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COVER STORY BY FREDERIC E. DAVIS

HERE AT LAST!

The color Macintosh is here, but guess what: It's an Apple II. The Apple IIGS is the newest member of the Apple II family, and it brings Apple's Macintosh

technology to the Apple II world in living color.

The Apple IIGS sports a lot of Macintosh-like features such as a mouse, pull-down menus, and windows. The IIGS will cost slightly less than

\$1000 for the CPU, keyboard, and mouse. Although the Apple IIGS falls somewhere between the Apple II and the Macintosh in terms of performance (the 16-bit processor in the IIGS is quite a bit

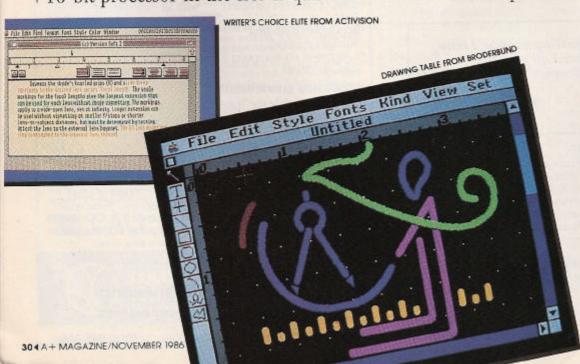
faster than the 8-bit processor in the Apple IIe but not as fast as the 32-bit processor in the Macintosh), the IIGS is superior to the Macintosh in two areas:

color and sound.

Apple chose the name IIGS to highlight these capabilities—the G in Apple IIGS stands for *graphics* and the S stands for *sound*. Although the Apple IIGS's color-graphics ca-

pabilities are quite impressive, they are not the best available; the sound, on the other hand, is outstanding and sets a new standard for personal computers. Some of the potential applications for







THE APPLE IIGS!

the Apple IIGs's sound capabilities include music education, sound analysis, voice mail, digitized voices, and talking foreign-language dictionaries.

We are always striving to make sure A + readers are the best-informed group of Apple users. In keeping with that goal, we have put together this special report on the Apple IIGS. Our coverage begins

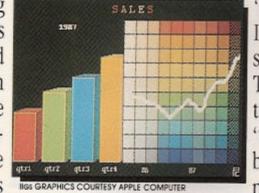
with this article, which gives you an overview of the IIGS-related products that are being developed by Apple and an impressive number of third-party developers. Next, starting on page 45, we

have an article entitled "A Technical Overview of the Apple IIGS," which presents the main technical features of the new machine. Then, on page 57, comes

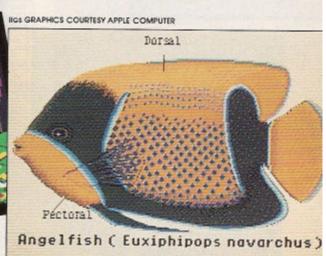
"The Making of the Apple IIGS" that gives you the story behind the machine. The last of our feature articles on the IIGS is "What's in the IIGS Toolbox?" which begins on page 77 and covers the

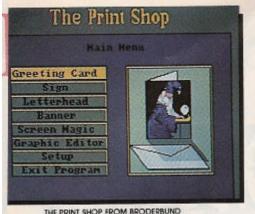
Macintosh-like Toolbox ROM, which gives the Apple IIGS a hefty dose of the Mac's personality.

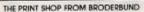
But that's not all; three of our top columnists present their views about the



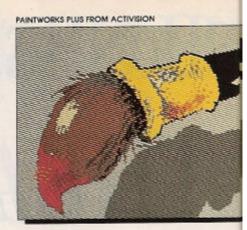












IIGS in this issue. Don't miss David | (version 2.0) that includes a built-in Thornburg's "Learning Curve," Steve Rosenthal's "Thoughtware," and Bob Lindstrom's new "GamePort" column.

MORE APPLE ANNOUNCEMENTS

In conjunction with the announcement of the Apple IIGS, Apple also introduced the Apple 3.5 Drive, the Hard Disk 20SC, a SCSI card for the Apple IIe DELUXE PAINT FROM ELECTRONIC ARTS

and IIGS, a monochrome monitor and an RGB color monitor for the IIGS, and

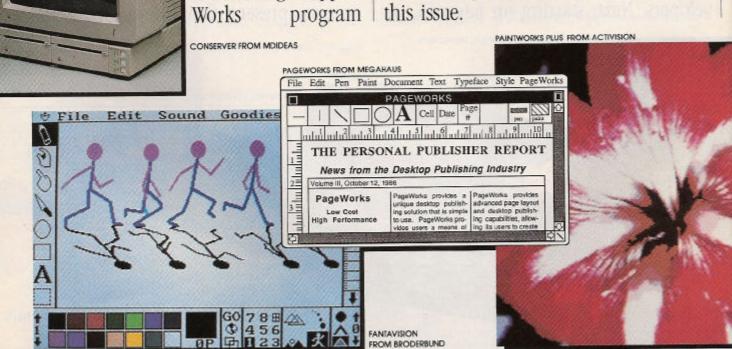
a new version of the best-selling Apple-Works

mail-merge function. The Apple 3.5 Drive is a new standard 3.5-inch disk drive with 800K of storage capacity that

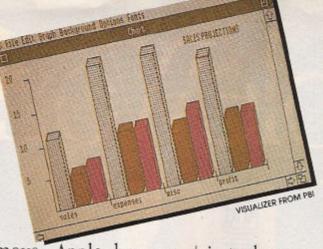
works with either the Macintosh or the Apple II series. The Hard Disk 20SC is a SCSI version of the Macintosh Hard Disk 20 that you can connect to the Macintosh Plus' SCSI port or to an Apple IIe or

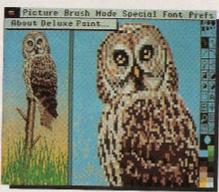
IIGS, using the new Apple II SCSI board. For more details, refer to the technical specifications of the newly announced hardware products on pages 46-47 of











