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A Sneak Preview
of IIGS Software
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**“IT’S
AMAZING!”**

STEVE WOZNAK
Apple II Creator

- ▶ SPEED
- ▶ COLOR
- ▶ SOUND
- ▶ COMPATIBILITY

The New
IIGS



***** 3-DIGIT 12
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 A12405CHADJ1*****15
 Dr. Kenneth Buchholz
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The New
IIgs

BACK TO THE FUTURE: APPLE'S AMAZING GS

by Eric Grevstad, *inCider* staff

The sensational Apple IIgs boasts something old and something new: compatibility with thousands of existing Apple II software packages, plus vibrant graphics, superb sound, and the Mac interface.

It's got expansion slots like the IIe, built-in interface ports like the IIc, and mouse-and-menu firmware like the Macintosh. It's got 16-bit speed, dazzling color graphics, and synthesized sound to die for, yet it'll run nearly all of your existing Apple II software at regular or double speed. In fact, except for the new keyboard, it'll fit inside your Apple IIe case.

In short, the Apple IIgs (the initials stand for "graphics and sound") is a phenomenal achievement. If you thought the new II would be priced to stem the tide of \$1000 PC clones, you'll be disappointed: Its custom chips make it a more costly high-end consumer product, leaving the IIe and IIc (with expected price cuts) to slug it out in the market trenches. But otherwise, the IIgs looks like a world-beater.

There's never been a computer like the IIgs. More accurately, there are several computers like it—the Commodore Amiga and Atari ST for color and sound, the Mac for ease of use, and the Apple II family for its software base—but the reason there's no precedent is that the IIgs is both a new and an old machine at the same time. (It's as if Commodore had announced a fast, flashy Amiga that also ran C64 programs.)

The IIgs is for Apple owners who've been tempted by newer machines' speed, memory, and powerful programs but don't want to lose their investment in Apple II software and peripherals—a good description of the situation in many schoolrooms, as well as that of individual owners.

To say that it's the most significant Apple II news in years is an understatement. It combines two of the most significant computers ever (the II and Mac), and represents a landmark commitment—dare we say recommitment?—to the market audience that made Apple a success. That audience has grown more sophisticated over the years, and Apple has responded with a II that's second to none in sophistication.

At first, the IIgs' role as a faster, more convenient II compatible will overshadow its gee-whiz abilities; *inCider's* preview in Cupertino came too early (June 11–12) to see the machine's new operating system, ProDOS 16, or any 16-bit, super-hi-res software except demos. Indeed, Apple's IIgs product manager Curtis Sasaki described the machines we tested as "two or three revs [revisions] away from production," complete with a minor glitch in the new video modes (the two rightmost pixels wrapped around to the left). Apple's plan then was to offer a free dealer replacement for the faulty graphics chip around January, but hardware manager Robin Moore told us at press time (mid-July) that the debugged chip should be ready for the IIgs' debut in September.

Even in not quite final form, though, the IIgs is important enough to dominate *inCider's* feature section this month. The following features detail the new Apple's software (both built-in and third-party) and its place in Apple Computer's product line. The rest of this article describes the IIgs hardware—a high-tech *tour de force*, with roots leading straight back to the hackers' garage.

The Platinum Package

The rainbow logo is unchanged, but beige and white have been replaced: All new Apple computers and peripherals are platinum (Apple's word for silver-gray). This fall's "new" IIc, unchanged except for officially supporting Apple's IIc memory-expansion card (which fits older machines as well), is white with a platinum keyboard.





Wozniak on the IIGs

Take it from one who knows his Apple II's: The new IIGs is "amazing."

So says Steve Wozniak, one of the founders of Apple Computer and the designer of the Apple II. Although Wozniak is no longer working full-time at Apple, he manages to keep up with new developments, especially of the Apple II variety. When *inCider* talked with him in June, he was anxiously awaiting delivery of his new Apple IIGs.

"It's a very good machine for people like myself—technicians—who need a computer right in the lab to develop hardware and software," he says. Wozniak plans to use the GS in engineering projects for his new company, CL-9, in Los Gatos, California. The extra speed a 16-bit processor offers is particularly attractive to him. "The higher speed gives me faster assembly-language code. I'll only have to wait eight seconds, as opposed to 40 seconds," he adds.

But Wozniak is also "very impressed" with the color and quality of graphics achieved by the GS: "One of the most impressive features is to see Mac-style graphics moving faster than on the Mac and in color." But the Mac-style interface goes beyond graphics and will bring the mouse-driven menu interface to all applications—Wozniak is excited about that. "I'm looking forward to getting a chance at mouse-based word processing on a II, in addition to painting and color," he says.

As for the sound, Wozniak predicts that enhancement will "have the most impact of all on education." Some applications that have been discussed include foreign-language lessons and training in musical instruments and composition.

In general, Wozniak is glad to see so many enhancements over the existing Apple II offered in one machine. "It's amazing to see so much done at once," he comments. And yet, at the same time, he's pleased to see that Apple has given some very serious thought to maintaining software compatibility with existing Apple II's: "I have hopes that it is very compatible and have reason to believe that it is very compatible."

Wozniak is so impressed with the new machine that he even predicts it will snare 50 percent of the installed Apple II user base in the next few years. And we can certainly count on him to be one of those IIGs users. □

—Deborah de Peyster

The IIGs system unit is half wedge and half rectangle, about the size of a IIe (counting its keyboard). Like older Apples, it serves as a stand for a composite monochrome or new hi-res analog RGB color monitor.

After what IIGs engineers say were lengthy debates about extra cost and classroom reliability, the Apple team decided on a detached keyboard. The 80-key, low-profile board contains the familiar IIe or IIc layout with two notable exceptions. One is a numeric keypad with its own clear and enter (return) keys.

The other is the solid-apple key—renamed the option key and moved just to the left of the open-apple (which also bears the Mac's cloverleaf command-key symbol). The bottom row of the keyboard, from left to right, contains caps lock, option (solid-apple), open-apple, single left quote (tilde), space bar, backslash (vertical bar), and then the four arrow keys. The reset button is centered above the top row.

Minor layout differences aside, the keyboard passed *inCider's* typing tests with flying colors—a bit firmer than a IIe board, but not as shallow or stiff as a IIc's. There are connectors for the IIGs' Apple Desktop Bus input port on both the left and right sides of the keyboard; whichever you don't use for the keyboard, depending on whether you're left- or right-handed, fits the IIGs' standard mouse.

16 Bits, No Waiting

Under the hood, the IIGs bears a family resemblance to the IIe: There's a 60-watt power supply on the left, seven expansion slots along the rear of the motherboard, a dedicated eighth slot, and even some familiar antiques like the Apple II game I/O (input/output) socket. There's no cooling fan, though Sasaki says the company recommends and will sell one to users who fill three or more slots; it will fit inside the case, under the power-supply box.

At second glance, though, the IIGs is clearly a brand-new animal. For one thing, the 6502 microprocessor has finally retired. The new Apple is built around the 16-bit 65C816 (or 65SC816, to read the GTE chip in one of the units we saw), which runs at either the familiar 1 MHz or a fast 2.8 MHz clock rate. (Apple technical documentation confesses that housekeeping chores reduce speed to an effective 2.5 MHz, except for system programs running in ROM.)

