THE MICROSOFT TABLET PC

A detailed look at Microsoft's proposed Tablet PC (July 2001 issue)

Flashback to 1992-1993: The pen computer craze is at its height. GRiD, NEC, Momenta, NCR, Compaq, Samsung, Toshiba, IBM, Dauphin and others are all marketing pen computers running Pen Windows. The target is the consumer, and the hype says that the pen will largely replace the keyboard.

Flashforward to 2001-2002: Is it going to happen all over again? It looks like it might. Microsoft is in the process of defining the Microsoft Tablet PC platform hardware specification, along with a pen-interface layer that will sit on top of Windows XP Professional. The initial target is corporate users, "knowledge workers with a productivity focus." Five big OEMs have signed up to build Tablet PC products. Microsoft is starting to crank up the hype engine, but so far the media is resisting.

History

In August 1999, when Microsoft announced ClearType, they also announced that they planned to create their own tablet "for computing, communicating and reading electronic books." To bolster the project, Microsoft brought in (among others) Chuck Thacker, a legendary computer innovator. While at Xerox PARC, Chuck was the chief designer on Alto, the first personal computer to use a bit-mapped display and mouse for user interface. Mr. Thacker is also the co-inventor of the Ethernet local area network. His current title at Microsoft is "Distinguished Engineer, Emerging Technologies Group." Clearly there's a heavy hitter at the core of this project!

In June 2000, Bill Gates demonstrated the very first prototype of the Tablet PC during the unveiling of Microsoft's .Net strategy. However, as it was such an insignificant part of the overall presentation, it received essentially zero press coverage.

Next, during his Comdex keynote in November 2000, Gates demonstrated an ID-enhanced prototype of the Tablet PC (beneath the dolled-up housing, the hardware was basically the same as it was in June). Gates positioned the product as "a full-function Microsoft Windows operating system-based PC incorporating the convenient and intuitive aspects of pencil and paper into the PC experience." What aggravated a lot of people in the pen computer business (including Pen Computing's editor Conrad Blickenstorfer—see his editorial in the March 2001 issue) was that Gates presented the Tablet PC as if it was a brand-new concept. It was as if the last 10 years of the pen computing business had never existed.

Press and analyst reaction to Gates' Comdex demo was not very positive. Largely it boiled down to "been there, tried that, need a keyboard." In a column written for ZDNet news (extracted and summarized below), John G. Spooner offered the opinion that for the Tablet PC to be successful, it would have to offer substantially more than today's notebooks:

"Hopefully the Tablet PC will offer a multi-modal user interface that combines input from voice recognition and handwriting recognition with the option for a keyboard and mouse. If the Tablet PC is the device that the "knowledge worker" will be carrying around in 2003, it must be significantly different from my IBM ThinkPad 570 notebook. There is no reason for me to give up my ThinkPad for anything at all unless it's something that's significantly cheaper or significantly easier to use. If Microsoft nails the user interface on the Tablet PC, this device will take off and nobody will look back and wish they still had their old ThinkPad. You and I will give up our notebook PCs for Tablet PCs, which will be much easier to live with and will easily take penned, spoken or keyed-in commands. Anything less is doomed to failure" WinHEC 2001 Microsoft revealed a lot about the Tablet PC hardware in March at WinHEC 2001. WinHEC, the annual Windows Hardware Engineering Conference, is where Microsoft updates OEM hardware engineers and driver developers (more than 2,200 of them this year) on the strategies, roadmaps and technologies for future PCs. In his keynote at WinHEC, Bill Gates again showed a prototype of the Tablet PC. Most of the Tablet PC demo was focused on how easy it is to use ink in a new note-taking application that Microsoft will offer. Actually, the application, temporarily called "Microsoft Notebook, isn't new at all. It's an enhanced version of "InkWriter", a program originally written by "Aha Software," a company that Microsoft bought outright in 1996. InkWriter was shrink-wrapped pen software that was enjoying modest sales success; when Microsoft bought the company, the product disappeared from the marketplace.

After Bill Gates' keynote at WinHEC, Microsoft held a lunchtime press briefing on the Tablet PC. Attended by more than 75 journalists, the briefing was the very first time the press has had an opportunity to ask questions about the Tablet PC. Alex Loeb, Microsoft's General Manager for the Tablet PC, hosted the briefing. On the podium were representatives from Compaq and Fujitsu, two of the five OEMs who have announced that they have signed up to build Tablet PCs (the others are Acer, Sony and Toshiba). Also on the podium were representatives from six technology vendors involved in the development of the Tablet PC prototype: FinePoint Innovations (pen-input subsystem), Flextronics (prototype design and assembly), Phoenix (legacy-free BIOS), Silicon Motion (video controller), Silver Cloud Manufacturing (anti-reflection LCD filter) and Transmeta (CPU)--more on each of these later.