DELUXE PAINT FROM ELECTRONIC ARTS

In a surprise move, Apple has announced a new color for all Apple products. You can say good-bye to the beige of the Apple II, II Plus, IIe, III, Lisa, Mac-

intosh, and their associated peripherals; you can say good-bye to the snow-white color of the Apple IIc, ImageWriter II, Personal Modem, and LaserWriter. The new Apple color is, believe it or not,

gray. Although some people at Apple are calling this new color platinum, I'm sticking with calling it gray. Beginning

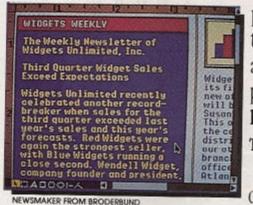
with the Apple IIGS, the new light gray is to become the standard color of all Apple products. Apple has already changed the color of the Apple IIc to this color, and you can expect the com-

pany gradually to convert the Apple IIe, Macintosh, and all its other hardware products to the new gray.

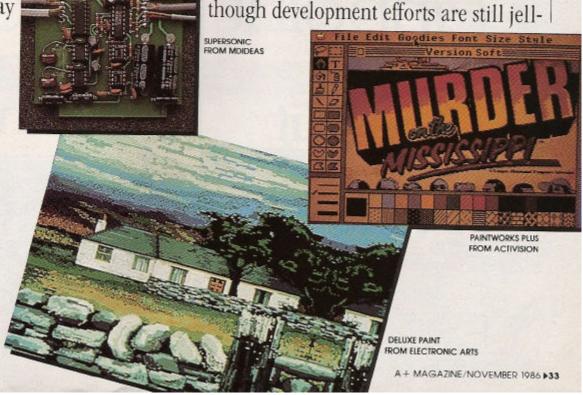
DEVELOPERS FLOCK TO THE IIGS

Software and hardware developers have given the

Apple IIGS a warm welcome, and it looks as if new products will be developed for the IIGS at a much faster rate than they were for the Macintosh. Although development efforts are still jell-







THE APPLE IIe-TO-IIGS UPGRADE

One of the most exciting aspects of the Apple IIGs announcement is word that Apple IIe owners can upgrade their computers to an Apple IIGS. Just as Apple has offered Macintosh users upgrades from the 128K Mac to the 512K Mac and now to the Mac Plus, Apple has now established an upgrade path for the Apple II community, even though the upgrade is currently limited to owners of Apple

He computers.

By upgrading your IIe to a IIGS, you will retain compatibility with most of your hardware and about 90% of your Apple II software while gaining the ability to run 100% of the new Macintosh-like software being developed for the IIGS. The upgrade involves simply swapping the IIe motherboard for a IIGS board and changing the back panel of

the Apple IIe to accommodate the IIGS's built-in connectors (see figures 1 and 2 below).

Upgrading from an 8-bit IIe to a 16-bit IIGs will give you the new 65816 processor, better graphics and sound, two serial ports, the AppleTalk network, a built-in disk-drive controller, and the Apple DeskTop Bus mouse connector. You will still have the same seven slots, but certain slots

are inactive when some of the builtin ports are in use. For example, a card in slot #1 will become inactive if the built-in serial port is used. On the other hand, a program looking for a serial card in slot #1 can use the built-in serial port if no serial card is in the slot.

Apple had not yet decided on the exact price or availability of the upgrade at the time of this writing, but

> it expects it to cost about \$600. Contact your local Apple dealer for more details about the Apple IIe-to-IIGS

upgrade policy.

Personally, I think that Apple's upgrade program should have been expanded to include Apple II, II Plus, IIc, and III owners, but the company does not plan to offer owners of these other 8-bit Apples an upgrade at this time.

—FD

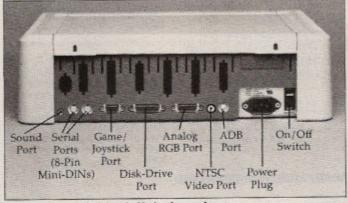


Figure 1: Upgraded Apple IIe back panel

1. 7 Expansion Slots Compatible with the Ile

2. IWM

Integrated Woz machine Single-chip disk controller

3. SlotMaker

Manages the expansion slots by generating control signals and buffers several clock signals

4. SCC

Serial Communications Control chip Provides AppleTalk

5. VGC

Video Graphics Controller Provides all Apple IIe and IIc graphic modes and the new super-high-resolution modes

6. FPI

Fast Processor Interface Controls system speed and "shadowing" and allows I/O access

7. Fast 128K RAM

8. Mega II

Integrates various chips of the Apple IIe and IIc

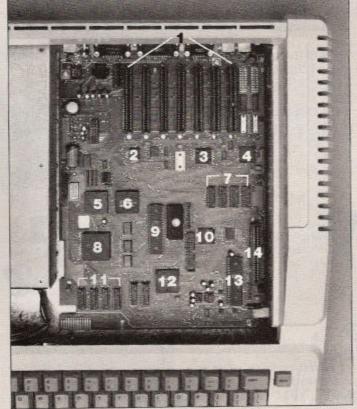


Figure 2: Upgraded Apple IIe with IIGS motherboard

9, 65C816 Processor

24 addressing modes: 13 original (65CO2) plus 11 new modes with 91 instructions, using 255 opcodes 24-bit address bus for access to 16 megabytes of memory

10. Keyboard GLU Interfaces Apple Deskil

Interfaces Apple DeskTop Bus to the system

11. Slow 128K RAM

12. Sound GLU

Interfaces the Ensoniq chip, with its dedicated 64K RAM, to the Mega II, allowing the Ensoniq to run independently of the Mega II

13. Ensoniq Sound Chip

32-oscillator synthesizer that, in most uses, will play 15 voices simultaneously

Memory-Expansion Slot

Dedicated ROM/RAM expansion slot ROM—up to 1 megabyte RAM—up to 8 megabytes

ing as we finish preparing this special report, we've done our best to round up information on most of the initial products. Keep in mind that many of these products will not be available immediately and that most of the information simply represents what developers have told us. Next month's A+ will include a chart with more details of new products for the IIGS (including the names and addresses of manufacturers), and future issues of A + will include actual product reviews. In the meantime, though, here's a brief roundup of the new products we've either seen or heard

Activision has created a MacPaint look-alike called Paintworks Plus and a MacWrite look-alike called Writer's Choice elite that look virtually identical to the analogous Macintosh products, with the important addition of color. The Paintworks Plus program is one of the first IIGS products we saw, and it looks like it and Writers Choice elite will be available right away. Activision is also working on a music-composition program called The Music Studio that should be out by the end of the year.