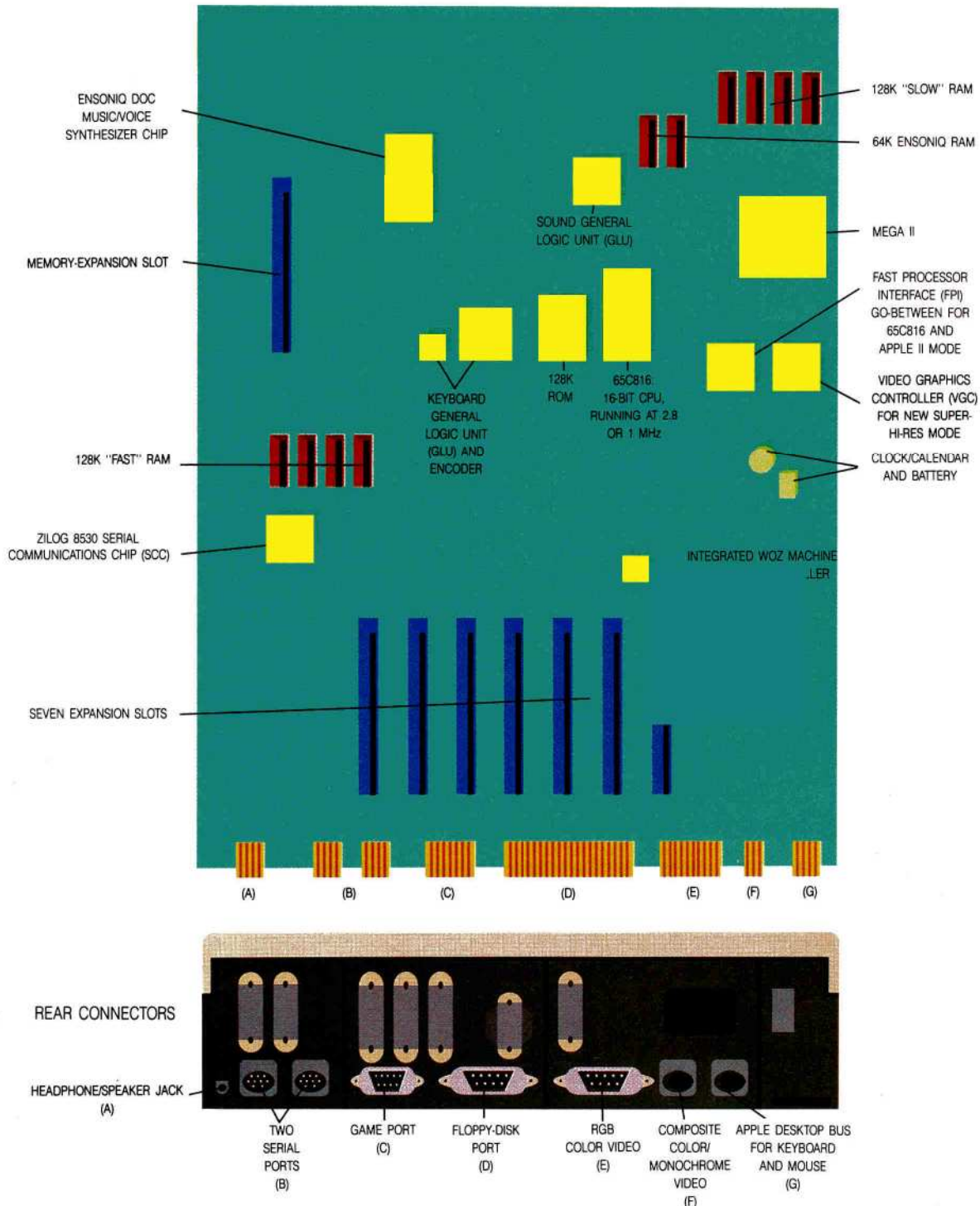
The 65C816 is a split-personality CPU. In emulation mode, it works exactly like the 8-bit 65C02, answering to the same instructions, running the same software (though with a choice of two speeds), and limited to the same 64K of memory at any one time. In native mode, it's a true 16-bit chip, not bottlenecked by an 8-bit address bus like the IBM PC's Intel 8088; in fact, its 24-bit bus can address up to 16 megabytes of memory simultaneously, with no bank-switching shenanigans. Sixteen megabytes is twice the maximum currently planned for the IIGs, or at least twice what's been said publicly.

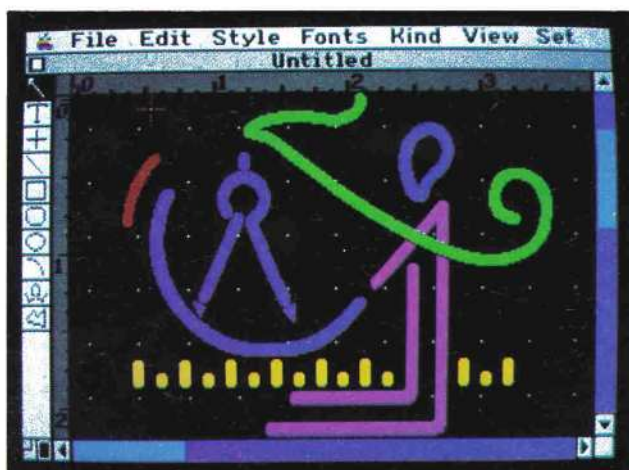
Memory Matters

The IIGs comes with 256K of memory, arranged on the motherboard in two sets of four 256K-bit chips. When running Apple II programs, one 128K set, with slightly slower access than its companion, is reserved for display, I/O, and system memory, while the faster RAM becomes two 64K banks for program use. New IIGs programs fit mostly into fast RAM, but can spill over into the slower space; Apple technical papers say that roughly 176K of the standard 256K will be available for 16-bit programs.

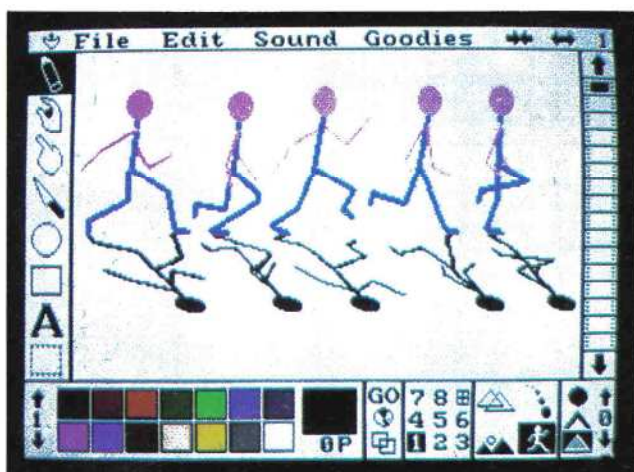
Figure. Diagram of sample IIGs motherboard and rear panel. Since the IIGs prototypes inCider saw in Cupertino were three months shy of being production models, Apple representatives wouldn't allow topless photos of the machines showing the interior logic board, or motherboard. However, they were too polite (though visibly uneasy) to prevent an inCider editor from drawing a freehand sketch of a sample board. This stylized diagram isn't guaranteed to accurately re-

flect final hardware, but shows some of the IIGs' main components and their positions relative to each other in the machines we saw. One thing the diagram can't convey is the flat profile yielded by Apple's use of newer surface-mounted instead of socketed technology. Except for the socketed CPU, RAM, ROM, and graphics controller, the IIGs' chips are efficiently mounted almost flush with the board.





Broderbund Software's *The Drawing Table* (above) and *Fantavision* (below) take advantage of the IIGs' graphics capabilities.



The Apple IIGs: Fast Facts

- The new Apple has a 16-bit (65C816) processor and 256K of memory, expandable to 8MB. It uses two operating systems: ProDOS 16, supporting a Macintosh-style Finder for new 16-bit software, and ProDOS 8 for Apple II emulation. One of its custom chips, the Mega II, is a complete //e except for the CPU and memory.
- Except for communications programs, the IIGs will boot and run nearly all existing ProDOS, DOS 3.3, and Pascal 1.3 software. You can temporarily leave a program to use a firmware Control Panel—changing options such as screen colors or switching between the traditional 1 MHz and a swift 2.8 MHz clock speed.

To surpass 256K, there's the IIGs' eighth slot—not equivalent to the //e auxiliary slot, but dedicated to memory expansion. This slot can carry up to 8 megabytes of RAM; according to Sasaki, Apple's own memory-slot card will stop at 1 megabyte, but third parties are expected to release 4- and 8-megabyte cards. The memory-expansion slot can also hold up to 1 megabyte of ROM, serving as an application ROM disk or adding extra convenience (an operating system, perhaps) to the standard 128K of ROM.

Does this mean current //e memory-card owners are out of luck? Partially. Auxiliary-slot cards such as Applied Engineering's RamWorks are useful only as sources of chips to plug into the socketed new board, but a peripheral-slot card such as Apple's //e expander will fit into one of the IIGs' seven expansion slots and will be recognized as a RAM disk.

The IIGs has a built-in real-time clock, powered by a lithium battery providing five to ten years' use (and soldered to the motherboard, upsetting *inCider's* consumer advocates, who think changing the battery in 1996 shouldn't require a trip to your dealer). The clock serves to time- and date-stamp disk files, though it uses different commands from those of current third-party timers such as the Thunderclock.