Again the press and analyst reaction was not very positive. In a story in PC Week, one corporate IT manager said that the Tablet PC was not at all compelling: "My company has several thousand laptops. We have found our staff to be quite productive with their laptops, so there is no reason to change." In the same story, an IT consultant was quoted as saying, "Handwriting recognition, which is simply not a compelling feature for us, does not have a good track record. It will take far more than this to make us think about giving up our laptops." Jerry Kaplan, the founder of Go and a pioneer of tablet computing, was quoted in a Business Week story as saying, "It's likely to be a compromised laptop and a compromised pen machine." David Coursey, executive editor of ZDNet's AnchorDesk, published what were probably the most damming comments. Extracted and summarized, his comments were as follows:

"Playing with the Tablet PC prototype [at WinHEC] was a depressing reminder of things I've seen before. The recognizer in the Tablet PC didn't come close to reading my handwriting, even when I wrote characters that everyone sitting around the table could read. A general purpose, "pen-based" computer that can't read my handwriting is a violation of the social contract. The prototype I played with--admittedly an early one--wouldn't have convinced me to build the Tablet PC, but then I'm not five desperate PC hardware companies."

AnchorDesk has a "TalkBack" message forum. Of the 150+ messages posted after David Coursey's two stories on the Tablet PC, about 35% were in favor of the Tablet PC and 65% were against. The main themes expressed in the messages were as follows:

- Typing is much faster than handwriting
- Everybody's handwriting is deteriorating because the keyboard dominates
- Handwriting recognition has to work on a pen tablet, otherwise forget it!
- Pen tablets are fantastic in vertical applications, particularly healthcare
- A pen tablet must have voice recognition to be really useful

After the press conference, there were two technical sessions on the Tablet PC at WinHEC. Alex Loeb gave a session on the Tablet PC strategy, and Chuck Thacker gave a session on the technical details of the Tablet PC prototype. The slides from both sessions were still on the Microsoft website as of the beginning of May (see www.microsoft. com/winhec/winhec2001). Most of the remainder of this article deals with information presented or discussed in those two sessions.

Why now?

One question that everyone asks is, "Why is Microsoft trying to create pen-based computers again, and why now?" Microsoft's answer is because technology allows it, i.e., because laptop hardware is finally ready for the product. Microsoft points to the significant improvements that have been made since 1992 in CPUs (lower power, higher performance), LCDs (lower power, higher resolution), batteries (lower weight, higher capacity), digitizers (lower power, higher performance), memory, wireless LAN network infrastructure, etc. Microsoft also points to improvement in handwriting recognition, speech recognition and font readability (ClearType), and promises a "new UI designed for pen input and easy navigation."

A cynic would say that the reason Microsoft is trying to create pen-based computers now is because the PC market is soft right now, and they're looking for every possible way of selling OS licenses (as David Coursey implies in his comment about "five desperate PC hardware companies"). But as was pointed out earlier, Microsoft actually started the current Tablet PC project in 1999, long before the current downturn. A more rational reason is that Bill Gates truly believes that the Tablet PC is a sort of "holy grail," and he really has picked now as the time to try again just because laptop hardware is in fact much more ready than it was in 1992. So with that as a reference point, let's circle back around and take a deeper look at the Tablet PC.

What is it?

Fundamentally, the Tablet PC is a notebook (laptop) without a keyboard. It's not a WebPad, as some of the members of the press still seem to think, it's a full-scale PC with a rotating hard disk. If you take any of today's very thin and light, high-end notebooks, rip off the keyboard, flip over the screen and add a digitizer, you've got what is basically a Tablet PC (except for some minor details, such as not being legacy-free). If you take the Fujitsu Stylistic 3500 and substitute an active digitizer for the passive (resistive) digitizer, again you've got what is basically a Tablet PC.

Microsoft is positioning the Tablet PC as "the evolution of the laptop." You have to admire Microsoft's ability to do product positioning. Whether you like them or not, they're capable of turning out some good marketing verbiage. Microsoft people at WinHEC often repeated the following phrases to describe the Tablet PC, almost in unison:

- Combines the simplicity of paper with the power of the PC
- Combines the rich features of a notebook with the simplicity of a pen
- A natural form of computing
- An adaptable, ergonomic form factor

As noted earlier, the initial target market is corporate users, "knowledge workers with a productivity focus." Microsoft envisions the typical user as a "corporate corridor warrior," someone who spends a lot of time away from their office in meetings with other people. Note the distinction between "corridor warrior" and "road warrior." Microsoft isn't trying to replace the notebooks you see used in airports the world over; they're trying to replace the pads of paper you see used in meeting rooms the world over. There's a subtle difference. In Alex Loeb's WinHEC session, she explained all about how using a

laptop in a meeting is "rude," about how it takes energy and focus to use, which decreases the user's eye contact with others at the meeting.

