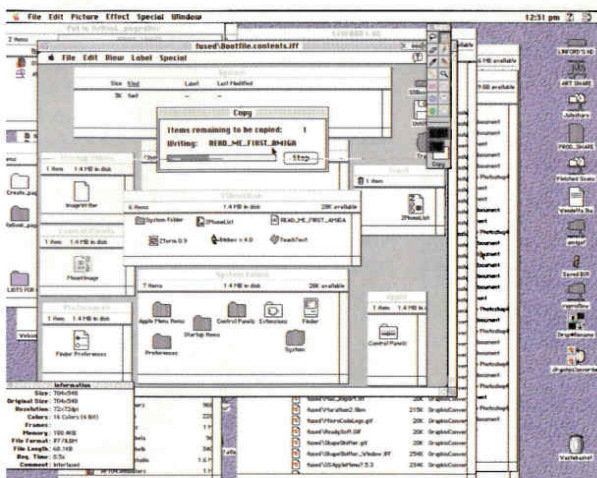
Fusion's minimal CD *BootFile's* contents – with a typical screen-switching glitch.
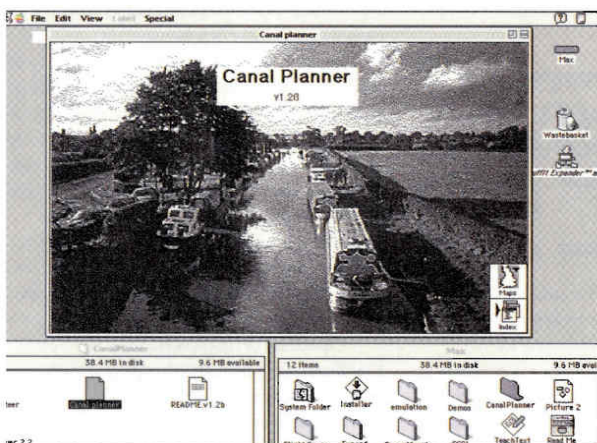
***Canal Planner*, Mac narrowboat AutoRoute, but where's the Cannock extension?**

Handlers on the Amiga generally distinguish between forks by adding a prefix or suffix to the name. Macs support longer file names than Amigas, but this is rarely a problem. You can rename any file on a Mac by pointing under the icon, clicking and holding, and editing the name.

Common archive formats for Mac files are .SIT – short for *StuffIT*, a Shareware compressor – and .HQX. The latter files are expanded, rather than compressed, so binary data can be represented just with printable characters – rather like MIME or UUencoded files on Unix and Amiga. MacBinary is similar but shorter, using all eight bits without error checking.

LhA is available for Macs, and on our CD, but little used except to transfer files from an Amiga. ZIP is also supported, but uncommon, and sadly LZX is unknown to Macs.

DOCUMENTATION

Both *Fusion* and *ShapeShifter* come with documentation in AmigaGuide form but *ShapeShifter's* manual is longer and more helpful.
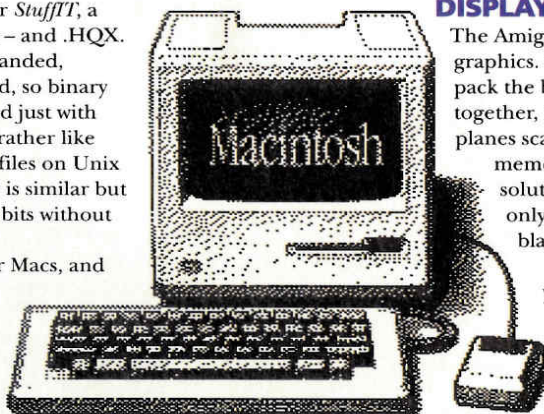
The *Fusion* guide includes a glossary for anyone still clueless about terms like 'icon', 'Mac' and 'hard drive' and troubleshooting answers to 50 questions, but it has no index and is rather inadequate for a commercial product, especially one that can just stop dead or crash if not set up just right!

The old Emplant manual was worse, but the product was simpler and at least it came printed on paper. It helps to convert *Fusion's* guide with a utility like *Guide2Text*, printing it out to ensure you've not missed anything.