II Compatibility: From El Grando to Mega II

Computers today commonly use VLSI (very large-scale integrated) circuits, but the new Apple carries the technology to extremes. The first four IIGs prototypes, dubbed "El Grandos" by the engineering team, were computers the size of conference tables, lashed together from old-fashioned wire-wrapped circuit boards with hundreds of IC's each. Once the design was debugged, it could be shrunk. Along the way, the Apple II—the whole computer, except for the processor and memory—was squeezed onto a single chip. It's called the Mega II, and it's the heart of the IIGs' compatibility with ProDOS, DOS 3.3, and Pascal 1.3 software. (Yes, WordStar and Studebaker lovers, Apple says the IIGs will run CP/M software with one of today's Z-80 cards, though some cards require a software patch.)

The Mega II encompasses the //e's MMU (memory-management unit), IOU (input/output unit), general-logic unit, timing generator, and character-generator ROM's (for upper- and lowercase and mousetext, with Swedish, German, Italian, Spanish, Danish, French, and U.K. as well as U.S. English). It also provides II-compatible composite and RGB video, including low-, hi-, and double hi-res graphics.

- New programs can take advantage of two super-hi-res modes, with bit-mapped graphics in 320-by-200 (256 colors on screen) or 640-by-200 (64 colors) resolution.
- The IIGs' sound capacity matches a music synthesizer's, with a digital oscillator chip supplying 15 voices or instruments. With proper software and I/O hardware, it can sample (record) and play back music or speech.
- There are seven expansion slots plus a dedicated RAM/ROM memory-expansion slot, as well as an array of built-in interfaces (disk drive, composite and analog RGB video, and two serial ports including AppleTalk network firmware). A mouse is standard equipment, as is a keyboard with numeric keypad. □

Another new chip, the FPI (fast processor interface), is the link between the old and new architecture, controlling 65C816 access to the Mega II and Mega II access to the faster RAM. Together, they ensure that the IIGs will boot and run practically anything your II Plus, IIe, or IIc can—in the case of *inCider's* trip to Apple headquarters, everything in a box of office disks ranging from AppleWorks, Mouse Desk, and SuperCalc3a to F-15 Strike Eagle and Stickybear Spellgrabber. One IIGs hung up after the title screen of Epyx' Ballblazer; another, with newer ROM's, ran the game successfully.

The major exceptions are communications programs, most of which (even Apple's own Access II) bypass formal I/O channels to directly address the II's serial hardware. Since the IIGs has a different communications chip (see below), Apple expects vendors to issue revised versions of their programs, as it's doing for Access.

You're in Control

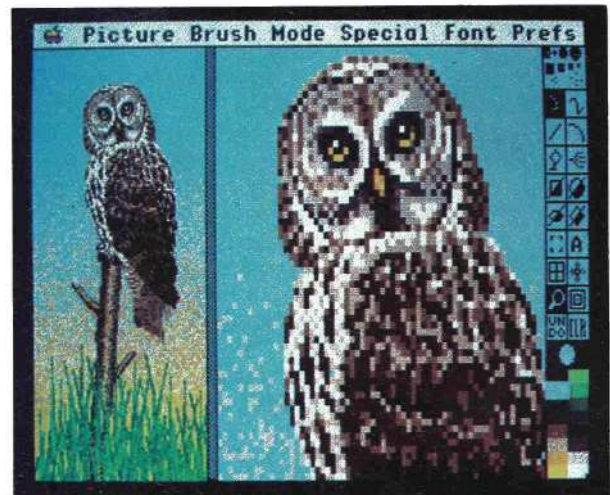
Users of self-booting software, as always, won't have to think about operating systems. New 8-bit (6502 emulation mode) programs will run under one of the IIGs' two operating systems, ProDOS 8, which doesn't look very different from the current ProDOS 1.1.1. (Screens we saw booted to a "ProDOS 8 1.2" message.) ProDOS 8 becomes the official operating system for the IIe and IIc, as well. At startup, it automatically checks to see whether it's on a IIGs and should read the clock.

But even when running an old program in an old graphics mode, you're never far from the IIGs firmware. Press the control, open-apple, and escape keys (except under ProDOS 1.1.1, which disables interrupts), and your program is temporarily frozen while a Macintosh-like Control Panel takes over the screen.

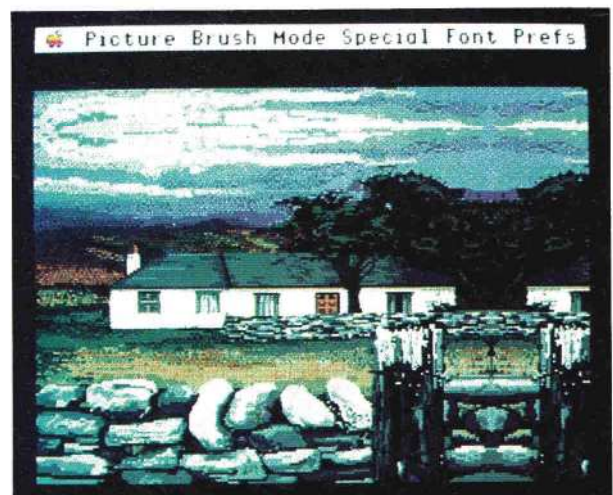
The 8-bit Control Panel is a 40- or 80-column text display, compared to the bit-mapped, mouse-driven dashboard that waits behind ProDOS 16 software. But it offers the same range of options, from setting serial-port parameters to setting the time and date, choosing a foreign character set and keyboard layout, controlling sound (such as error beep) pitch and volume, or sizing a RAM disk. Default choices are preserved in battery-backed memory until you change them again.

Speeding Up Software

You'll probably use two Control Panel choices more often than any other. One lets you choose among 16



Above and below are examples of Electronic Arts' Deluxe Paint program running on the Apple IIGs. The above illustration was designed by Richard Antaki. The illustration below is by Avril Harrison.



IIGs Specifications

Processor: 65C816 (16-bit CPU with 24-bit address bus). Switchable 1 and 2.8 MHz clock speeds in both native (ProDOS 16) and 65C02 emulation (ProDOS 8, DOS 3.3, Pascal 1.3) modes.

Memory: 256K of RAM; expandable to 8.25MB. 128K of ROM; expandable to 1.125MB.

Graphics: Apple II-compatible 40- and 80-column text and low-, hi-, and double-hi-res graphics modes. Super-hi-res at 320 by 200 pixels (256 on-screen colors) and 640 by 200 pixels (64 on-screen colors). Palette of 4096 colors.

Sound: Ensoniq 15-voice music/speech synthesizer chip with 64K of dedicated RAM and 32 digital oscillators.

Expansion: Seven Apple II-compatible expansion slots; one dedicated RAM/ROM memory-expansion slot. Clock/calendar standard.

Ports: Composite and analog RGB color video. Disk-drive port (daisy-chain up to four 3½-inch 800K or 5¼-inch 140K drives). Apple Desktop Bus for keyboard and mouse. Two serial ports for printer, modem, AppleTalk (network firmware built in). Game/joystick port. Sound port/headphone jack. □

colors for text, background, or border display—blue AppleWorks on a yellow background within a green frame, for example. The other lets you toggle between slow (1 MHz) and normal (2.8 MHz) speeds.

The faster speed is a barely controllable riot for graphics games ("Go, Stickybear, go!"), but will be the usual choice for applications. Our unofficial stopwatch tests yielded approximately double speed—a SuperCalc3a recalculation in 0.6 instead of 1.3 seconds, an AppleWorks word-processing search-and-replace in 15.5 seconds instead of 35.1. Sasaki claimed Apple's tests show a somewhat greater improvement, though he admitted that a //e with an accelerator card like Applied Engineering's TransWarp is still faster by 5 to 10 percent. (Our test times are for IIGs slow versus fast modes; the IIGs at 1 MHz was trivially slower than a regular //e, but differences were within the margin of stopwatch reflex error.)

Super Graphics

The following articles contain more detail about 65C816 native mode and ProDOS 16 software, though at press time we don't know as much as we'd like to. Suffice it to say that IIGs programs will work like Macintosh programs, with pull-down menus and point-and-click mouse control, and that the centerpiece of ProDOS 16 will be a Mac-style Finder that makes file copying, for example, as easy as dragging icons from one disk to another (even, according to Apple literature, formatting and handling file conversion among ProDOS, DOS 3.3, and Pascal disks). Software developers' jobs will be eased by a Mac-type toolbox of standard ROM- and RAM- or disk-based routines for such tasks as managing memory, menus, and windows, drawing and shading graphics, and handling a clipboard or scrap buffer.