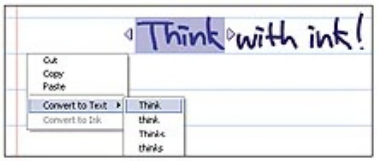
For anyone who's been in the vertical pen tablet business anytime in the last 10 years (e.g., at Fujitsu), this is old news. Microsoft seemingly presents it as if it's brand new information. Actually, what's happening is that Microsoft is simply applying good marketing skills to the pen tablet. Relatively few vertical pen tablet companies articulate the message about laptop versus tablet usage very clearly. This is because either (a) it's such common knowledge in markets such as Sales Force Automation that it's just taken for granted, or (b) the company is selling pen tablets into vertical markets that don't involve a lot of face-to-face meetings, such as Utilities.

Regarding whether Microsoft will eventually try to sell the Tablet PC to consumers, all they'll say is that they expect their OEMs and ISVs will expand the market focus beyond the original target. You can see from some of the things that Microsoft people say about the Tablet PC, however, that they're edging towards a more horizontal view. For example, Chuck Thacker observed in his session that "getting comfortable" with any device is the key to absorbing information from it. When he asked how many audience members printed a 1-3 page document rather than reading it on their PC screen, the majority of the audience held up their hands. Chuck argued that a tablet presents a more natural reading environment--you can hold it in your lap with your feet up on the coffee table, or you can comfortably read in bed with it. That's probably true, as long as you're not using the pen to do anything more than circle things or make minor annotations.

Ink, not handwriting

This leads directly to a key element of Microsoft's Tablet PC positioning -- they are significantly de-emphasizing handwriting recognition. The reason seems to be that they're afraid it won't work well enough. During the press briefing and the WinHEC sessions, Microsoft took great pains to emphasize the inherent value of ink. Microsoft people often repeated the following phrases, again almost in unison:

- A tablet makes ink rock
- Ink is the focus, not handwriting recognition
- Ink is a first-class citizen
- Ink as ink



Charlton Lui's Tablet PC demo during Gates' WinHEC keynote focused almost entirely on the manipulation of ink. Only once or twice did he show actual recognition, and then it was post-processing ("re-purposing text" in Microsoft-speak) of existing handwritten text, which he already knew would be recognized with 100% accuracy. Some of Microsoft Notebook's ink-management capabilities that Charlton demonstrated included the following:

- Moving ink words as though they were text
- Searching blocks of handwritten ink for a specific word
- Bolding individual words and phrases of ink
- Scaling entire blocks of ink
- Delayed or background recognition [See "Think with Ink" screenimage]

Microsoft's position on the value of ink is actually pretty reasonable. Consider the typical person who takes notes in a spiral-bound paper notebook during a meeting. They don't always type up the notes and format them into a Word document immediately after the meeting. Many times (more often than not), they just leave the notes in ink format. They can refer to them and use them as is. Similarly, when they annotate something or draw circles and arrows, it's useful in that form. Microsoft Notebook's capability of searching and manipulating ink makes it even more useful. Ink doesn't always have to be transformed into data.

But ink usage alone is simply not enough to make a successful pen tablet. When asked directly about handwriting recognition, Alex Loeb said "Microsoft has state-of-the-art handwriting recognition, but it's still not perfect and it may not work for you. So the Tablet PC is not being presented as a handwriting recognition machine, but instead as a product where the emphasis is on ink."

Microsoft's recognizer

It's unfortunate that Microsoft is so nervous about handwriting recognition. The Tablet PC software will include a very good recognizer-probably the best one that's currently available anywhere. Let's take a closer look at its origins.

Microsoft has had a small team of engineers working on handwriting recognition continuously since the early 1990s. Their first product was the less-than-stellar MARS recognizer (Pen Services 1.0, 1991), followed by the improved GRECO recognizer (Pen Windows 2.0, 1995). Windows CE 1.0 shipped in 1996 in the US without any recognizer at all. In 1998, Windows CE 2.0 came with a recognizer, but it wasn't based on the Microsoft core product. Although Microsoft was working on a version for CE 2.0, it was not finished in time, and so they substituted CIC's Jot recognizer at the last minute.

In September of 1999, Microsoft acquired the right to use the intellectual property (source code) of Calligrapher, without acquiring the product or the company outright - an indication that for once, Microsoft didn't buy something in order to kill a rival. The initial use of Calligrapher was in Windows CE 3.0 (released in 2000 as the "Pocket PC"). While CE 3.0's primary recognizer was the one that the recognizer team couldn't finish in time for CE 2.0, Calligrapher (renamed "Transcriber") was also included as an option.