Applied Engineering is working on a 16-megabyte RAM card and an accelerator board for the IIGS. The accelerator board will supposedly run at 6 megahertz, as opposed to the IIGS's

standard 2.8 megahertz.

AST Research will be offering several products for the IIGS: an exciting color-graphics digitizing board called the VisionPlus that works with NTSC standard video signals such as those used by VCRs, televisions, and other home video equipment; the Sprint Disk RAMdisk card; the RamStack IIGS 4-megabyte memory-expansion board; and a version of the AST 2000 hard-disk and tape-backup unit that allows mounting of the tape drive as a volume on the IIGS desktop.

Bose, a manufacturer of high-quality loudspeakers, has announced the Special Edition Roommates. These speakers are a special version of Bose's Roommate speakers that the company has issued in a special light-gray color to match the new Apple look and connect to the IIGS's sound port. The Roommate speakers are smallish high-quality speakers with a built-in amplifier that were designed

It looks as if
new products will be
developed for the
Apple IIGs at a
much faster rate than
they were for the
Macintosh.

to amplify portable tape players and

compact-disc players.

Brøderbund has four impressive new products for the IIGS: News-Maker, a desktop-publishing/pagelayout program that features color printing on the ImageWriter II and high-quality printing on the Laser-Writer or any other PostScript printer; Drawing Table, a MacDraw-like object-oriented drawing program in color that allows importing of bitmapped images and is compatible with the LaserWriter; Print Shop IIGS, a complete revision of this classic program that allows color-graphics editing and color printing; and Fantavision IIGS, a major update to Fantavision that features sound and super-high-resolution graphics.

Chancery Software is coming out with CSL Marks, which is a sophisticated grade-book program for teachers that the company also offers for

the Macintosh.

DataDesk is a manufacturer of alternative keyboards for the IBM PC market, and it has developed the Turbo-ADB Keyboard, an IBM-style professional keyboard with 15 function keys that works with the newly announced Apple DeskTop Bus standard for connecting keyboards, mice, and other input devices to the IIGS (and future Apple computers). This type of keyboard should prove especially useful when IBM PC compatibility comes to the IIGS (which should be within six months—we'll keep you posted).

Electronic Arts has converted its Deluxe Paint from the Amiga and its Deluxe Music Construction Set for the Macintosh to run on the IIGs. The Deluxe Music Construction Set, in fact, looks as if it is the first major product to take advantage of the HGS's fantastic sound capabilities.

First Byte has taken its Smooth-Talker speech-synthesis technology, developed on the Macintosh, and redesigned four of its programs to take advantage of the IIGS's superior sound capabilities. The company has announced four educational programs aimed at students in the kindergarten through ninth grade: KidTalk, for creative writing; Speller Bee, for alphabet and spelling skills; MathTalk, for elementary math; and First Shapes, for a simple introduction to geometry.

General Computer, best known as the developer of the Hyperdrive for the Macintosh, is introducing a version of its FX20 external SCSI hard-

disk drive for the IIGS.

Great Wave Software has drawn on its Macintosh development efforts to come up with KidsTime II, which is really a combination of two programs: ABKey and KidsNotes. ABKey is an alphabet and keyboard-skills game, and KidsNotes is a beginners' music tutorial.

Kurta Corporation has created a new type of graphics tablet that features a cordless pointing device that can double as a mouse. Decent graphics tablets for the Apple II have always been in short supply; this product should be a real help in exploiting the Apple IIGs's graphics ca-

pabilities.

MacNifty Central is working on a modular multifunction board codenamed Project Phoenix. The board's first module is a sound digitizer with 256K of RAM that allows you to sample, edit, and play back sounds, much as you would with the firm's Sound-Cap system for the Macintosh (see "Digital Sound for the Mac" on pages 106-113 of the May 1986 issue of A+). The second module adds NTSC-standard video-digitizing capabilities with advanced software that features real-time frame grabbing and special effects such as chroma-key, color-shift, and colorprinting capabilities. The third module adds a MIDI interface that will supposedly allow you to upload and download sounds to and from MIDI instruments. The fourth module, not likely to appear until well into next year, will be a process-control center for use in such varied applications as

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home control and robotics.

MDIdeas is offering the SuperSonic stereo sound board to allow you to hook up stereo speakers to the IIGS; the OctoRam 8-megabyte RAM-expansion card; and The Conserver, a combination power strip, surge-suppressor, fan, and monitor platform that allows you to place two 3.5-inch drives between the IIGS monitor and system unit.

MicroProse has converted its Silent Service submarine-simulation game to work on the IIGS.

Orange Micro has several products for the IIGS: ProGrappler, a printer interface with menu-driven software in ROM; RamPack 4GS, a four-megabyte RAM card; and The JuiceBox, a power-strip/fan combination.

Peak Systems is offering a variety of SCSI storage devices for the IIGS. The Sierra 2040 combines a 20-megabyte hard-disk drive with a 40-megabyte tape drive, and the Sierra 3040 is a similar unit with a 30-megabyte

hard-disk drive; the interesting thing about these units is that they have an automatic timer that can automatically back up the hard disk onto the tape drive at a specific time. Peak is also offering its Plus series of stand-alone storage devices, which include 20-, 30-, 45-, and 65-megabyte SCSI hard-disk drives and a 20-megabyte tape drive.