The most obvious differences between IIGs and Mac programs will lie in graphics and sound. The third of the IIGs' major custom chips, the VGC (video graphics controller), supplies two functions: the QuickDraw II set of screen graphics tools and the GS' two new super-hi-res modes.

The VGC produces a gorgeous 16-shade gray scale on the IIGs' composite monochrome monitor, but most buyers will want the high-contrast (black-matrix background) analog RGB display to show off super-hi-res color—a palette of 4096 colors available in either mode, though not all at once.

The first super mode supports a resolution of 320 (horizontal) by 200 (vertical) pixels, using 4 bits of memory per pixel to show up to 16 colors on any one scan line and a maximum of 256 different colors on screen. The second super mode doubles that resolution to 640 by 200 using 2 bits per pixel, though maximums drop to four colors per

scan line and 64 colors on screen. Those colors, Sasaki admits, are technically shades achieved through dithering (mixing blue with white, for instance); the number of true simultaneous colors in 640 mode is more like 16.

Symphonic Sound

As for sound, an adjustable error beep is only the beginning. The IIGs has the same Ensoniq DOC (digital oscillator chip) found in that company's Mirage music synthesizer, with its own 64K of RAM to store and manipulate digitized waveform representations or samples. The synthesizer chip includes an analog-to-digital converter and 32 oscillators; since one serves as a clock and most applications will use two for each voice (loading and playing waveforms, respectively), that lets the IIGs play 15 voices or instruments at once.

While there's room for the IIGs' sound capabilities to grow—neither stereo output nor the popular MIDI (Musical Instrument Digital Interface) are standard, though both are likely add-on products—the Ensoniq chip is already reason enough to hook up an external speaker to the IIGs sound port. (The IIGs has the same built-in low-fidelity speaker as the //e.) With the proper software, for instance, the IIGs can be a string quartet or a 15-piece band—it sounds like a musical instrument, not like a computer imitating one.

According to software engineer Gus Andrate, digitally sampled music, though it hogs disk and memory space, is good enough to make office coworkers ask "What CD [compact disk] is playing?" A sample tape-deck program and external mike recorded and played our voices with dictation quality. The entertainment, educational, and business possibilities—from French or music lessons (perhaps with a low-cost piano keyboard?) to communications software that answers phone calls with your voice—are some of the most rewarding areas for IIGs speculation.

Mass-Storage Decisions

Got an old Disk II? Plug its controller card into a IIGs slot and load your software; the combination, Apple promises, will run with no problems. If you're building a IIGs system from scratch, however, or want to leave the new machine's expansion slots free for future gadgets, you'll probably rely on its //c-style IWM (Integrated Woz Machine) controller chip and SmartPort disk interface—a port that's flexible enough to be no help at all in your decision whether to use 3½- or 5¼-inch disks.

According to Apple documentation, the IIGs' disk port can daisy-chain up to four floppy drives in a mix of one DuoDisk (which counts as two 5¼-inch drives), one or two 5¼-inch (140K) UniDisks, and one or two 3½-inch (800K)

The //e Upgrade

Apple II and II Plus users are out of luck, but //e owners will be able to convert their computers to Clark Kents: the mild-mannered exterior and keyboard of the original //e case, concealing a new IIGs logic board with 65C816 processor, 256K of RAM, and all the features, ports, and expansion capacity of the new model. (Keyboard and mouse are available separately; Apple feels owners who already have a //e mouse and card will want to keep their investment.)

Since the retrofit involves much more than putting a

card in a slot—it's a replacement of the entire motherboard and base pan, with a new back panel for IIGs ports—Apple discourages owners from making the change themselves. That means dealer labor will probably hike the upgrade price; at press time, that price is still as unclear as the IIGs' cost. IIGs marketing manager Tom Virden predicted a \$300-\$400 difference between the two, however, which might put the upgrade in the \$1000 range. In late June, IIGs product manager Curtis Sasaki said that Apple had not set a policy as to whether or not upgraders could keep their //e motherboards. □



What you'll get when you open your IIgs package: a system unit, keyboard, mouse, 3½-inch system (ProDOS 16 and utilities) and tutorial disks, and Applesoft BASIC, system disk, owner's guide, and setup manuals.

drives. Single drives can be either existing UniDisks of either size or the new 3½- and 5¼-inch Apple drives scheduled for release at IIgs rollout. (They're platinum color, and the 3½-inch drive plugs into either a IIgs or a Macintosh.) If you want a fifth or sixth floppy, a pair of 5¼-inch disks will run off a controller card in slot 6.

As far as the 3½- versus 5¼-inch drive decision goes, Apple and its customers are in an awkward position. The smaller disks are faster, quieter, sturdier, and more spacious, and deserve to become the market standard; Apple supplies the IIgs tutorial, ProDOS 16, and Finder on two 3½-inch disks, and new 16-bit software will presumably appear in 800K format. On the other hand, the IIgs can run thousands of existing Apple II programs, and they're on 5¼-inch floppies. Current owners can use their old drives with their new machines, but will ultimately have to buy a 3½-inch drive if they haven't already. Novices, at least for a while, will almost have to buy one of each.

Apple's Macintosh Plus has a SCSI (Small Computer Systems Interface, pronounced "scuzzy") port, used primarily for fast transfer of hard-disk data, as standard equipment. This led market watchers to guess that the

IIgs would have one, and it does—on an optional card for the IIgs and IIe, not as standard. Along with the SCSI card, Apple announced a matching 20-megabyte hard drive. The Hard Disk 20SC takes up extra desk space (10 by 11 inches) beside the computer, but can load programs or data at the breathless rate of 1.25 megabytes per second, according to Apple press information.

Communications and Networking

So far, we've mentioned almost every port along the IIgs' rear panel, from composite and RGB video to the disk port and Apple Desktop Bus (which can take input devices such as graphics tablets as well as the keyboard and mouse). If you've been waiting in suspense all this time, there's a game/joystick port back there, too.

And there are two built-in IIc-style serial ports, which most buyers should use for the traditional connections to printer and modem. There are, however, two changes in the IIgs' communications architecture. One is that the machine uses the same Zilog 8530 SCC (Serial Communications Chip) as the Macintosh—that's why communications software that expects to find earlier models' 6551 ACIA's

Another AppleWorks

As reported in our September News Line (p. 14), a new AppleWorks will appear when the IIgs does, but it won't be a mouse-driven, Macintosh-style program. Instead, the ProDOS 8 upgrade of Apple's best-selling multifunction package (for the IIe and IIc as well as the IIgs) adds two evolutionary features: a mail-merge function for word processing form letters, and extra memory support similar to the AppleWorks patches supplied with current memory-expansion cards. In short, the new AppleWorks will have as standard some of the features now sold as third-party enhancements.

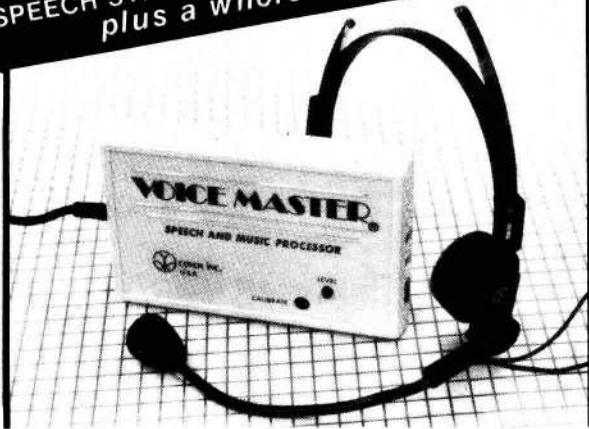
In a 128K system, the revised AppleWorks' 56K desktop is only 1K larger than version 1.3's; word-processor files are still limited to 2250 lines, data bases to 1350 records, and spreadsheets to 2K of data per row.

In a IIgs or a IIe or IIc with an Apple expander card, however, not only does the desktop grow (up to 1012K in 1-megabyte machines, as with AppleWorks 1.3), but so do allowable files: word processing to 7250 lines, data bases to 6350 records, and spreadsheets to 10K per row.