Next, Microsoft "blended" Calligrapher with the Microsoft core recognizer technology to form the basis of a new recognizer that will be used in the Tablet PC. It may seem hard to believe that handwriting recognizers (an esoteric technology if there

ever was one!) from two completely different companies could be blended successfully, but in fact, it has been accomplished. The general subject is called "reco fusion" in academic papers on the subject.

The first release of the new recognizer will be in the initial release of Windows XP. This will be the first recognizer for Windows released since GRECO in 1995. The hardware required to use the recognizer in the initial release of Windows XP will be a Wacom graphics tablet or equivalent. The interface to the recognizer, while different from that for Pen Windows, will be documented so third parties can replace the Microsoft recognizer with their own if desired.

The bottom line is that the combination of the last six years of Microsoft core recognizer development blended with the well-accepted Calligrapher technology should yield a world-class handwriting recognizer for the Tablet PC.

Software architecture

The Tablet PC software platform is based on Windows XP Professional (only!). Microsoft has no plans to make any part of the Tablet PC software backwards compatible to any flavor of Windows 9x. The core of the software is an add-on layer that sits on top of XP. Since XP is currently scheduled to appear in retail stores on October 25, 2001, and the Tablet PC is a 2002 product, the add-on layer will not be available with the initial release of XP. Microsoft says that the add-on layer will initially only be available to OEMs, but that this strategy will be re-evaluated after the first year, when upgrades start to become an issue.

The logic is that the user should initially get support for any custom or special hardware directly from the OEM. If the Tablet PC hardware becomes widespread and common, then Microsoft may include the add-on layer and hardware drivers for most existing products directly in the OS. This is similar to the way things work today. If you purchase a special piece of hardware such as a USB fingerprint reader, you generally must obtain a driver from the manufacturer of the reader. On the other hand, if you purchase a "generic" piece of hardware such as a network adapter, the driver is already included in Windows.

If you've been around the pen business for a while, this architecture may sound suspiciously like Pen Services in Windows for Pen Computing. It is and it isn't. Pen Services was also a layer on top of Windows, but Pen Services was a "hack" while the Tablet PC layer uses standard Windows NT/2000 architecture. Pen Windows relied heavily on undocumented entry points into Windows 9x for its connection to the OS. The Tablet PC layer uses what's known as "Input Method Editor" (IME) architecture, which is the way all input devices of any kind get information into Windows NT/2000. As a result of Pen Services' back-door connection to the OS, there were places in Windows 9x where you just couldn't use the pen—for example, to handwrite a URL in Internet Explorer. According to Chuck Thacker, the Tablet PC's use of IME is "perfectly standard" and this kind of problem will not occur.

This standardization could conceivably have an interesting side effect. Suppose that Microsoft doesn't "nail the User Interface," and in fact comes up with something that the market completely rejects. Since the interface to the OS is (supposedly) totally standard, it's theoretically possible for a third party to create an equivalent layer to replace the Microsoft offering. Whether this is likely to happen or not is debatable.

The good news that results from using the standard Windows NT architecture is that "all Windows applications can be used with a pen on the Tablet PC." Both Alex Loeb and Chuck Thacker repeated this statement several times during their WinHEC sessions.

Changes to the Windows XP core required by the Tablet PC were very few—the only things added were support for the pen, support for the hardware buttons on the tablet, and some enhancements to ACPI. The Tablet PC layer will include the handwriting recognizer, support for ink, pen applets required to configure and control the system, one or more on-screen keyboards, a gesture manager, a "text input processing" (TIP) module, and the user interface. Software to support speech recognition may also be added, but nothing more than a passing mention was made of this at the WinHEC conference. User interface Almost no information has been released on the details of the actual pen user interface (separate from the Microsoft Notebook application). Generally it is supposed to be fairly simple, utilizing basic click, hold and select functions. Gestures are used to perform various actions. For example, to do a right-click with the pen, the user makes a gesture and then selects "right-click" from a pop-up menu. It is not known if user-defined gestures will be available. When asked why the pen barrel button wasn't used to perform a right-click, as is the case on some vertical pen tablets, Chuck Thacker said, "We don't use the pen barrel button because people generally can't use it."

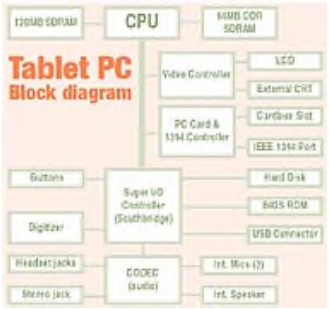
Anyone who's used Pen Windows knows the feeling of frustration and even anger that can occur when you can't get the system to do what you want, either because recognition fails or because the pen doesn't act the way you think it should or seems erratic. The new Tablet PC pen user interface is described by Microsoft as "providing a graceful fallback when things fail, and allowing easy correction." It remains to be seen what this really means.