Microcode do have a website which promises to provide more information, but that's not much help if you don't have an Internet connection.

Macs are easy to use, even by Amiga standards, but if you want to tweak the configuration you'll probably need help from a Mac guide, human or printed.

You shouldn't need much help understanding the Mac system or file organisation – most of it is self-evident if you've used an Amiga or PC Windows, which owe much to ideas pioneered on the Mac.

AppleGuide tries to replace printed documentation with hypertext, and fails for want of structure, detail and ease of use. Multitasking is feeble by Amiga standards. Bubble help, as in MUI, tells you the purpose of buttons your mouse pointer lingers nearby. Error messages are rare but typically useless – if a Mac program needs to issue a message, it's a design failure!

DISPLAY MODES

The Amiga has its own way of doing graphics. Other colour computers pack the bits for each pixel together, but Amigas store them in planes scattered around chip memory. This was a neat solution in 1985 – the Mac had only two colours to play with, black and white.

Amigas still work well if you're short of memory and only want a few colours on each line of display, or your software knows about specialities like HAM modes, but they're hassle for emulators because 'chunky pixel' operations that take just one step on alien hardware require six or eight, and often tricky arithmetic, on ECS or AGA Amiga graphics.

This bottleneck encouraged plug-in video cards which store displays as Mac, PC and Unix systems expect. Old cards
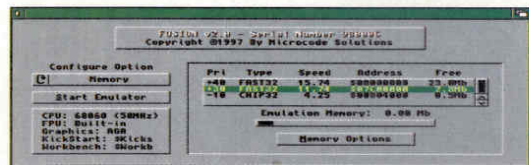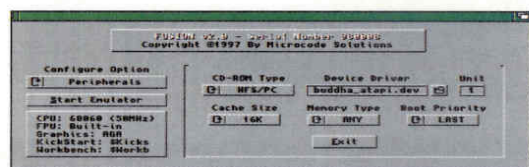
Fusion can access either an ATAPI or SCSI CD-ROM drive directly (top), needs contiguous memory (middle) and supports a variety of graphic drivers.
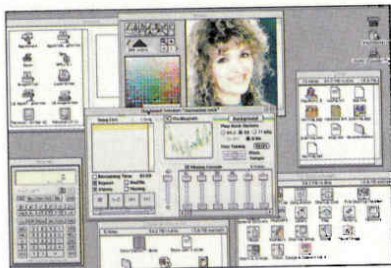
offer more colours than contemporary Amiga hardware, and new models are faster in all modes. These require an Amiga with Zorro slots, and preferably a video expansion slot too, and they're not cheap either.

ShapeShifter has a well-defined interface for display add-ons, called EVDs (Extended Video Drivers) so
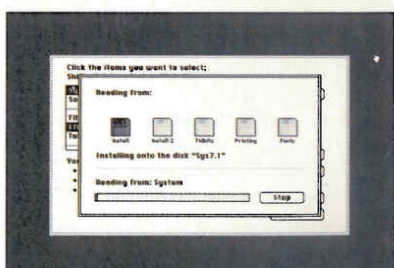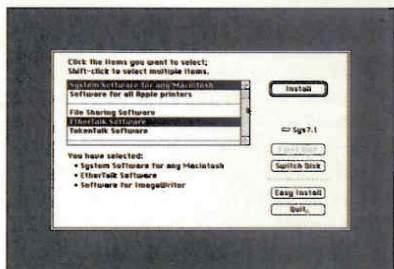
Apple's System Installer (top) is pretty but ponderously slow. *ShapeShifter* (middle) needs Ethertalk and System 7.0 or later for 'any' Mac. With installation underway (bottom), play Towers of Hanoi – slowly.

Continued overleaf ➡

If AFCDs leave you wanting more Fusion lets you use MacFormat cover CDs too, and there are plenty of files on the Internet.

custom support is freely available for most graphics cards and Amiga chip sets. It gives direct access to Amiga bitplanes, Grafitti, Merlin, Picasso 2 and Retina Z3 boards, as well as *CyberGraphX*, *EGS* and *Picasso96* retargetable graphics (RTG) schemes. Features vary so it's worth trying all the possibilities, including third-party drivers, to get the best match for your system and software.

