Macintosh IIci: Expanding the Boundaries

Architectural leap forward

Apple has held its lead as the world's premier maker of personal computers by regularly taking bold, innovative steps in product design. The Macintosh IIci represents one of the most significant steps forward in the evolution of the Macintosh architecture since the introduction of the Macintosh II.

In the nine months since the introduction of the Macintosh IIci, the machine has garnered praise for its manufacturing excellence, its flexible product design, and the sophistication of its architecture. In fact, it was the only CPU to receive the prestigious Byte Magazine Award of Excellence for 1989. Developers clearly value its performance and functionality - at the recent MacWorld in San Francisco, it was the demonstration machine of choice on the show floor. And customers frequently cite the machine's incredible flexibility - the configurable performance, the 'extra' NuBus slot, the breadth of its monitor support - as proof of its long term value.

All of these are valid perspectives, but frequently lost in all this praise is one *very* important point. The Mac IIci is the first Macintosh (along with the Mac IIfx) which is truly ready for computing in the 1990's.

Why the fuss?

Why? The reason is fairly simple. Unlike previous versions of 68030-based systems, the IIci is a brand-new architecture (both in hardware and in software) from the ground-up. This gave the system designers several opportunities to extend the boundaries of Macintosh computing. The Mac IIci is the first system with a higher clockspeed and built-in video, the first with 32-bit QuickDraw in ROM, the first system to use non-contiguous memory, and the first to use the PMMU for memory addressing. Here are short descriptions of some of these architectural changes, why they are important today, and what they will mean to users in the near future:

• **New Memory and I/O architectures.** In order to support the increased clock speed, the IIci has a different memory and I/O architecture than previous '030 based machines. This architecture is what gives the IIci such a range in performance - from approximately 20% faster than a IIcx (using the color built-in video) to almost twice as fast as a IIcx (using both a cache card and a NuBus video card). This ability to configure system performance is without parallel in the personal computer industry, and presents customers a clear growth path for the future.

• **Use of the PMMU**. The Macintosh IIci is the first machine to use the Paged Memory Management Unit (which is built-into the 68030) to map the physical locations of memory (i.e., where the hardware see the system's DRAM) to the logical locations which the operating system and applications actually use. This has several benefits:
- Convenient memory configurations. Unlike the Mac II architecture, DRAM of any density can be placed in either bank of memory. This simplifies the process

of configuring the machine.

- Low cost, high performance built-in video. To lower the overall system cost , the Macintosh IIci uses main system memory to support the video buffer for the machine's built-in video. The designers realized they could get a substantial performance increase if they located this video buffer in the bottom of the physical address space - in exactly the same logical addresses reserved by the Macintosh operating system for low memory globals. By using the PMMU to map the logical addresses to a different physical address space, they achieved higher performance while maintaining compatibility.

• **“32-bit clean ROMs”.** The Macintosh IIci was also the first machine with "32 - bit clean" ROMs. Unlike previous versions of the Macintosh II (i.e., the II, IIx, IIcx, and even the SE/30), this means that the Mac IIci can support a very large address space - as much as 4 gigabytes - with either A/UX or System Software 7.0. This has two benefits:

• Large DRAM configurations. With all of today's Mac IIs, the hardware supports as much as 128 megabytes of physical memory, but current System Software only understands the first 16 megabytes. Since some of this 16 megabytes is allocated to NuBus and ROM, customers are effectively limited to a maximum of 8 megabytes of RAM in their system. The combination of 'clean' ROMs and System Software 7.0 overcomes this limitation in both the IIci and IIfx, and will allow people to use as much RAM as their job requires.

• Large Virtual Memory address space. Virtual memory is a technique where the system uses part of the hard disk as an extension to main system memory. This gives the user the illusion of having a lot more RAM than is physically present in the system, thereby allowing them to work with larger files, more applications, or both, without investing in expensive memory. Again, the combination of 32-bit clean ROMs and System Software 7.0 will give both the IIci and IIfx the ability to support large (i.e., more than 15 megabytes) virtual address spaces.

• **“Bottoms-up” ROM.** Unlike earlier machines, which used a variation on the original Macintosh II ROM, the IIci ROM was completely overhauled and built from scratch. This had the benefit of faster code execution (the machine doesn’t have to jump to find patched-out segments of code), smaller DRAM requirements (the patched out code usually resides in DRAM), and additional features within the ROM itself. Two new features included in the Mac IIci ROM include:

• 32-bit QuickDraw. Apple introduced 32-bit QuickDraw in May 1989. Because of its ability to support over 16 million colors (i.e., true color) and up to 256 levels of translucency, it quickly became a new color standard within the Macintosh community.

• Built-in video support. Consistent with the plug-and-=play design philosophy of Macintosh, the designers engineered a ROM-based monitor identification scheme for the Mac IIci’s built-in video. When the machine is started, the ROM automatically identifies which monitor is plugged into the built-in video slot, and communicates items, such as

monitor size (pixel resolution) and type (monochrome or color), to the rest of the operating system so that the correct image is displayed.