About the prototype hardware

Microsoft built the Tablet PC prototype as a "proof of concept." It's not a "reference design," i.e., it's not intended as rigid guidance or direction to the five OEMs. Microsoft built it because they needed some hardware on which they could test system and application software, test and optimize software-hardware interaction, work through major laptop-oriented hardware issues, explore the ergonomics of a pen tablet, and test usability and features with customers. Microsoft is not going into the hardware business—that's why they have OEMs. Why didn't Microsoft use the existing Fujitsu Stylistic 3400 pen tablet, which is probably the best on the market, instead of inventing their own? Most likely because Microsoft didn't want to get too close to any one of the five OEMs, and because Chuck Thacker truly wanted to build a pen tablet from scratch (doing something yourself is how you really learn what's what!).

As of the beginning of May, about 40 prototypes have been built. According to Chuck Thacker, Microsoft plans to build a total of about 300. The prototype is just that, a prototype. It's not really a practical product. For example, there's no external access to the battery or the hard disk, no internal modem and no DRAM expansion capability. Most notebooks today have all of these features and more. The prototype is simply a demonstration of what's possible today, with emphasis on making it as thin as possible, to help people get the concept.

Building the prototype



According to Alex Loeb, the prototype started with a schematic drawn by Chuck Thacker. Next, Microsoft hired Flextronics, the second-largest contract manufacturer in the US, to build the prototypes. This entailed doing the mechanical design, laying out the PCB, doing heat analyses, etc.—all the things you have to do to build a complex product from scratch. Flextronics is, by the way, the company that builds most of the Handspring Visor PDAs; Solectron, the #1 contract manufacturer in the US, builds the rest of them.

Heat is always a very difficult part of the design of a tablet, since there's only one heat-dissipation surface (the back). According to a rep from Flextronics, one of the more interesting specs that Microsoft gave Flextronics on the Tablet PC was that "it should be less hot than a cat on your lap." It is not known if Flextronics made any thermocouple-based measurements of live animals on actual humans. In any case, this is probably one reason for the very strong emphasis on low power consumption that is evidenced throughout the design of the prototype.

The Tablet PC is one of the few products where Microsoft actually designed and built a hardware prototype themselves, rather than relying on their OEMs. It was particularly amusing listening to Chuck Thacker describe in his WinHEC session how hard it was to actually make it work. Microsoft usually doesn't have to implement the specs they define; that's up to the OEMs. Chuck Thacker said the main problem was that "power management is a nightmare" (welcome to the real world, Mr. Thacker!). Examples of specific problems that Thacker said he encountered include the following:

- Power states that should work don't
- Going from the power off state to the fully active state after insertion of a PC Card causes an "interrupt storm" from the PC Card controller
- It isn't possible to independently power down the USB, audio and IEEE 1394 controllers
- Switching between portrait mode and landscape mode can be difficult

Thacker believes that a power reduction of up to 1.5 watts can be achieved if all of the power management problems in the Tablet PC prototype are solved.

Pen-input subsystem

As mentioned earlier in this article, six key technology vendors were represented at the press briefing at WinHEC. We've already covered Flextronics' contribution; to gain a better understanding of the design philosophy of the Tablet PC, it's worth taking a look at the contribution of each of the other five companies. First is the provider of the pen-input subsystem, FinePoint Innovations (formerly part of Mutoh America, and Kurta before that). FinePoint makes an active RF digitizer. "Active RF" means that the pen contains a miniature RF transmitter (operating at 460 KHz) that transmits through the LCD to a sensor grid (antenna) positioned behind the LCD. A controller chip takes samples of the pen's position 133 times a second. This compares very favorably with the typical 30-40 position samples per second taken by a mouse. The result is very fast, very smooth ink.

Another key characteristic of an active RF digitizer is that the pen can hover over the screen and the cursor tracks it, just like moving a mouse without clicking. The ability to hover (also called "proximity sensing") is becoming essential as Windows grows more complex. Windows XP makes more use of hovering to provide information to the user than any previous version of Windows. For example, if you hover over a thumbnail image in XP, you get an entire panel of information about the image, not just the file name.

The primary alternative to an active RF digitizer is a resistive (also called "passive") digitizer. This is what is used on all PDAs and on many vertical pen tablets. Compared to an active RF digitizer, a resistive digitizer has a lower sample rate, lower resolution, less accuracy and no hovering. For these reasons, Microsoft has declared that all Tablet PCs must use an active digitizer with a sample rate of at least 100 samples per second.