The original Amiga Mac emulator A-Max stuck to mono Amiga graphics. Its rival Emplant added custom drivers for A2410, AGA, CyberVision, *CyberGraphX*, ECS and *EGS*, Merlin, OpalVision, Picasso 2, Piccolo, Retina, Spectrum and other esotechnica, but struggled to keep up with new arrivals.

Fusion takes a more selective approach. The only cards specially served are the Retina Z2 and Z3. Others are driven via *Picasso96* or *CyberGraphX* RTG libraries, discussed in *AF101*. Only version 3 of *CyberGraphX* works properly. You're best off using *Picasso96* on a Z3 Retina, as long as you've got a modern Workbench – the custom Retina driver is less capable, but it's *Fusion*'s only non-Amiga native driver compatible with Kickstart 2.

GRAFITTI

Lateral thinking inspired German hackers to develop Grafitti, a plug-on which reads the digital signals from any Amiga video port and re-scrambles them so that 'chunky' display data can be stored in Amiga bitplanes. Display output software pretends it's got a chunky display map, ideal for *Doom*-style 3D, Mac and PC emulation; the hardware does the rest. This works but has limitations.

Grafitti offers 256 colours per screen, chosen from an 18-bit palette of 256k colours – more choices than with ECS but less than AGA.

Old Amigas bottle out at 720 pixels per line, stalling Grafitti at 360 columns on 16-bit Amigas. This is too few for Mac emulation. AGA 'Super Hi-Res' modes have twice as many pixels, but
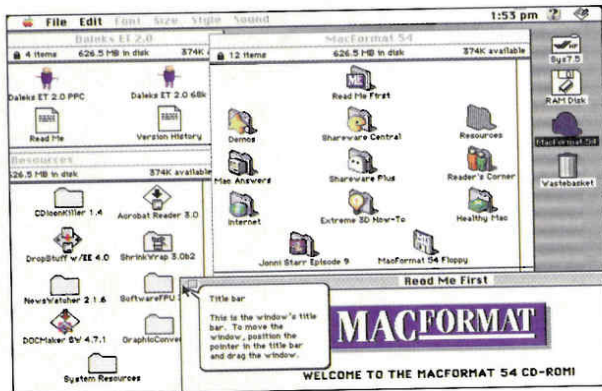
Mac systems strive to avoid error reports – when they do appear, you know why!

after Grafitti has finished you still only get 'Hi-Res' 640 to 720 pixel horizontal resolution, and no more than 283 lines unless you can stand a flickery interlaced display.

> **One major claim for Fusion is the option to replace Apple's QuickDraw system routines with optimised code...**
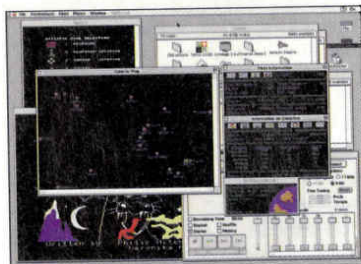
This 'Mac' is playing an Amiga MOD and two Spectrum games in resizeable windows.

The advantage is the software driver, and both *Fusion* and *ShapeShifter* come with Grafitti drivers which are much faster than software which translates displays into planar format on the fly. Grafitti is a neat hack, if you haven't got the internal slot, but any real graphics card will easily outperform it.

AKIKO

Fusion has two display modes just for CD^{32} owners! These use the Akiko chip, a sort of internal Graffiti without the resolution limits, which converts pixels from chunky to planar format in clumps of 32. Add-on *ShapeShifter* drivers can also use Akiko if it's there, benefiting committed CD^{32} owners with a keyboard, a hard disk and floppy add-ons.

QUICKDRAW

One major claim for Fusion is the option to replace Apple's *QuickDraw* system routines with code optimised for your display. Thus system-friendly Mac programs – which means most of them – can take advantage of Amiga optimisations and hardware assistance like blitters, on the motherboard or graphics cards, without the need for graphics to be rendered Mac fashion into a 'pretend' screen area and then periodically translated into Amiga form.

Benchmarks make the most of this advantage, rating *Fusion* far beyond

ShapeShifter in *QuickDraw* graphics speed. With real programs the benefit is more modest, and there's a risk that shortcuts introduce new bugs.