What about the 16-bit, mouse-and-menu version of AppleWorks? According to *inCider's* sources, there might not be one. While today's AppleWorks will continue to be supported, Apple reportedly feels that the required rewrite would make little sense, considering the array of 65C816 software due from other developers. Possible candidates include Microsoft Works, the high-powered integrated package currently being prepared for the Macintosh. □

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(asynchronous communications interface adapters) won't work, as mentioned earlier. It's a matter of hardware compatibility; the IIGs firmware emulates the familiar Super Serial Card, as far as software commands are concerned.

The other difference is that printer and modem connections are only two of the IIGs' three communications abilities, any two of which you can use at a given time. The third is AppleTalk, protocol firmware for which is built into the IIGs just as into the Mac—a significant statement of Apple's plans for the new II in local-area networks, particularly since networking is an increasingly hot topic in educational-computing circles these days.

AppleTalk, announced in January 1985, is currently languishing as a system used primarily to connect multiple Macs to an office LaserWriter, as Apple still hasn't released the critical file-server component that will let networked computers share programs and data (if you want to ruin a friendship with an Apple official, say "AppleTalk file server"). But once complete, the network promises to be an affordable alternative to big corporate LAN's like 3Com's Ethernet, although its speed (230,000 bits per second) and size (300 meters maximum) are correspondingly less. If networking makes the transition to America's schools and small businesses, it'll be good to see the IIGs side by side with the Macintosh.

The Wish List

The IIGs doesn't have absolutely everything an Apple hacker could wish for, as project engineers confessed to us while our escort from Apple's public-relations staff blanched and sputtered. While the machine's 8-bit expansion slots provide compatibility with most Apple II add-ons, the designers considered adding 16-bit slots for more powerful peripherals. The video circuitry's place on the motherboard doesn't allow for quick upgrading as even more colorful, higher-resolution displays become feasible. The firmware Monitor includes new commands for the 65C816's extra functions, but Applesoft is boringly unchanged, with no support for the new graphics and sound (although ampersand routines may let programmers tap some of the toolbox firmware).

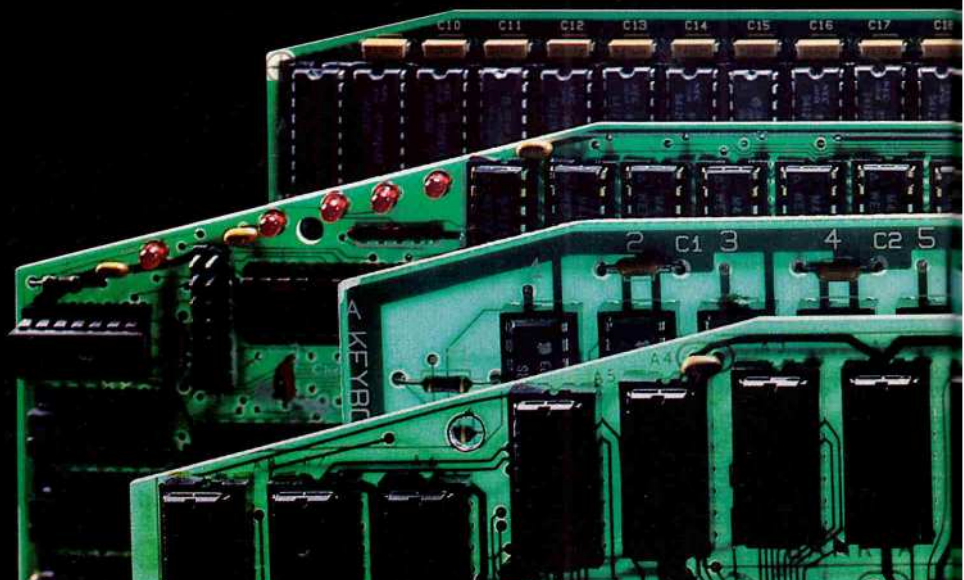
Also, while the IIGs is definitely inspired by the Macintosh interface, the Mac remains Apple's performance leader. It has a faster processor, higher resolution (albeit in black-and-white), and more ROM—instead of disk-based programming tools. The Mac's 68000 CPU also allows such conveniences as a switcher that supports multiple programs in memory at once, a feature Apple won't promise for the weaker 65C816.

On the other hand, Apple's Vice President for Product Development, Jean-Louis Gassée, told us, "We are already working on the successor to this machine. . . [and ensuring] that the software for [the IIGs] will run on it, even if we make hardware changes at the lowest level." When it comes to upward compatibility, Apple is clearly hanging on to its good habits.

Besides, for now the IIGs isn't meant to be Apple's top of the line. It's meant to revitalize the Apple II world—which it does with a vengeance, with fireworks, with choirs singing. No other microcomputer company has ever made a totally new machine that's hardware- and software-compatible with an old one; no other company has ever had such a large, loyal installed base to benefit from the maneuver. Seeing the sensational IIGs, you realize the slogan "Apple II Forever" was wasted on the IIc. ■

The New
II GS

Whether you're a full-fledged programmer or a novice computerist, an array of software and firmware tools will let you take full advantage of the power, sound, and graphics of the new Apple II GS.



LOOKING INTO ROM

by Paul Statt, *inCider* staff

Turn on the Apple IIgs. If you own an Apple IIe or IIc, you have some software for the GS already. Boot a disk you like—it'll probably run.

So what's new? Try control-open apple-escape (not control-open apple-reset: that still resets), and you reach the first "new" software for the Apple IIgs—the Control Panel. It's a memory-resident desk accessory that lets you set certain parameters for your new machine.

For instance, you can set the operating speed. The 65C816 microprocessor races along at 2½ million cycles per second (MegaHertz). Your old IIe or IIc toddled along at 1 MHz. You can set the throttle on the IIgs for either speed: If you run applications written for the IIe or IIc at the fast rate, they work as if you had an accelerator card.

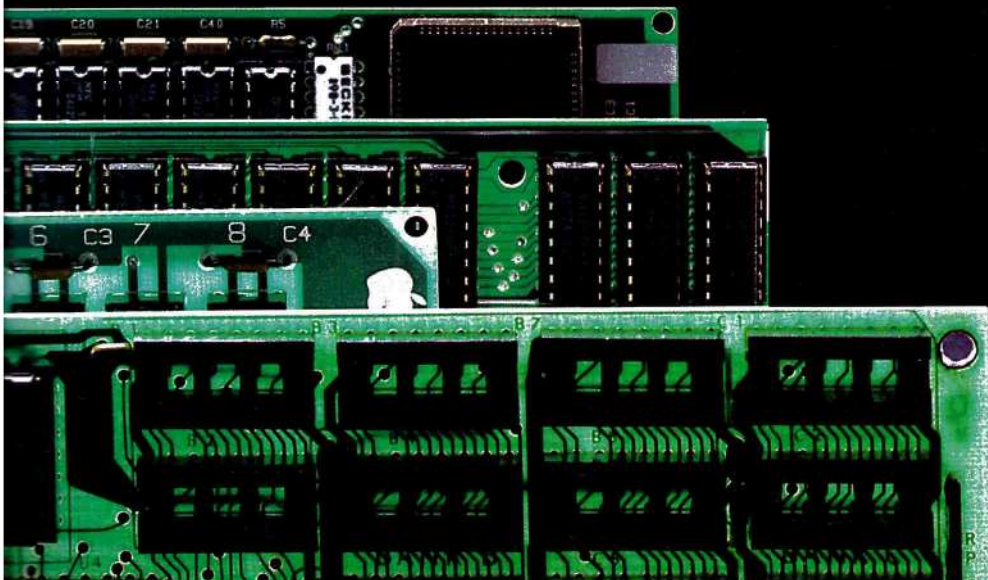
You can set the clock and calendar with the Control Panel. You can allocate slots for various peripherals. You can choose the language in which you want to type: The IIgs isn't a translation machine, but it does have several foreign character sets and keyboard layouts in ROM. You can modify the display—set it for 40 or 80 columns, or

choose your favorite colors for the text and background. You can set parameters for various input/output ports—line length or carriage feeds for printers, baud rate for modems.