Legacy-free BIOS

Phoenix's primary contribution to the Tablet PC prototype is the legacy-free BIOS. Today's current notebooks are not legacy-free—they typically have a serial port, a parallel port and a PS/2 mouse/keyboard port, all legacy devices supported by the BIOS. Today's typical notebook BIOS, represented by Phoenix's NoteBIOS 4.0 product (generically, "Platformware," to use Phoenix's term), can support booting from USB floppies, CD-ROMs, Zip disks and hard disks. However, a notebook BIOS always expects the notebook to have an internal keyboard, so there's no support for a USB keyboard at boot. That was one of the changes that Microsoft required in the Tablet PC's legacy-free BIOS. Other changes include significantly reducing the power-on self test (POST) time to 6 seconds, reducing the resume time to under 2 seconds (that's almost instant-on!), tweaking the power management, adding support for the pen (e.g., in the BIOS setup program), and removing support for all legacy hardware devices.

Low-power CPU

The Tablet PC prototype uses a 600 MHz Crusoe TM5600 CPU from Transmeta. Transmeta has been in the news a lot lately, with somewhat mixed results. Their claim to fame is "x86 Code-Morphing software" (dynamic binary code translation), which delivers lower power consumption than Intel with roughly the same horsepower. Whether the claim will hold up over time is unclear, since Intel has started fighting back aggressively with its newest ultra-low-power Mobile Pentium III. Certainly the actual power consumption numbers on the TM5600 spec sheet look very good indeed:

- 1.0 W typical while running office productivity applications
- 0.1 W when idle between keystrokes
- 2.0 W typical while running CPU-intensive applications such as DVD movies

Actually there's nothing in the Tablet PC architecture that requires the Transmeta CPU; an Intel CPU (or in fact any x86-compatible CPU from AMD, Via or National) would work just as well. Jerry Ascierto from EE Times remarked on the curious lack of any Intel representation at the Tablet PC press briefing. Two technical analysts were quoted in his story as saying they expected initial Tablet PC designs (from the five OEMs) to be powered by 800-MHz-and-above Mobile Intel Pentium III chips rather than by Transmeta chips. John G. Spooner and Ian Fried from ZDNet reported that Intel is in fact working with several PC makers to create its own "Tablet PC Reference Specification" based on the ultra-low-power mobile Pentium III chip (apparently completely separate from Microsoft's effort). Hmmmm...

Low-power video controller

The Tablet PC uses a Silicon Motion LynxEM+ video controller. Silicon Motion, founded in 1996 and headquartered in Silicon Valley, is a relative newcomer in the video controller business. While they have some notebook design wins (in some HP, NEC, Panasonic and OEM-branded Taiwanese notebooks), they are dwarfed by ATI and NVIDIA. On the other hand, the two major players are engaged in a race for dominance in 3D performance in their mobile video controllers, and the Tablet PC doesn't even really need 3D. So there's some logic to Microsoft's selection of Silicon Motion for the Tablet PC.

Silicon Motion's claim to fame is low power consumption. A few years ago, when mobile CPUs were consuming 10+ watts, the video controller was a small percentage of the total system power consumption. Now that mobile CPUs are in the 1-2W range, the video controller has become a much larger percentage of total system power consumption. To achieve very low power consumption, the LynxEM+ uses dynamic clocking control for individual logic blocks within the controller. In addition, the graphics driver externally controls the power supply voltage (the controller is built using CMOS process options that tolerate a wide supply voltage operating range).

Another key, but not-so-obvious factor is the need for rotation support. Most video controllers for notebooks don't support hardware rotation—after all, why would you need portrait mode in a notebook? A tablet, on the other hand, really needs rotation support, since you should be able to use it in either orientation. The Silicon Motion video controller is one of the few that includes hardware rotation support as a standard feature.

Actually, just like in the CPU area, there's nothing in the Tablet PC architecture that absolutely requires the Silicon Motion video controller; any low-power video controller with hardware rotation support would work—it's just that there aren't very many of those. 2D video controllers don't have much sex appeal these days, so nothing's been written in the press yet about Microsoft's selection of Silicon Motion.

Covering the LCD

Last but not least is Silver Cloud Manufacturing. Silver Cloud's contribution to the Tablet PC is the window (filter) over the LCD. Actually it's much more sophisticated than you might think. The filter is made of several laminated layers of polyester and acrylic, optimized to maximize light transmission (transmissivity is in the range of 92%-95%). The filter is about three millimeters thick. There's an anti-reflective (AR) hard coating on the top surface, and a high-gloss AR coating on the bottom surface. The purpose of the AR coatings is to reduce reflections caused by ambient lighting. Graphics are embedded between the layers, which protects them from wear. While filters such as these are sometimes made of tempered glass, plastic was selected for the Tablet PC because of its light weight and easy machineability. Note that the Tablet PC is not specified as being "outdoor (sunlight) readable." Given Microsoft's target market of the corporate worker, the assumption is that the Tablet PC is basically an indoor product. Of course it's possible to create an outdoor-readable Tablet PC by using an appropriate LCD technology coupled with appropriate polarizers and filters. There's nothing to prevent an OEM from doing so, but it seems unlikely that this will occur in the first generation of Tablet PCs.