REFRESHMENT

Some programs write directly to the Mac hardware, bypassing the system – an approach frowned upon by manufacturers but loved by hackers for its speed and simplicity. In these cases Jim Drew's *QuickDraw* boosters are sidestepped, leaving blank areas unless the entire display is periodically updated the hard way, dot by dot, to catch direct writes to the 'Mac' display which might not otherwise reach the Amiga. You configure the 'refresh rate' at which the whole screen is redrawn.

High values – more than about ten updates per second – give better animation but can sap most of the processor power, even on a fast Amiga.

MEMORY MANAGEMENT

Salvation comes from clever, manufacturer-discouraged direct programming of the Memory Management Unit in superior Motorola processors. The MMU intercepts the processor's access to memory. It can shuffle a million 4k 'pages', monitor reads and writes and control processor caches, page-by-page.

Optimal refresh schemes use the MMU to detect modified parts of the screen memory, avoiding the need to refresh others. This is faster and less RAM-intensive than the alternative of 'delta buffering', comparing the old raw data with updates in an attempt to save redundant conversions.

MMU DIVINATION

Cheap Motorola processors – the original 68000, stock A1200s' 68EC020 and the 68EC030 in the A4000/030 and bargain accelerators – lack memory management. The 68040 and 68060 are available in bargain EC versions without memory management ($75 for a 50 MHz 68EC060!) but these are not yet used in Amigas, although they do work.

Mac emulators expect you to know whether or not your machine has a working MMU, to select an appropriate driver. MMU programming is a black art, forbidden by Commodore, and if you're not sure whether your MMU works the only way to find out is to try it – with a risk of crashing – or examine

Marathon 2 runs nicely on a 68040 or above with Zorro graphics.

he entrails of your Amiga, looking for
he not-so-magic letters 'EC'.

All A3000s and A4000s other than
!000/'030s boast hardware memory
nanagement. 50MHz '030 accelerators
hould all have MMUs, as the cheaper
C part is only available in lower
peeds. 68020s require an external
MMU chip, the rather obscure 68851;
he original 68000 cannot support
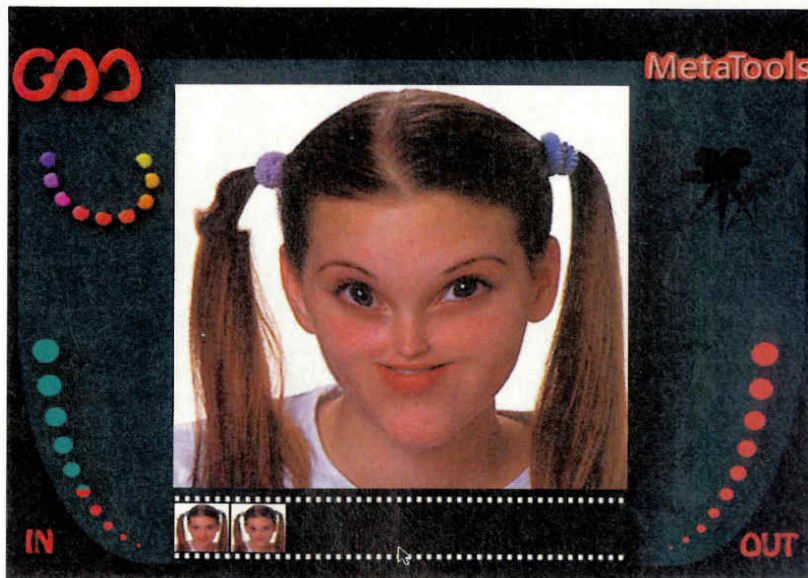onventional memory management due
o design oversights.

AMIGA MODES

he simplest Amiga screen mode – a
one bitplane – works like the original
nonochrome Mac display, except that
Mac pixels are square and the Amigas
re usually oblong. When colour Macs
rrived later they opted for packed
creen modes, storing two 16-colour
ixels or one 256-colour in each byte.

ECS Amigas can emulate 16-colour
nodes, but bitplane conversion makes
hem irritatingly slow. 32-bit AGA
.migas can manage 256 colours, but
gain this is slothful unless memory
nanagement is used to minimise
rocessor overheads.