PBI has two IIGS programs, CommWorks 16 and Visualizer. CommWorks 16 is a communications

QUICK-REFERENCE GUIDE TO IIGS PRODUCTS

This table contains a sampling of products, and the preliminary information herein is based on manufacturers' claims. For further information on any item in this table, please circle the corresponding Reader Service Number on the reader-service card in this issue.

HARDWARE

				READER SERVICE
COMPANY	PHONE	PRODUCT	DESCRIPTION	NUMBER
Apple Computer, Inc.	(408) 996-1010	Apple 3.5 Drive	Disk drive	// T
The sale of the little of		Apple 5.25 Drive	Disk drive	-
		Apple SCSI Card	SCSI-interface card	-
		Hard Disk 20SC	SCSI hard-disk drive	_
Applied Engineering*	(214) 241-6060	(16-megabyte RAM board	Memory-expansion card	-
		(Accelerator board)	Add-in board	
AST Research, Inc.	(714) 553-0340	AST-2000	SCSI hard-disk drive	506
		RamStack IIGS	Memory-expansion card	507
		SprintDisk	RAMdisk card	508
		AST VisionPlus	Graphics digitizer	509
Bose Corporation	(617) 879-7330	Special Edition Roommate		510
DataDesk	(800) 826-5398	Turbo-ADB Keyboard	IBM PC-style keyboard	511
D III II I	In CA: (818) 780-1673			
General Computer Corp.	(617) 492-5500	Hyperdrive FX-20	SCSI hard-disk drive	512
Kurta Corporation	(602) 276-5533	Kurta Graphic Input	Digitizing tablet (mouse alternative)	513
Auta Corporation	(0.00)	System	• • • • • • • • • • • • • • • • • • • •	0.000
MacNifty Central	(612) 566-0221	("Phoenix")	Modular multifunction board	514
MDIdeas	(415) 573-0580	Conserver	Combination power strip/surge	515
772-74-43	(110) 070 0000		suppressor/fan and monitor platform	
		OctoRam	Memory-expansion board	516
		SuperSonic	Stereo sound and amplifier board	517
Orange Micro, Inc.	(714) 779-2772	JuiceBox	Power-strip/fan combination	518
Orange where, me.	(/11)///2//2	ProGrappler	Menu-driven printer-interface	519
		· · · · · · · · · · · · · · · · · · ·	board that allows various screen dumps	
		RamPack 4GS	4 megabytes of memory expansion	520
Peak Systems, Inc.	(512) 329-1020	Plus20 (30, 40, 65)	20-, 30-, 40-, or 65-megabyte SCSI	521
reak systems, inc.	(312) 323-1020	114320 (30, 40, 03)	hard-disk drive	THE STREET
		Plus20T	SCSI tape backup	522
		Sierra 2040	20-megabyte SCSI hard-disk drive	523
			and 40-megabyte auto tape backup	
		Sierra 3040	30-megabyte SCSI hard-disk drive and	524
			40-megabyte auto tape backup	
ProAPP, Inc.	(408) 559-3552	ProAPP10, ProAPP 20	10- and 20-megabyte SCSI/disk-	525
			port hard-disk drive	
Street Electronics Corp.	(805) 684-4593	Echo IIb	Speech synthesizer	526
		00000000000000000000000000000000000000		

program that features VT-100 terminal emulation and offers add-on modules for text editing, bulletinboard systems, emulation of other terminals, and more. Visualizer is a business-graphics package that can use data directly from AppleWorks and can overlay charts and graphic images.

ProApp is offering its ProApp 10 and ProApp 20 10- and 20-megabyte hard-disk drives, which feature both a disk-port connector and a SCSI connector. The drives can be partitioned into a separate volume for each of the two ports, so two computers can use the drive (not simultaneously).

Roger Wagner has made some IIGs enhancements to its MouseWrite word-processing program; the firm is coming out with Merlin 16, a 65816 version of MerlinPro; and perhaps of greatest interest is a product tentatively called SoftSwitch, a Switcherlike program for the IIGS that allows you to load and switch between mul-

tiple applications.

Styleware has developed Multi-Scribe GS, a IIGS version of its innovative MultiScribe program for the IIe and IIc. MultiScribe GS allows you to edit multiple documents at the same time and allows cutting and pasting of graphics into a document. The company also says it is working on a MacDraw-like object-oriented drawing program for the IIGS that prints in color on the ImageWriter II or in high-quality black and white on a La-