The LCD

The LCD used in the Tablet PC prototype is a standard Toshiba 10.4" XGA (1024 x 768) polysilicon TFT. The same LCD is used in one model of the Fujitsu Stylistic 3400, and in several ultra-lightweight notebooks. XGA resolution in a 10.4" LCD yields a dots-per-inch (dpi) value of 122, which is the highest of any standard notebook currently shipping. Typical 13.3" XGA notebook LCDs have a dpi of around 96. Higher dpi values mean that the screen looks sharper and finer; it also means that unless the font size is increased proportionally, type sizes are smaller and harder to read (especially when you're over 40!).

Actually the LCD was slightly modified for the Tablet PC prototype. In order to fit the FinePoint active RF digitizer's sensor grid behind the LCD, Toshiba had to modify the mechanical characteristics of the LCD's "tab over" (wraparound) electronics slightly to make room for the grid. This is a common modification when designing a product with an active RF digitizer.

Backlight brightness on the LCD is controlled via a software applet; the power level can be varied from 5W down to 2W.

Other components

Much of the rest of the Tablet PC hardware is pretty straightforward. [See Tablet PC Prototype Specifications Table] The hard disk is a standard 2.5" notebook drive; the capacity is irrelevant. DRAM at 192 MB is reasonable, given that 128 MB is the

minimum for Windows XP. The PC Card slot is perfectly normal; the only interesting aspects are (1) there's only one slot (to minimize the prototype's thickness), and (2) the PC Card controller (Texas Instruments PCI-4410) also provides the IEEE 1394 port. The presence of an IEEE 1394 port on the Tablet PC may be puzzling to some, until you realize that Microsoft's PC-2001 desktop platform specification requires four 1394 ports—so having one in an "evolved notebook" isn't unreasonable.

The audio specification (AC97) is standard notebook technology; the only interesting aspect involves the microphones. Chuck Thacker attempted to improve the voice recognition capability of the Tablet PC prototype by placing a microphone on each side of the front bezel (stereo). The result was actually worse performance, since the two microphones picked up twice as much background noise. In his WinHEC session, Chuck said that if he had to do it again, he'd use an array microphone (driving a DSP) which really would improve the voice recognition. Hopefully the five OEMs heard him say that!

The I/O ports on the Tablet PC prototype are notable only by their legacy-free nature (no parallel, no serial and no PS/2 ports). However, the chip that provides the USB port, the audio and the HDD interface (the Acer Labs M1535 Southbridge) is a hidden gem. This is a very powerful chip—it also includes a PS/2 keyboard and mouse controller, three more USB ports, three 16550 serial ports, an IEEE-1284-compatible parallel port, a traditional floppy disk controller, an IrDA port and a software modem interface—none of which are used in the Tablet PC prototype! You can see that an OEM could easily create a tablet which, when in tablet form, would meet the "legacy free" requirement, but when docked, would have all ports of a traditional legacy notebook. All the OEM would have to do is change the BIOS. Whether this will be allowable under the guidelines of the Tablet PC hardware platform specification is unknown.

The battery is a 40 watt-hour lithium-ion pack; battery life is defined (somewhat vaguely) as "four hours." Power management is ACPI-only, in keeping with the legacy-free theme (no APM!).

Size and weight

For some reason Microsoft didn't publish the exact dimension of the Tablet PC prototype; it is only described as being "approximately 8.5 by 11 inches." The thickness, at 0.9 inch, makes it probably one of the very thinnest full-PC products ever built. The housing is magnesium, a material that's been used sporadically in portable computers ever since GRiD introduced the very first laptop, the Compass, in 1982. The weight is exactly 1400 grams (3.09 pounds). In his WinHEC session, Chuck Thacker mentioned a focus group study that was done early in the project to determine the ideal weight for the Tablet PC. The answer turned out to be 2.25 to 2.5 pounds. Interestingly, the focus group felt that an 8.5x11 tablet that weighed less than 2.25 pounds was inherently too light to feel durable.