ShapeShifter's AGAboost does not
equire an MMU, but prefers a 68030
nd uses a big delta buffer and a half
negabyte table for conversions,
iboriously rewritten at every palette
hange. *AGAboost* supports obscure
.GA modes like Euro36 and Super72.
: can speed things up by 'dithering'
56-colour displays into less demanding
4-colour modes. Despite the name,
.GAboost can render 256-colour Mac
oftware on ECS machines in 64-colour
xtra half bright' mode, although
alette restrictions become obvious.

This is, would you believe, *MetaTools'* *Goo* running on a standard AGA display, thanks to *Fusion*.

Fusion handles the Mac's multiple monitor system (left) admirably – if you have enough memory.

Speedometer (below), the Mac equivalent of *SysInfo*, shows a standard A4000/'040 in favourable comparison to a Quadra in all but graphic speed.

THOUSANDS & MILLIONS

When 256 colours is not enough, even
choosing them from a much wider
palette, Macs take a different approach.
'High colour' and 'true colour' modes
use five and eight bits respectively to
determine the red, green and blue level
of each pixel, giving 32,000 or 16 million
colours. Humans can't distinguish all of
the brighter variants yet some darker
colours are not available, because our
eyes are not linear like a computer
display, but 'true colour' seems pretty
close to reality.

AGA Amigas support 16 million
colours, but not all at once. There are
never enough pixels! HAM8 comes the
closest, with 64 basic colours and the
option to fine tune subsequent dots to
an exact 24-bit hue.

AmiRefresh modes in *Fusion* emulate
thousands and millions of colours on an
AGA HAM8 screen. It works
impressively, but it's slow (though not as
slow as you would imagine).

Third party EVDs abound for
ShapeShifter. AGA-EVD is aimed at basic
'020 or '030 systems. It works accurately
in 2, 4 or 8 pixel modes, and rather
vaguely and slowly in HAM8, emulating
the Mac 'thousands' setting. It can
render four and 16-colour displays on
ECS Amigas, but still requires
Workbench 3.

ShapeShifter's Savage driver, from
Hungary, supports 16 colours on all
Amigas with an MMU, and 256 and
32768 colours with AGA. It outruns
AGAboost and AGA-EVD, typically
needing less RAM and CPU time, but
requires a full-spec 68030. *FastECS* comes
in 68030 and 68040 versions, using
memory management to update 16-
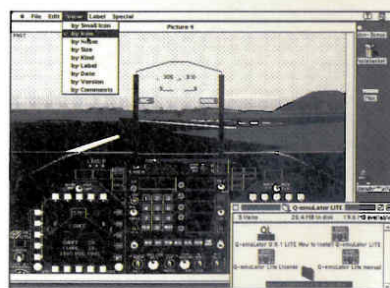colour *ShapeShifter* displays on Amigas
with 16-bit ECS graphics.

The venerable megapixel A2410
monitor is supported by *Fusion* through
RTG, and a *ShapeShifter* EVD for the old
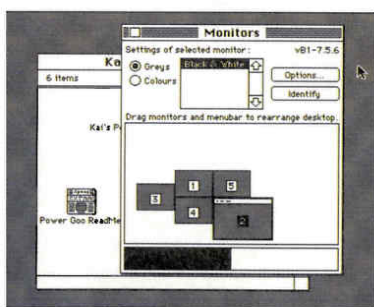*EGS* package.

BIG DESKS

A Mac speciality is support for multiple
monitors. You can position these to view
a 'virtual desktop' so the pointer, icons
and windows can be moved from one
screen to the next, with all displayed at
once. This is great for Computer Aided
Design and Desktop Publishing, with
tools and menus on one screen and the
design uncluttered on another.
ShapeShifter supports up to two
displays, while Fusion can handle six,
given enough output and monitors. In
Fusion you can have different monitors
set up on different Amiga screens, but
this somewhat negates the advantage of
having a bigger desktop area.