The Control Panel allows people who don't program the sort of control over their software that Apple IIe and IIc owners need a bit of BASIC to master. It does the work of all the "PR#1" or "escape" commands the older machine requires to control the way software communicates with the world.

The intent of the GS is akin to that of Apple's Macintosh: to make the computer more accessible to nonprogrammers. In fact, Apple promises a Control Panel for the production version of the IIgs that will resemble the Mac desktop, and will use icons and the point-and-click mouse interface to set up the computer.

Apple also promises a Finder. The Macintosh Finder, on which it's modeled, is an application in ROM that selects programs and takes care of disk upkeep—formatting, for instance. The Apple IIgs Finder should do the same.



Variations on a ProDOS Theme

The Apple tradition—in the II as well as the Mac—is an invisible operating system: The op system is there, but you can boot up Stickybear without ever seeing it. In keeping with that tradition, and that of Apple compatibility, the IIGs uses ProDOS.

Apple's Professional Disk Operating System, ProDOS, is the software the IIGs uses to get to its storage medium—5¼-inch disk, 3½-inch disk, or hard disk. The Apple IIGs has two versions of ProDOS: ProDOS 8 and ProDOS 16. The former runs like the old 8-bit ProDOS the Apple IIe and IIc use, but the latter takes the 16-bit power of the Apple IIGs into account. ProDOS 16 requires at least 256K of RAM—and that makes it impossible for an old Apple II to run it—and can use up to 16 million bytes. Because it's a part of the Apple IIGs system, ProDOS 16 doesn't require the complex global bit page map to manage memory, but instead uses built-in memory-manager firmware (see below).

All three flavors of ProDOS—plain, 8, and 16—use the same disk formats and file structures, and thus can read data files from each other. Your data in old ProDOS format will not be lost to your Apple IIGs software.

ProDOS 16 will let you open an unlimited number of files; ProDOS held you to eight. Unlike ProDOS, which supported two devices per slot (for a total of 14), ProDOS 16 will support any number of peripherals. At least three separate device protocols are possible under ProDOS 16. It supports named devices, unlike ProDOS, which requires volume names. ProDOS 16 also offers several new operating-system calls, including GET ENTRY, WRITE PROTECT, GET DIB, SAVE STORE, RESTORE STATE, and SET INIT MODE.

Programs working under ProDOS 16 won't run under older versions of ProDOS; software written for the older ProDOS will run under ProDOS 16.

In short, the Apple IIGs is compatible with the Apple IIe and IIc. Software written for the older machines will run on the new one—if it was written to Apple's specifications. Software that bypasses the operating system and firmware in the old Apple IIe and IIc and goes directly to the hardware won't cut it on the IIGs; the only way Apple engineers could ensure compatibility was to create a machine that followed the rules to the letter.

What this means to you is that an old program that won't run, that hangs up after the title screen, or displays just a half screen may require only a small change in its code to make it run perfectly. The programmer probably cheated and wrote the software using "illegal entry points." You can make most of them legitimate, if the code is accessible.

ROM: The Heart of the IIGs

Programmers, particularly beginners, will be glad to hear that the IIGs has Applesoft BASIC in ROM. The more experienced among you won't be happy to learn that it's the same old Applesoft with which graphics magicians

have been struggling for years: The display memory is still in the middle of program memory, bit-mapped graphics-animation routines are lacking, CIRCLE and BOX commands are missing. Applesoft in ROM on the Apple IIGs is a language for the old Apple, not for the high-powered IIGs. Apple seems to feel that its Toolbox (see below) makes additions to Applesoft superfluous, but there's no route from Applesoft to the Toolbox routines. Not yet.

Included with the Apple IIGs is a neat introduction to BASIC. It's not as complete as the *Applesoft Reference Manual* that comes with IIe's and IIc's, but it's a good beginning.

A big part of the Apple IIGs ROM is taken up with new Tools for programmers. The Toolbox is familiar to the Mac programmer; it's anathema to the Apple II programmer, who would as soon write into RAM with a soldering iron if he thought he could save a few lines of code. A software tool in the Mac or Apple IIGs creates a window on the display screen, so that the programmer doesn't need to write that code—he "calls the tool" that does the job. It's like using PEEKs and POKEs in BASIC to call Monitor routines, except that tools do more than "ring a bell and return an error message."

The Apple IIGs Monitor itself is bigger than the old one. The display is improved: For instance, hexadecimal and ASCII values appear simultaneously. Since the 65C816 has 16-bit registers and a 24-bit address bus, the new Monitor needs extra digits in the bank address to get at it all. The Apple IIGs Monitor also adds altogether new features, such as a search function that can find any pattern up to 236 bytes long, hex-to-dec or back conversions,

and base 16 addition and subtraction.

The Apple IIGs Monitor includes a mini-assembler and disassembler for the 65C816. They support all of the microprocessor's 91 instructions and all 24 addressing modes for a total of 256 operation codes.

Another part of the Apple IIGs hard memory takes care of all the interrupts the new hardware requires—routines that keep the keyboard, sound chip, graphics chip, clock chip, and so forth all in order.

All together, the Apple IIGs has 128K bytes of built-in firmware. That's as much ROM as the IIc had RAM. The sudden need for all that permanent memory is that the Apple IIGs is two machines in one case—a programming feat performed with shadows, not mirrors. Programmers will also need to remember that a great deal of the personality of the new machine is in ROM.

gs Magic

Apple has breathed the soul of an old machine into its newest one. The Apple IIGs knows two tricks that let it run almost all of today's Apple II software as well as tomorrow's—the software that will make the computer act like a

"In short, the Apple IIGs is compatible with the Apple IIe and IIc. Software written for the older machines will run on the new one—if it was written to Apple's specifications."

television or a record player. The hardware trick is the Mega II integrated circuit, which is a lot smarter than you are and probably smaller—it's an Apple II on a chip (see "Back to the Future: Apple's Amazing GS," p. 36, for details).

The software trick is harder to see: It's memory sleight-of-hand that assigns two 64K banks in the Apple IIgs—half of its total 256K in four banks—to emulate the IIe and IIc.

Why bother? The Apple IIe and IIc—that is, the Mega II in the Apple IIgs—can address only 128K. It addresses those two 64K banks at the speed of the old Apple processor, the 6502, which is 1.02 million cycles per second (MHz). The 65C816 in the Apple IIgs works two and a half times faster, at 2.5 MHz. Input and output slots on the IIgs run at 1.5 MHz, as must display pages. The memory the Mega II doesn't handle is addressed and refreshed by a GS fast processor interface (FPI) chip.

Apple engineers solved the speed problem by *memory shadowing*—writing instructions into two banks of memory simultaneously. One bank runs slowly to control input, output, and display pages, while the other bank moves quickly to accomplish the actual processing of information.

The fast banks are banks \$00 and \$01; the slow memory is in \$E0 and \$E1. When the Apple IIgs pretends to be a IIe or IIc, banks \$00 and \$01 emulate the main and auxiliary banks of memory—what Apple calls Fast RAM. The effect is that the IIe or IIc program runs as it would on a IIe with an accelerator card.

Tools for the IIgs

But the Apple IIgs would hardly be news if it were a mere IIe with an accelerator. In addition, the machine's faster microprocessor and dedicated sound and graphics chips will make possible a number of new programs—indeed, entirely new kinds of programs. Using the Toolbox, programmers can easily write code for the Apple IIgs with its complex of chips and levels.

The Toolbox is a notion familiar to Macintosh programmers. The Mac includes a series of firmware routines—software "hard-wired" into the Mac hardware—that take care of all the functions that give the machine its distinctive "point-and-click" interface. A Toolbox manages windows, menus, fonts, dialog boxes, and more.

When Apple designed the IIgs, its engineers drew on the company's experience with the Mac and selected the most useful Mac routines. Tools come in Tool Sets, and the ten Tool Sets in the Apple IIgs comprise the Toolbox.

The Apple IIgs, with its limited memory (compared to that of the 512K Macintosh) and greater need for ROM space to run Apple IIe and IIc programs, has to keep some Tool Sets on disk to load into RAM. Apple decided which tools would be stored on disk and which would be in ROM in the IIgs, but preliminary documentation hints that programmers will be able to reassign tools at will.