So what's the catch?
Just as the Macintosh II uncovered all of the applications which made design assumptions based on previous generations of Macintosh (e.g., a fixed size screen, 8 megahertz clock speed, DRAM limitations), the Macintosh IIci also revealed another set of incorrect programmatic assumptions. Most developers have now revised their products to be Macintosh IIci (and implicitly, System Software 7.0) friendly, so virtually all of the early compatibility problems have vanished (see note below). However, here is a short list of the kinds of problems encountered just after the IIci began to ship:

• "Too fast". Some applications assumed that Apple would make nothing other than 8 megahertz and 16 megahertz machines, and wrote their applications accordingly. The Mac IIci, and now the Mac IIfx, are both much faster machines, and even more powerful machines are expected in the future.

• New memory map. The full-time use of the PMMU, coupled with System Software 7.0's Virtual Memory and 32-bit clean ROMs, require that applications make no assumptions about the physical location of either instructions or data. This problem affected both applications and NuBus cards which wrote directly to a physical address in main memory.

• 32-bit QuickDraw. Even though 32-bit QuickDraw was introduced over a year ago, many developers had not revised their applications when we introduced the Mac IIci in September. Applications which assumed the 24-bit addressing mode supported by QuickDraw in earlier versions of Macintosh would sometimes generate an illegal address (i.e., one which didn't physically exist in memory). Although attributable to the new imaging model, this is another example of applications which are not "32-bit clean".

So where are we?
The good news is that the majority of third-party applications run perfectly fine on the Mac IIci. Developers, anticipating next generation hardware and software architectures (System Software 7.0 and beyond), have revised their products to fully exploit the anticipated performance and feature sets. (For a complete list of compatible products, see the "Product Compatibility Lists" sub-folder in the "Third Party Products Work with Apple Products" under the "Third Party Connection" icon on AppleLink.) The result is clearly a win for Macintosh customers, who can take advantage of the the Mac IIci's performance and flexibility today, and whose applications will become even more functional with future releases of our Operating System.

If you are looking for a personal computer that is designed to take advantage of the changing technologies of the 1990's, consider the Macintosh IIci. It was designed with an eye to the future and built to keep you one step ahead.

Macintosh IIci Features:

• Full 32-bit 68030 microprocessor: 25 MHz clock offers superior processing power and performance. Built-in Paged Memory Management Unit (PMMU) supports multi-tasking operating systems, such as A/UX.

• 68882 floating point math coprocessor: Provides fast processing of complex mathematical functions, such as logarithmic and trigonometric series.

• Built-in 120-pin cache connector: The cache connector will accept a high-speed cache memory card, which can increase system performance 30 to 40 percent by putting frequently used information in to special high-speed memory.

• Built-in video support: Makes system set-up easier, eliminates the need for a NuBus video card thereby increasing expandability of the system. The Apple monitors supported are:
- 12-inch Apple High-Resolution Monochrome Monitor, with up to 256 shades of gray
- 13-inch AppleColor High Resolution RGB Monitor, with up to 256 colors or shades of gray
- 15-inch Apple Macintosh Portrait Monitor, with up to 16 shades of gray

• Three NuBus expansion slots: Allows configuration of the system for specific needs, and reconfiguration as requirements change and new technology becomes available.

• Apple 1.4 MB SuperDrive. The High density floppy disk drive makes it easier to work in multivendor environments where access to data from other computers is important. SuperDrive allows you to format, read, and write to Apple 400K, 800K, 1.4 MB floppy disks, as well as ProDOS, MS-DOS, operating system/2 720K and 1.44 MB floppy disks.

• Parity support: This feature is available to customers requiring the maximum degree of memory-checking ability. The optional parity feature must be ordered at time of purchase, and includes the Parity Generator Chip (PGC) and Parity DRAM.

• Eight built-in ports: two serial ports; two Apple Desktop Bus ports; one SCSI port; one DB-19 serial port; one DB-15 video port; one sound port. The ports allow connection of the system to a wide variety of popular peripherals that don't require additional expansion cards, as well as to AppleTalk networks, external floppy and hard disk drives, sound systems, monitors, etc.

• Locking power switch: Particularly useful when the system is used as a network file server, this feature allows the system to restart it self in the event of a power failure.

• Available Configurations

Macintosh IIci CPU
Order Number: M5710LL/A

Macintosh IIci Hard Disk 40 CPU
Order Number: M5715LL/A

Macintosh IIci Hard Disk 80 CPU (4MB)
Order Number: M5740LL/A

Macintosh IIci Hard Disk 80 Parity CPU (4MB)
Order Number: M5745LL/A

Macintosh IIci A/UX Hard Disk 80 CPU (4MB)
Order Number: M5750LL/A