Graphics cards present some
problems, Picasso 2 and *CyberGraphX*
drivers can't detect screen swaps, so
Mac and Amiga graphics sometimes
appear on the wrong page when you
swap screens, requiring a manual
redraw to tidy up the mess. Picasso 2(+)
and *EGS* system cards, like GVP's
Spectrum, support only 256 colours
without conversion. *CyberVision64* and
Picasso96 don't require conversion in
15-bit (thousands) and 24-bit (millions)
colour modes, therefore making them
that much faster. Retina, *CyberGraphX*
and *Picasso96* support in *Fusion*
consumes an extra 4Mb of fast RAM.
This is a hefty extra burden – don't
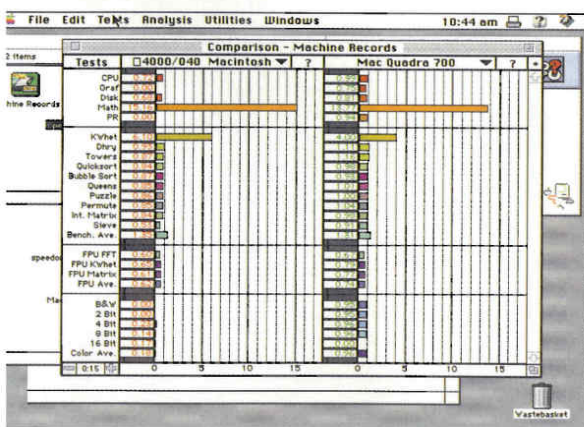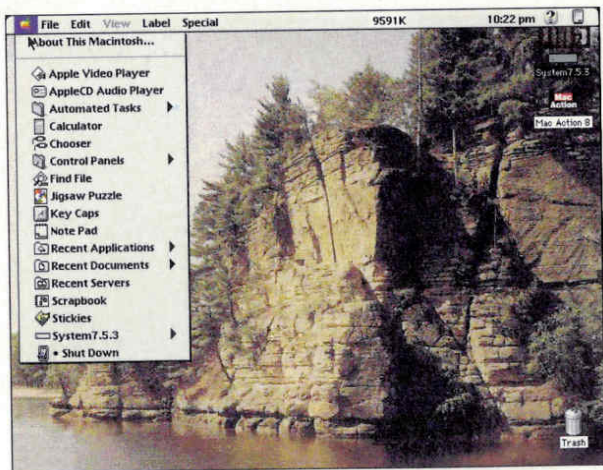
Continued overleaf ➡

Demos for old models run very well, even in basic mono.

File Edit View Label Special   9591K   10:22 pm

About This Macintosh...

Apple Video Player
AppleCD Audio Player
Automated Tasks ▶
Calculator
Chooser
Control Panels ▶
Find File
Jigsaw Puzzle
Key Caps
Note Pad
Recent Applications ▶
Recent Documents ▶
Recent Servers
Scrapbook
Stickies
System7.5.3 ▶
• Shut Down

Full-screen backdrops were a recent arrival on Apple screens.

← expect much change from 30Mb if you need to run *NetScape* and Mac System 8.

CONCLUSIONS

Fusion has arrived in a marketplace now dominated by the Shareware *ShapeShifter*. It follows Emplant and Emplant Lite and it's pure software: one 880k floppy in a CD box.

With help from both Nick and Ben, I've spent over a month trying *Fusion 2.0* on 68030, 68040s and A2/3/4000/060s, with Warp Engine and A4091 SCSI drives, ATAPI and ZIP drives, Catweasel, Buddha, Commodore IDE and HD floppies.

Each configuration required careful experiment, with changes of Mac ROM or CPU forcing reinstallation. The number of resets – forced and spontaneous – must number in the hundreds. But I persevered because, when it works, *Fusion* is brilliant, as you can see from the features discussed elsewhere.

Problems stem mostly from poor docs, bugs and Apple's restrictive practices. *Fusion* won't work with abundant, ready-made *ShapeShifter* boot files or the 'system disks' tailor made for each Mac model. You need a 'generic' system installation for any Mac, or the emulator sticks or crashes.

With *NoiseSome* in your WBstartup *Fusion*'s audio code gets stuck, leaving RAM allocated with no message and reset the only way out.