Tools are assigned places in ROM or RAM by yet another tool—the Tool Locator, which itself resides in ROM. The Memory Manager in ROM allocates memory in

RAM—a considerable feat of navigation through the complex memory map of the IIgs. It does what the system global page in ProDOS does, and makes it possible for the Apple IIgs to easily handle large coresident applications such as spelling checkers and telecommunications programs.

QuickDraw II is a tool whose inspiration and namesake is the graphics wizard QuickDraw. QuickDraw managed the Mac's black-and-white pictures; QuickDraw II uses a number of QuickDraw subroutines and adds color. QuickDraw draws lines and text characters and fills areas. In the IIgs, super-hi-res is the standard display mode, so QuickDraw will have an important job in every application written for the new machine. The most important QuickDraw II routines are in ROM, while less crucial ones are assigned to RAM.

To make arithmetic easy, the Apple IIgs includes a floating-point numerics tool, the Standard Apple Numerics Environment (SANE). It adds, subtracts, multiplies, and so forth, as well as accomplishing more esoteric jobs such as converting hex numbers to decimals and returning true random numbers.

The Apple IIgs Control Panel, a ROM program you can use to change the machine configuration and set the clock at any time, is the responsibility of the Desk Accessory Manager, which also controls small coresident applications like calculators and appointment books.

Application programs such as word processors and spreadsheets respond continuously to your tickling the keyboard or mouse. The GS Event Manager keeps the machine informed of your behavior and tells the application what to do in response to your keystrokes. The Event Manager also manages to draw windows within windows,

and to know where the pointer was on the screen when you clicked the mouse button.

The Sound Manager sets up the music and speech generators in your Apple IIgs sound chips, without intensive programming on your part. Sound Manager tools also read and write sound code into and from RAM, start and stop the music, and turn the volume up or down. (In addition, it handles the single-bit sounds of the Apple IIe and IIc with ease.)

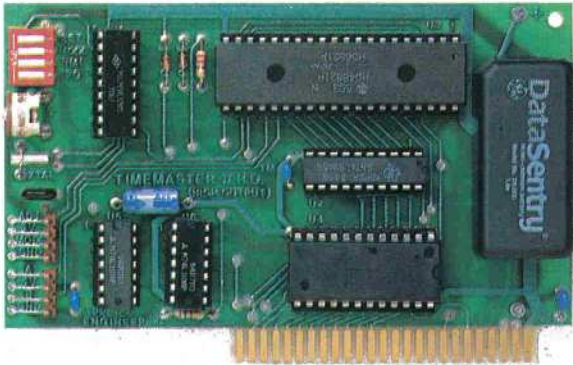
Other tools reside in ROM: Integer Math Tools, Text Screen Tools that let applications use text modes without switching banks (graphics is the standard mode on the IIgs), and a Scheduler that tracks and allocates time on the CPU to system code. Still other routines perform a variety of minor functions.

Apple has an interesting idea for Disk Tools: "ROM" routines you load from disk into RAM. Without saying how, Apple claims you can locate the tools of your choice in ROM and reserve the others to disk; that would likely require burning an EPROM.

The disk-based tools are the menu manager, window manager, control manager, line editor, dialog manager,

"When Apple designed the IIgs, its engineers drew on the company's experience with the Mac and selected the most useful Mac routines. Tools come in Tool Sets, and the ten Tool Sets in the Apple IIgs comprise the Toolbox."

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scrap manager, and print manager. What these tools have in common, aside from a disk, is that they're the most "Mac-like" tools on the Apple IIgs, except for QuickDraw. It appears that you load them into RAM, and into "high RAM" at that, since the smallest banks, \$00 and \$01, are reserved for Apple IIe and IIc emulation. Some sacrifice in speed of execution seems unavoidable.

Another advantage to which we can look forward is a set of built-in drivers in the print-manager software/firmware that can control all kinds of printers—including new ones such as the LaserWriter and other laser printers.

Programming for the GS

Apple says programming for the IIgs will be easy. Not only do the Tools make this possible, but other standards help, as well. Object files in the Apple IIgs follow a standard format, regardless of their source—that means programs written in different languages will be presented to the machine the same way. A "linker" and a "loader," working with those standard object files, can create modular programs and combine segments written in different source languages into a single program. The advantages of *team-written* software are immediate: Each programmer can write his or her own part of the whole in the language that best suits that segment. (The choice of development language isn't wide open, though. The Apple IIgs standard object code is available from assembly language, C, and Pascal.)

The Apple IIgs assembler is based on the ORCA/M assembler—it's not a version of the Apple IIe and IIc EdSam assembler. But it does support the instruction sets and addressing modes of the 6502, 65C02, and 65816 microprocessors. It features assembler directives, macros (including predefined macros for I/O, ProDOS calls, graphics, and other common assembly-language routines), segmented object files, and partial assembly so that changes don't require reassembly of the entire program.

While it's similar to Macintosh C, IIgs C includes some changes to accommodate the smaller microprocessor. C programs for the IIgs can easily include segments written in Pascal or assembler.

Pascal for the IIgs resembles Macintosh Pascal; hence, it's also similar to Instant Pascal for the Apple II, but it's unlike UCSD Pascal.

In June as this was written, information about much of the software/firmware for the Apple IIgs was sketchy. ProDOS 16, for example, wasn't completed yet; developers had been using a preliminary version called ProDOS 12. We couldn't find the Finder, and the Mac-style interface was nowhere to be seen, in either the Control Panel or applications. We did see early attempts at a paint program that were stunning, and a "digital tape recorder" that digitized our probing questions.

As you read this in October, a load of new programs for the new Apple IIgs should be on your dealer's shelves. It will look like Macintosh software in color, and the interface will have the Mac feel. That look and feel is the offer of the firmware in the Apple IIgs, if programmers choose to take it. ■

The New
IIGS



WHO WILL BUY THE IIGS?

"The reincarnation of the Apple II spirit": For education, home, and small business, the powerful, high-end IIGS combines open architecture with sophisticated graphics and sound.

by Dan Muse, *inCider* staff

What's platinum and goes between the Apple IIe and the Apple Macintosh? The answer: the new Apple IIGS. Its color is platinum, and its position in the Apple II product line is between the IIe and the Mac. Officially, Apple says, the GS is the high end of the Apple II family, and the company will market the machine for educational and home-business applications. Unofficially, the GS has no bounds, and you, the user, will decide where the GS fits in.

The GS in Perspective

With the release of the GS, the Apple Computer product line looks like this, ranging from least powerful and expensive to most powerful and expensive: Apple IIc, Apple IIe, Apple IIGS, Macintosh 512, and Macintosh Plus. According to Apple's New Product Manager Randy Battat, the GS represents the high end of the II family, but doesn't change the positioning of the IIc and IIe (although Apple says we can expect price cuts). "The GS is a new II. It doesn't replace anything," says Apple's Battat.

Apple had four objectives in designing the IIGS, says Battat:

- It had to be an Apple II and run existing II software.
- It had to be faster.
- It needed increased memory addressing.
- It needed sophisticated graphics and sound capability.

In many ways the GS offers the best of both worlds. It combines the Macintosh's user interface and sophistication with the Apple II's software base and open architecture. But the GS isn't a merger of the Macintosh and the II. The Mac and II will each retain a "unique identity," according to Battat.

"In terms of power and capability, there's some overlap with the Mac. Is the market going to be confused? I don't think so," says Apple's Vice President of Product Development Jean-Louis Gass e.

What makes an Apple II unique, Battat says, is its "special base" of thousands of software packages and the company's ten years of experience in designing Apple II computers. Battat says this experience let Apple build a II that's comparable to the Mac for less money.

If you were expecting to buy the new GS at a price that rivals the Atari 520 ST or one of the popular IBM clones, you'll be disappointed.

When *inCider* editors viewed the Apple IIGS in June, Apple officials were reluctant to talk pricing. They did indicate, however, that the cost would be in the \$1300 range. Add an RGB monitor and a disk drive, and the price for a complete system is about \$2000. "It's an expen-

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"We're not going to try to play that [low-end] game."
Jean-Louis Gassée



Photos courtesy of Apple Computer, Inc.

sive product to build. When you try to build two software bases under the same roof, there is no way we can make it as low as the Apple II is today. We're not going to try to play that [low-end] game," Gassée says.

"I don't expect the economy-oriented customer to be necessarily wanting this [product]," he adds.