SOFTWARE

COMPLANY				READER SERVICE
COMPANY	PHONE	PRODUCT	DESCRIPTION	NUMBER
Activision, Inc.	(415) 960-0410	Music Studio	Music-composition and -education software	527
		PaintWorks Plus	MacPaint look-alike	528
		Writers Choice elite	MacWrite look-alike	529
Brøderbund Software, Inc.	(415) 479-1700	Drawing Table	MacDraw-like (object-oriented) application	530
		Fantavision	Animation with sound	531
		NewsMaker	Desktop-publishing/page-layout	532
			software with color drawing and printing	g
		Print Shop IIGS	Menu-driven color-graphics editor	533
Chancery Software	(604) 685-2041	CSL Marks	Grade-book software	534
Chang Labs	(800) 831-8080 In CA: (800) 972-8800	Rags to Riches	Accounting package	535
Electronic Arts	(415) 571-7171	Deluxe Music	Software for composing, edit-	536
		Construction Set	ing, and playing music scores	III DANIELI III
		Deluxe Paint	Paint program	537
First Byte, Inc.	(213) 595-7006	FirstShapes	Elementary geometry program	538
		KidTalk	Beginning creative-writing software	539
		MathTalk	Beginning math-skills software	540
		SpellerBee	Alphabet and spelling tutorial	541
Great Wave Software	(415) 325-2202	KidsTime II	Typing and music tutorial	542
Learningways, Inc.	(617) 576-3007	Explore-A-Story	Creative-writing software	543
MECA	(203) 222-1000	Managing Your Money	Personal-finance software	544
MegaHaus Corp.	(619) 450-1230	PageWorks	Desktop-publishing/page- layout program	545
MicroProse Software, Inc.	(301) 667-1151	Silent Service	Submarine simulation	546
Monogram	(213) 215-0355	Dollars and Sense	Personal-finance software	547
Orange Micro, Inc.	(714) 779-2772	Color Paint	Paint program	548
PBI Software, Inc.	(415) 349-8765	CommWorks 16	Telecommunications software	549
		Visualizer	Business-graphics package	550
Quark, Inc.	(303) 934-2211	(desktop-publishing	Desktop-publishing/page-	551
		software)	layout product	551
Roger Wagner	(619) 562-3670	Merlin 16	65816 assembler	552
Publishing, Inc.		MouseWrite	Word-processing program	553
		SoftSwitch	Switcher-like program	554
Scholastic, Inc.	(800) 325-6149	Talking Text Writer	Creative-writing software	555
StyleWare, Inc.	(713) 668-1360	(Draw program)	MacDraw-like (object-oriented)	556
		MultiScribe GS	Word-processing program	557
TML Systems, Inc.	(904) 636-8592	Pascal	IIGS version of TML Pascal for the Mac	558
Tom Snyder Productions	(617) 876-4433	Puppy Love	Artificial-intelligence simulation	559
United Software	(818) 887-5800	ASCII Express MouseTalk	Telecommunications software	560
VIP Technology Corp.	(805) 968-4045	VIP Professional	Integrated spreadsheet, data- base, and charting software	561

serWriter or other PostScript printer.

Tom Snyder Productions is developing a IIGS version of its delightful Puppy Love program (see "News-Plus," September 1986, page 15), which combines fun and games with artificial-intelligence instruction. The company expects the program to be available through Addison-Wesley by Christmas

TML Systems has created a IIGS version of its Macintosh Pascal language that allows programmers to write Pascal programs that run on both the Macintosh and the IIGS.

United Software has taken a lot of the features of its classic ASCII Express Pro telecommunications program and combined it with a Macintosh-like user interface to create ASCII Express MouseTalk, which promises to be one of the most powerful mouse-driven communications programs for any computer.

VIP Technology is developing a IIGS version of its VIP Professional spreadsheet that combines the Apple user interface with a Lotus 1-2-3

This is just the tip of the iceberg. We'll be sure to keep you up to date on new IIGs happenings in upcoming issues of A+.

clone. In fact, VIP claims that the program is compatible with Lotus 1-2-3, Version 1A and can use the same files and commands as 1-2-3.

On the desktop-publishing front there is quite a bit of activity. Besides Brøderbund, which has the aforementioned NewsMaker, MegaHaus and Quark are producing their own programs. MegaHaus has introduced PageWorks, and Quark is developing Quark Extra. All of these packages work with the LaserWriter and other PostScript printers.

In the area of financial management and accounting, Chang Labs has converted its popular Rags to Riches accounting program from the Macintosh to the IIGS, Monogram has converted the Macintosh version of the best-selling Dollars and Sense to the IIGS, MECA has written a IIGS version of its Managing Your Money program, and VIP Technologies is producing a IIGS version of its VIP Professional spreadsheet.

In the education arena, Learningways is working on a version of its Explore-A-Story program that makes use of some IIGS features, and Scholastic is tweaking Talking Text Writer to take advantage of some of the IIGS's capabilities.

Tip of the Iceberg

All in all, a very respectable amount of new products is in development for the IIGS; indeed, the above list is just the tip of the iceberg. We'll be sure to keep you up to date on new IIGS happenings in upcoming issues of A +.

Following this article is the continuation of our special report on the IIGS. Read on and enjoy.

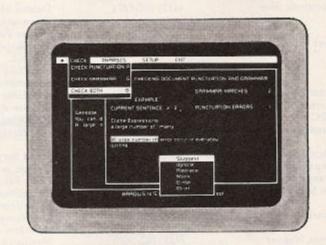
Here's How to Screen Your Grammatical Errors

Sensible Grammar saves you embarrassment and improves your credibility by helping you screen out the grammatical errors in your papers. And it's easy to use on your Apple II computer because it is AppleMouse compatible and has Macintosh-like screens.

Possible mistakes are shown to you in context, a replacement word or phrase is suggested, and you are then given the option to accept or reject the suggested

Sensible Grammar does much more than catch bad grammar. It also.

- · checks your capitalization and punctuation, as well as the spelling of abbreviations;
- searches out phrases that are inconcise, vague, wordy, faulty or repetitive;
- points out expressions that are informal, pompous or sexist;
- calls attention to cliches, slang and trite language;
- allows entry of your personal hackneyed expressions and then lets you know every time you use them.



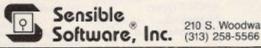


Sensible Grammar

for your Apple 128K //e and //c computer is available for \$99.95.

AppleWorks Compatible!

*Sensible Grammar works with the following word processors, AppleWorks, AppleWriter-ProDOS version (Apple Computer, Inc.); Format II Enhanced-ProDOS (Kensington Microware), Mouse Write text files (Roger Wagner Publishing); MouseWord (International Solutions); PFS:WRITE-ProDOS (Software Publishing, Inc.); Word Juggler (Quark Inc.); WordPerfect (SSI Software); Zardax-ProDOS (Computer Solutions) and others. Owners of tradomarks indicated in parentheses.



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HARDWARE BY GARY B. LITTLE

Getting acquainted with Apple's latest offspring

1983, Steve Wozniak, inventor of the original Apple II, made some remarkably candid statements in an electronic conference on CompuServe. Commenting on Apple's future plans for the II series, he said we could expect to see a new machine by the middle of 1984 that would use "a revolutionary 6502-based processor" and be able to access 16 megabytes of memory directly.