Once started, weird system-dependent errors can occur unless you tweak the setup. Some Mac extensions cause problems, and lock-ups far outnumber error messages. I could not get Mac System 7.1 to work at all, or boot from the System 7.5 Group Upgrade CD. My A4091 and CyberStorm 060 combo clobbers *Fusion*'s virtual memory, but it worked on the Warp Engine, favoured by Drew

The only known picture of shy *ShapeShifter* Christian Bauer (top). Emplant and *Fusion* guru Jim Drew (bottom).

MicroCode Solutions is former Emplanter Jim Drew's new incarnation.

for development, and on a standard A4000/040. ATAPI and NEC SCSI CD ROMs worked, but my Toshiba 3401 would not.

COMPARISONS

ShapeShifter seems to have got stuck at version 3.8, with no updates for the last six months; it lacks the extras in *Fusion*, like multiple-monitor support, virtual memory – nascent in *ShapeShifter* – AHI 16-bit audio, almost-direct SCSI for scanners, DATs and Music CDs, System 8 compatibility and compatibility with the old Emplant hardware (handy if you have the Deluxe board, as it can then handle the SCSI, printer and modem ports).

But *ShapeShifter* is much easier to get started, better documented, and given plenty of CPU power even supports sound input, still a ghosted option in *Fusion*'s menu.

Both require at least a 68020 processor with Workbench 2, but *Fusion*'s 'minimum requirements' are more exacting than *ShapeShifter*'s. It demands at least Mac System 7.1, 4Mb fast RAM, 20Mb hard disk space and a high density floppy drive.

Mac system software is difficult to come by on floppy disks now and for the generic disk set (which you you will need to run *Fusion*), you are looking at paying a premium (eg, OS 7.6 is $99 on CD and $129 on floppy).

A set of disks designed for a specific Mac or range of Macs (eg, those that may have come with a Performa) may have worked on *ShapeShifter*, but are likely to lock up *Fusion*. However, if you own the rights, Apple's updater, to be found on their website, can upgrade you to the full system 7.5.3 from just a *Disk Tools* disk.

Fusion can boot from current (system 7.6 or 8) Mac CDs but it helps to have a *Disk Tools* floppy to initialise your first hard disk partition. Real Mac drives come pre-initialised, of course! The CDs include floppy disk images, but *Disk Copy* will only extract them with a genuine Mac SuperDrive (this won't prevent you using the many individual installers though). Other metal-bashing programs that fail include many MIDI packages – a great loss – *RAMdoubler* (so use real virtual memory!) and NetBSD (use the Amiga version). Many non-32-bit clean applications, usually very old versions of current software, or poorly coded Shareware, can also be run on *Fusion*, though only at the cost of losing the capability for virtual memory.

Fusion prefers *at least* 8Mb RAM, 50Mb hard disk space, System 7.5 or later, a 512k Mac ROM image, CD-ROM and a processor with both FPU

and MMU. System 8 requires 16Mb RAM, about 100Mb of disk space and a full 1Mb ROM image, (patched by *Fusion* for any 32-bit Amiga CPU, not just a PPC or full '040 that Apple require).

Without CPU-card expansion, Amiga users will struggle to make enough RAM available. Worse, all the memory needs to be in one contiguous block. Macs cannot cope with memory in 'fragments', as the Amiga system can, and often must.

Fusion's virtual memory support trades up to 767Mb of hard disk space – and time – for real memory. Like all *Fusion*'s wildest hacks, it's system-dependent and may be hard to set up, but crucial for compatibility with greedy programs like *PhotoShop*.

Without the support of MicroCode Solutions and Blittersoft, *Fusion* would be too 'bleeding edge' to be useable. It's a pig to start up and still needs more testing on the myriad of potentially-suitable Amiga configurations. But it's ambitious, clever and good value if you've got the time and patience to get to grips with it. ∎

SPEED: Impressive when it works.	● ● ● ● ●
MANUAL: Skimpy and disk only.	● ● ○ ○ ○
ACCESSIBILITY: Tortuous and frustrating to install.	● ○ ○ ○ ○
COMPATIBILTY: Erratic to use until carefully tuned.	● ● ● ○ ○
VALUE: Cheap by Mac standards.	● ● ● ● ○

OVERALL VERDICT: Very promising but, at the same time, very fragile.

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80%