"Apple IIe users who want to upgrade to the IIGs can retrofit their systems for \$300-\$400 less than the price of the IIGs," Tom Virden, Apple's IIGs introduction marketing manager told *inCider*.

The GS Goes to School

While price is important to everyone, educators are particularly sensitive to the bottom line. Betsy Pace, Apple's marketing manager for K-12 education, says Apple is aware of this. The IIGs will replace the IIe at the top of the K-12 price scale, but, Pace says, the price structure of the various educational packages shouldn't change radically.

"The GS is the home-education connection," explains Pace. She says she doesn't see a parent buying a IIGs just for home education, but if a child uses an Apple II at school and the parents want a powerful computer for home business or productivity, the GS is a likely candidate.

In developing the IIGs, Pace says, Apple recognized the value of Apple II's already in schools and the investment those schools have made in Apple II products. "The progress of the Apple IIGs doesn't leave the older computers behind," Pace says. Because educators don't have a lot of money to spend on computers and software, it's important that what they already have doesn't become obsolete.

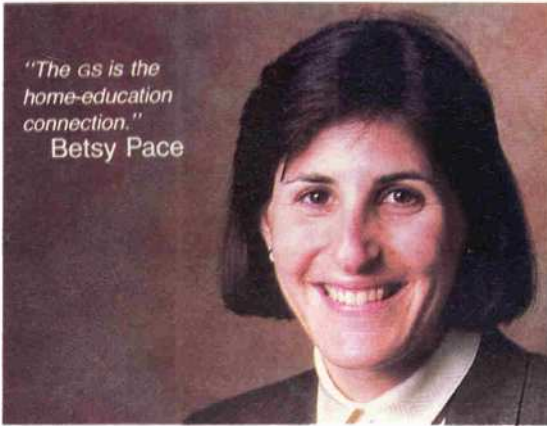
The GS will naturally replace the IIe at the high end of the K-12 price scale. Pace says she believes educators will continue to buy IIe's, however, because they know they have the option of upgrading to the GS. The IIe will continue to be the computer Apple recommends for use in kindergarten through grade 8. The GS will be used in grades K-8 for higher-level applications, though—for example, reading programs that take advantage of the GS' sound and graphics capability.

The GS' power and speed (and software that takes advantage of them) make it the Apple best suited for the high-school classroom, according to Pace.

For teachers, Pace says, Apple recommends the IIGs because of its strength as "a productivity workstation." It will let teachers run the instructional programs they use in the classroom as well as their own classroom-management software. Another important aspect of the GS for teachers is its ability to talk to other computers on the AppleTalk local-area network.

The GS is compatible with AppleTalk through its RS-422 interface. Apple expects the GS to play a pivotal role in

"The GS is the home-education connection."
Betsy Pace



the educational network. According to Virden, "The GS is the network master."

The network capabilities of the GS and its ability to run 16-bit business software make the new II the primary machine for school administrators, according to Pace. The Macintosh is reserved for district-level administrators, who need sophisticated business programs and data communications. The Macintosh will also be used for niche applications in grades 9-12 (for example, desktop publishing), she says.

Pace says the option of retrofitting the IIe (replacing the IIe's motherboard with the IIGS motherboard) will eliminate educators' fear of obsolescence. Educators can expect the prices of the IIe and IIc to drop as the GS enters the scene. At press time, though, Pace said a figure for the GS hadn't been set, but she did note it would be "aggressively priced."

On the Home Front

GS should strengthen Apple's solid foothold in the educational market. Outside school, however, the market positioning of the GS isn't as clear-cut.

Apple's game plan is to market the IIGS as it has marketed the IIc and IIe, relying on dealer sales and avoiding at all costs the low end of the market (as well as low prices). Apple's Virden calls the IIe and IIc high-end consumer products, and the IIGS the high end of the II line.

According to Virden, Apple will not market the GS directly against low-priced mass-merchandized computers, such as those from Atari and Commodore. "We are aware of competition," says Virden, but he makes it clear Apple has no intention of getting into a price war. "You know damned well that we're not going to match the Atari 520," he adds.

Instead, he explains, Apple will rely on its strength: "We are committed to our dealers." In launching the GS, Virden says, Apple has focused on "how can it work best for the dealers." He notes, "We also want to build a grass-roots movement [by] talking to user groups."

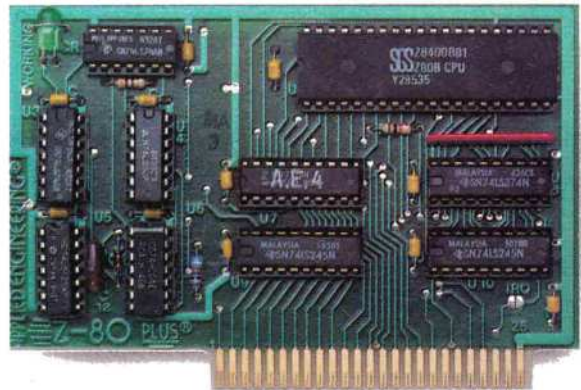
According to Ellen Petry Leanse, Apple's user-group evangelist, user groups will be involved with the IIGS at the product roll-out phase through a cooperative effort with dealers.

Representatives from about 500 user groups will receive modified presentations by dealers. "We want to reach out to end users and make them more comfortable with the machine," Leanse says. As "unbiased third parties," she adds, the involvement of user groups will benefit the dealer and the end user.

Moving Toward the Fringes

According to Virden, the GS will attract users who were on the fringes of deciding which computer to buy: "A lot

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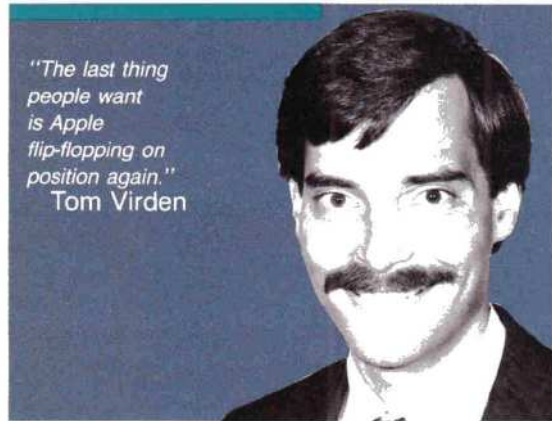
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"The last thing people want is Apple flip-flopping on position again."
Tom Virden



of business users with //e's have accelerator cards and upgrades. They're right on the ragged edge." They're considering going to MS-DOS and 16 bits, but they don't want to give up their Apple II software, according to Virden.

The existence of a computer that runs current Apple II software and offers sophisticated sound and graphics and powerful 16-bit software—a computer that seems to combine the best features of the //e and the Macintosh—may confuse users trying to decide on a machine. Virden maintains that the Mac 512K and Mac Plus will still be the high-end Apple business systems. "The last thing people want is Apple flip-flopping on position again," Virden says, alluding to Apple's previous positioning of the Apple III, Lisa, and Mac as top-of-the-line systems.

But if the customer's toughest decision is which Apple computer to buy, Apple isn't worried. Gassée says there's a philosophical difference between the II and the Mac.

Users who want to "lift the hood" and get inside the computer will be more likely to look at a IIgs; others will want only the easier-to-use Mac. "There are people who would not touch an Apple II, and there are people who would not touch a Mac," Gassée says.

New Life for the II

While a number of Apple officials are planning the marketing and positioning of the IIgs, Gassée prefers to talk about the computer itself: "I'd rather talk about usages than markets and niches."

The Apple IIgs is "the reincarnation of the Apple II spirit," says Apple's Gassée. "There's so much users can do [with the GS]." It has more power and sophistication than earlier II's, but for those so inclined, the hood still lifts easily.

"It's better than compatible, because it's faster," Gassée says. He warns, however, that "100-percent compatibility is not something you want to guarantee."

Gassée realizes that the best-laid marketing plans often go astray. He jokes about his "Zen theory of marketing": Put the computer out there and see who buys it.

When Gassée refers to his "Zen theory," though, he's only half kidding. While Apple has carefully positioned the GS in the educational and high-end home markets, Gassée hints at the IIgs' greater potential: "We should not try to artificially constrain this product by positioning it as an educational computer or a home computer. . . . It could be an interesting small-business type of machine. My idea of positioning tends to be simplistic: It's the high-end-technology Apple II." ■