He was referring to the so-called Apple IIx project, but, for a variety of reasons, notably the infatuation of the Apple brass with the Macintosh (announced in January 1984), the project was ultimately scrapped.

But now, three years after this initial hint of things to come, Apple has finally created a computer that meets Woz's tantalizing specifications: the Apple IIGS. The GS stands for graphics and sound, the two sexy features Apple will use to lure customers from the grasp of Commodore and Atari. In this article, I'll explain what makes the GS so special.

The 65816 Microprocessor

The GS uses the Western Design Center 65816 microprocessor, a powerful device that has, in its native operating mode, 16-bit data registers, 24-bit addresses, and a 16-megabyte address space. The 65C02 microprocessor of the IIe and IIc, which offers 8-bit data registers, 16-bit addresses, and a 64K address space, is a lightweight by comparison (see fig-

The main reason Apple decided to use the 65816 was that it could also operate in an emulation mode in which it mimicked a 65C02 exactly. Apple has combined this ability to emulate with a clever hardware design that converts part of the 65816 memory space into a Ile-compatible memory space. The result is a computer with considerable growth potential that also works with almost all existing IIe software. Users will have plenty of software to use on the GS until the more powerful native-mode applications and applications that take advantage of new features such as graphics and sound are available.

Here are some other features of the 65816 that make it an attractive microprocessor for software developers: The direct page (the new name for the 65C02's zero page) can go anywhere in the first 64K of memorynot just on page 0-meaning that an application can use its own direct page, so you don't have to worry about overwriting reserved areas (but you can still have only one direct page at a time).

 The stack can also go anywhere in the first 64K, not just on page 1, and it can be larger than a single page. Thus, the computer can handle more stack operations, such as passing parameters and keeping track of

nested subroutines.

 The A, X, and Y registers can be 8 bits or 16 bits in size. The use of 16bit registers instead of 8-bit registers simplifies mathematical and indexing operations involving numbers greater than 255 (but less than 65536).

· Several new instructions and ad-

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dressing modes are available that let you develop faster and more compact programs.

System Speed

The 65816 of the GS operates at an effective clock rate of either 1 MHz or 2.5 MHz, selectable through a software switch. In the fast mode (2.5 MHz), the GS operates much like a IIe with an Applied Engineering Trans-Warp card (or similar speedup card) -about 31/2 times as fast as usual. (Actually, a IIe with an accelerator card operates faster than the GS.) In the slow mode, the GS operates at the same speed as a standard IIe or IIc. Memory Space

The 65816 treats memory as a consecutive series of 256 banks, each 64K in size, rather than as one continuous 16-megabyte space (see figure 2). A

GS, in its minimal configuration, uses only six of these banks, four for RAM (256K) and two for ROM (128K).

The core RAM banks are numbers \$00, \$01, \$E0, and \$E1. You can add more RAM by installing a memory card in a special memory-expansion slot on the motherboard; this RAM occupies consecutive banks starting with bank \$02. Apple's memory card can hold up to four megabytes, although you'll probably use only 256K or one megabyte until memory prices drop. The GS ROM occupies banks \$FE and \$FF and contains Applesoft (yes, the same old Applesoft), an enhanced system monitor, firmware for built-in I/O ports, and some programming tools.

All IIe-style applications load and run in banks \$00 and \$01 on the GS. They work properly because the GS hardware configures these two banks to behave like main and auxiliary memory on the IIe, complete with language-card (bank-switched-RAM) spaces. The main difference is that the simulated main and auxiliary memory areas contain no special video memory buffers for the text and graphics display modes. (You store data in a video buffer when you want to change what's displayed on the screen.) These buffers are in RAM banks \$E0 and \$E1 instead.

A Ile application still works properly on the GS, however, because every time it writes to what it thinks is a video buffer in bank \$00 or \$01, the GS causes a write to the actual buffer

Technical Specifications

Apple IIGS

PROCESSOR

65816 microprocessor, 2.8 MHz clock speed, 8-bit data bus; 24-bit address bus allows for addressable memory of 16 megabytes

256K RAM standard, expandable to 8 megabytes 128K ROM standard, expandable to 1 megabyte

OPERATING SYSTEMS

Works with ProDOS 16, ProDOS 8, Pascal, CP/M (with Z80 card), and DOS 3.3

EXPANSION SLOTS

8: 1 dedicated multipurpose RAM/ROM memoryexpansion slot; 7 additional input/output slots

GRAPHICS DISPLAY

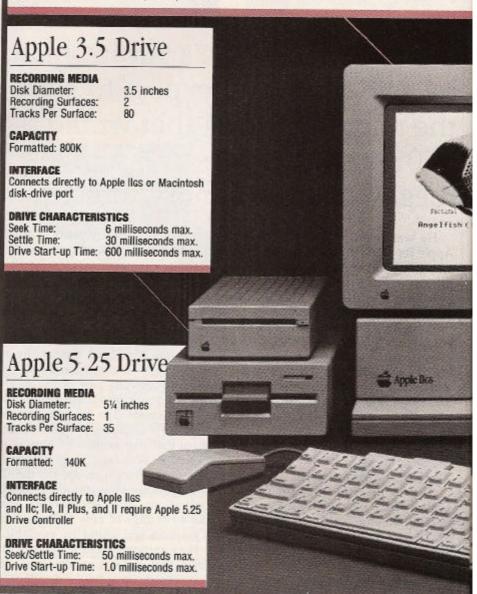
7 video-display modes:

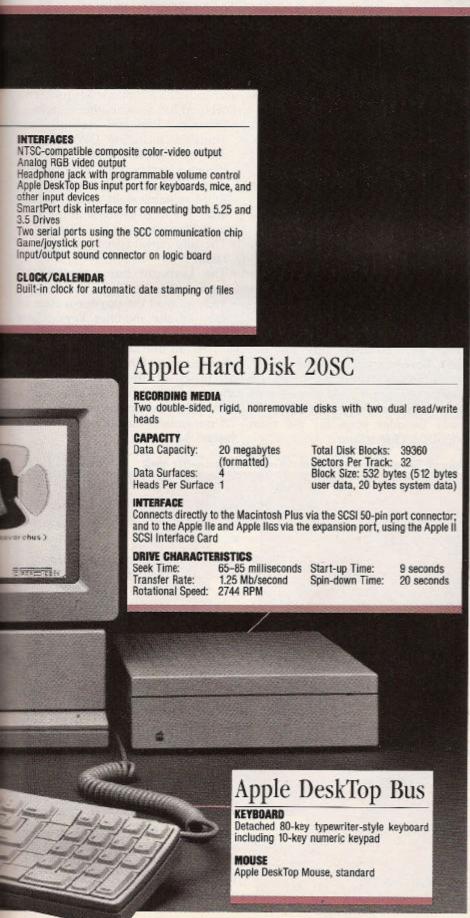
- 40-column text mode (by 24 lines)
- 80-column text mode (by 24 lines)
Low resolution: 40 H by 4 V dots, 16 colors
High resolution: 260 H by 192 V dots, 6 colors
Double high resolution: 560 H by 192 V dots, 16 colors
Super high resolution: 320 H by 200 V dots, 16 colors
per scan line out of a palette of 4096 colors; 640 H by
200 V dots, 4 colors per scan line out of a palette of

4096 colors

SOUND CAPABILITY

Ensoniq 32-oscillator synthesizer chip with dedicated 64K RAM





in bank \$E0 or \$E1 as well, causing screen updating—a process called shadowing. The I/O space from \$C000 to \$C0FF is also shadowed, since the actual I/O locations exist only in banks \$E0 and \$E1.

To maintain compatibility with existing Apple II peripherals and to respect video timing constraints, all activity in banks \$E0 and \$E1 takes place at a speed of 1 MHz, even if the GS has been told to operate in the fast mode. Therefore, the system slows during screen updates, reducing performance somewhat, particularly for graphics-intensive applications. Screen-read operations, however, can take place at full speed if the application reads from the shadowed video-buffer area in bank \$00 or \$01.

The operating-system subroutines in the system ROM use most of the non-video-buffer areas of banks \$E0 and \$E1 for data storage. Some free space is left over that a 65816 native-mode application can use, however. Slots and Ports

From an I/O point of view, the GS combines the best of the IIe and IIc: It has seven expansion slots, as the IIe does (plus the special memory-expansion slot I mentioned above), and five built-in I/O ports, as the IIc does. You can't use them all at the same time, however, since the ports emulate cards in slots. You tell the GS whether you want to use a port or its corresponding slot by using a Control Panel desk-accessory program in the GS ROM. (You can call up the Control Panel any time by pressing Control/ open-apple/ESC; when you leave it, your application returns intact.)

The built-in I/O ports are two serial ports (one of which you can use for AppleTalk), an 80-column text-display port, a mouse port (a mouse is standard equipment on the GS), and a disk-drive port.

The serial ports are controlled by the Intel 8530 Serial Communications Controller (SCC), the same chip the Macintosh uses. Since Apple did not employ the 6551 chip it uses in the IIc and the Super Serial Card, most existing communications programs do not work on the GS. These programs generally access a serial port's hardware registers directly, but they aren't familiar with the new 8530 yet. Publishers of such com-



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munications programs will probably announce updates shortly.

The disk-drive port, called the Smart Port, can handle up to four external drives connected in a daisy-chain arrangement. The standard GS package has one 800K UniDisk 3.5 drive connected to this port.

The connectors for the two serial ports and Smart Port are at the back of the GS system unit. There you will also find connectors for a game controller, the keyboard, and composite (NTSC) and RGB video. The connector for the mouse is on the side of the keyboard.

The seven internal expansion slots are almost identical to their IIe counterparts, meaning that most single-function cards available for the IIe also work on the GS. Multifunction cards that create phantom slots (such as the AST Multi-I/O and the Street Electronics BusinessCard) do not work, however, since the 65816's 24-bit addresses confuse them. Of course, you won't need to use cards such as these anyway, since the GS already includes ports for the most popular I/O functions.

The Keyboard

The GS keyboard has all the features of the IIe keyboard, and more. Two improvements are noticeable immediately: The keyboard connects with a flexible cord to the system unit and includes a numeric keypad. The keyboard has several other features:

- Different keyboard layouts are available, including QWERTY (of course), Dvorak, and others such as French, German, USA, English, and more. The character-generator ROM contains eight different character sets to go along with the keyboard layouts.
- The auto-repeat speed is user-selectable.
- The keyboard has a type-ahead buffer.
- You can read the up/down state of each of the modifier keys (Caps Lock, Shift, and Control) directly.

You can use the Control Panel to change many of the operational characteristics of the keyboard. Since these characteristics are stored in a battery-backed-up memory area, the GS remembers them every time you restart the system.

Figure 1: The 65816 register sets in the emulation and native mode

	65CO2 emulation mode			65816 native mode	
Accumulator		A		A o	A A
X Index Register		x		хн	X XL
Y Index Register		Y	23 16	YH	YL
Data Bank Register			B = Data Bank Register		
Stack Pointer	01	S	00	SH	SL
Direct Register	15	o o	00	DH	DL
Program Counter	PC PCH PCL		K = Prog	PC PCH PCL ram Bank Register	
Status Register		Р			Р

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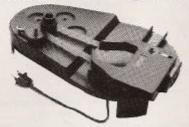
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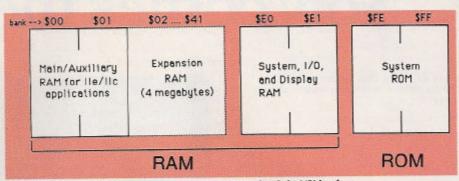


Figure 2: The Apple IIGS memory map—each RAM bank is 64K in size.

Apple Desktop Bus

The keyboard connects to the GS through a new intelligent I/O port called the Apple Desktop Bus (ADB). The ADB lets you daisy-chain the keyboard and a variety of pointing devices, such as the GS mouse. The daisy-chain connector is on the side of the keyboard. Apple has published the software and hardware protocol for the ADB, so I suspect we'll soon be seeing devices such as graphics tablets, trackballs, and light pens for connection to the ADB.

Sound

The sound emanating from the GS has much more potential than that of any other microcomputer currently on the market. The GS's sound chip is called the Ensoniq DOC (Digital Oscillator Chip) and is the same chip the Mirage music synthesizer uses.

The Ensoniq has 32 waveform oscillators, two of which are reserved for internal timing. The remaining 30 oscillators are paired off to form 15 independent sound generators or voices. Every voice can "sing" any waveform you like, at a specified volume and tempo, so you can generate complex sound effects or music.

Clock

A real-time clock is built into the GS. It is battery-operated, so it keeps time even when the GS is turned off. A nice feature of the clock is that it does not use up an I/O slot or port, as it usually does when you add a clock card to the IIe. A new version of Pro-DOS for IIe-style applications (the successor to version 1.1.1) installs a driver for the clock as soon as it senses it is running on a GS.

Super-High-Resolution Graphics

The GS provides all the video-display modes of the IIe and IIc, in addition to two new color-display modes, called super-high-resolution graph-

ics, with these pixel dimensions: 320 (horizontal) by 200 (vertical) and 640 (horizontal) by 200 (vertical). The video buffer for both these modes is 32K in size and is located from \$2000 to \$9FFF in bank \$E1.

Each horizontal line on the superhi-res screen can be associated with any one of 16 user-definable color palettes, each of which contains the definitions of 16 colors that can appear on the line. Thus, up to 256 different colors can appear on the screen at one time, but with clever programming, using scan-line interrupts, you can display many more. Every color within a palette is defined by a 12-bit code (4 bits for red, 4 bits for green, 4 bits for blue), meaning it can be one of 4096 different colors. That should provide enough variety to keep game designers and artists happy for quite a while!

In the 320 × 200 mode, you can assign any of the 16 colors in a palette to a pixel on the line. Each pixel is defined by four data bits containing the color number within the palette. The 640 × 200 mode is more restrictive, however-only 4 of the 16 colors in the palette can be assigned to a pixel (two bits per pixel). Which 4 of the 16 are available depends on the horizontal position of the pixel.

ProDOS Operating System

There are two versions of ProDOS you can use with the GS; the one you use depends on the type of application you're running. Standard Pro-DOS, the one that works on the entire Apple II line, is now called ProDOS 8 and must be used with He-style applications. ProDOS 16 works with applications that run in the 65816 native mode, so it runs on the GS only. The fundamental difference between ProDOS 16 and ProDOS 8 is that a program can execute ProDOS



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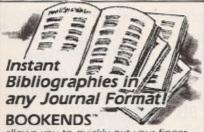
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16 commands from anywhere in the 16-megabyte memory space and can perform I/O transfers anywhere in memory. ProDOS 8, on the other hand, works only in the lowest 64K of memory.

Software Tools

Apple has made it clear it would like GS-specific applications to use the desktop metaphor the Macintosh has popularized. To this end, it has created a Macintosh-like toolbox of standard subroutines that programmers can use to easily create windows, pull-down menus, dialog boxes, and other user-interface trappings on the super-hi-res screen. The core group of drawing routines is called—what else?—QuickDraw II. See the book excerpt "What's in the Toolbox?" in this issue for more information on this aspect of the IIGS.

Many of the GS tool sets are located in ROM; application programs load others from disk as they need them. Eventually, as the tool sets stabilize, the RAM-based tool sets will find their way to ROM, as they have on the Mac, meaning that more RAM space will be available for applications, which will run more quickly.

Apple is currently putting the finishing touches on a Programmer's Workshop for developers of GS software. It will include an editor for creating source-code files, a 65816 assembler, and a linker for creating executable applications from objectcode modules created by the assembler or a compiler.

Apple intends to release two highlevel-language compilers-C and Pascal-for the GS Programmer's Workshop. When I wrote this article (in early August), however, both were still in development, and all I had seen was some preliminary documentation for C. Strangely enough, Apple does not appear to be working on a compiled BASIC for the GSperhaps we'll see one from an independent publisher instead. You can still use Applesoft, of course, but it won't take advantage of any of the new features of the GS, including the extra memory space.

The Future of the GS

The GS will be attractive to those who love flashy graphics and symphonic sound, at least once some good software that exploits these features becomes available. It still makes sense to buy the GS in the meantime, however, because it runs existing software about 2½ times faster than the IIe does, it has a better keyboard, and it has built-in I/O ports and expansion slots.

I do not expect to see developers of business and productivity software stampeding to use QuickDraw II and the user-interface tools to create Macintosh-like applications on the GS. The reason is simple: Text-screen operations are much faster than graphics operations, and users want speed. The speed differential is particularly great for applications, such as word-processing programs and communications programs, that frequently update and scroll the screen.

Ease of use is not really an issue, since programs based on the textbased file-card metaphor, such as AppleWorks, have proven to be just as easy to learn as those based on the Macintosh desktop metaphor. Obviously, some business applications will use the super-hi-res graphics screen; they include charting and drawing programs, database programs that work with images rather than text, and word-processing programs that display text as it will appear when printed. Just don't expect them to run as quickly as the equivalent programs on the Macintosh do.

I expect to see, very soon, new versions of the classic text-screen-based business applications we already have on the IIe and IIc, rewritten to take advantage of the extra memory the GS offers. They will probably work with the mouse as well, because it is standard equipment on the GS. •

Gary Little practices computer law in Vancouver, British Columbia, and enjoys writing about Apple computers in his spare time. His next book, Exploring the Apple IIGS, will be published by Addison-Wesley in early 1987.

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