Hardware platform specs

The ultimate output of all of the work that Microsoft is doing on the Tablet PC platform will be four major pieces, as follows:

- A pen-centric layer on top of Windows XP Professional
- A note-taking application, temporarily called Microsoft Notebook
- A set of tools to enable ISVs to create pen applications
- A Tablet PC hardware platform specification

The last item is the first one that will be released by Microsoft. As a specification, in concept it's no different than any of Microsoft's other PC hardware platform specifications. It's a set of "guidance specifications" that tells OEMs how to build products that meet Microsoft's requirements, which in turn are based on market requirements. This spec is an OEMs' bible—it sets the standard. Microsoft has not said exactly when they're going to release the Tablet PC hardware platform specification; the current estimate is "later this spring".

Microsoft has indicated that the Tablet PC hardware platform specification will generally be a subset of the PC-2001 specification (see www.pcdesguide.org/pc2001). The specs will be relatively loose, meaning that the OEMs will have a significant amount of leeway in determining exactly what they want in their Tablet PC products. This is in marked contrast with the initial hardware platform specification for the Windows CE 1.0 devices. If you recall, all of the CE 1.0 devices created by the OEMs were extremely similar, which was really undesirable. When questioned about this, Alex Loeb said, "We [Microsoft] really do learn from our mistakes!"

All that's known today about the Tablet PC hardware platform specification today is the following:

- Must be 400 MHz minimum (this is a Windows XP requirement)
- Must have 128 MB DRAM minimum (this is a Windows XP requirement)
- Must use an active digitizer with hover and a sample rate of greater than 100/second
- Must be legacy-free
- Must have a battery life of greater than 4 hours
- Must not use a fan
- Should be thin and light
- Should have high-quality audio
- Should have very fast resume from suspend (ideally less than one second)
- There will not be a required LCD size or resolution
- There will not be a required form factor

The freedom of innovation that the last two items gives the OEMs is significant. Microsoft said they expect some OEMs may build e-book size tablets (possibly using a 7" LCD), some may build large-screen tablets (using a 12.1" or larger LCD), and some OEMs may even build convertibles (back to the future: GRiD invented the first convertible pen computer in 1992).

When, how much and other details

Microsoft said that the five OEMs plan to ship Tablet PCs in 2002. The only OEM who has announced anything more definitive is Compaq, who said at the WinHEC press briefing that they plan to ship a Tablet PC during the first half of 2002 (this is probably based on Microsoft's selection of Compaq as the "lead OEM" in the Tablet PC project). Microsoft said that the Tablet PC software is planned to be available "during 2002," and that the schedule "depends on an iterative process of feedback from corporate customers." It should be clear by now that the Tablet PC is basically a thin notebook without an integrated keyboard. Pricing is therefore expected to be similar to competitive notebooks. Nobody has said anything about a "cost delta for pen enabling," which was a topic of discussion the last time around in 1992-1993. Pricing (and distribution, of course) is entirely up to the OEMs. Since the Tablet PC is a notebook, essentially everything that's ever been written about wirelessly enabling a notebook applies. Integrated local area wireless LANs, wide-area wireless using PC card radios, Bluetooth--you name it, everything applies with no change. The same goes for docking—it's a laptop! An OEM would be foolish to create a Tablet PC without some form of dock. This was clearly the assumption in everything that Microsoft presented about the Tablet PC, although no details on docks were given.

Assessment

Will the Tablet PC be successful this time around? Well, Microsoft is probably correct in saying that laptop hardware is finally ready for it. The author believes that the success of the product will depend on the following "musts":

- Microsoft must "nail the UI." The Tablet PC user interface must be intuitive to use, with no user contortions required. Gestures have to work and be easy to remember. All the bits and pieces have to work together logically.
- Handwriting recognition must work well enough so that the average person (and David Coursey) is happy with it when writing simple things. That doesn't mean 100% accurate, it just means "good enough"—and consistently so!
- 100% of all Windows applications must work properly with the pen. If some applications don't work, users will simply reject the concept.
- Microsoft must learn from the failure of Pen Windows. Even though it was a "hack" and is therefore dissed by most Microsoft engineers, there is still a lot to be learned from it.
- Microsoft must leverage the knowledge and experience of the vertical pen tablet OEMs. They've been building pen tablets successfully for 10 years and they've already lived through just about all of the issues. This is really hard for Microsoft to do, since "vertical isn't mainstream," but they've got to do it!
- "Version 1" of the Tablet PC software must be better than typical "Version 1" Microsoft products. Most users simply won't suffer through three half-baked generations of this product.
- The docking strategy for each Tablet PC product must be well thought out and perfectly executed. Creating clean, effortless, foolproof docking is really difficult, but it's essential for the success of a keyboard-less product.
- he products from the five OEMs must be well differentiated. For the Tablet PC to be successful, the market must really "get the concept." If the OEMs can create five significantly different products (e.g., a convertible, an e-book, two visibly different standard tablets and a big tablet), it will really help the market catch fire.

Microsoft can miss on one or possibly two of these things, but if they miss any more, Version 1 of the Tablet PC will crash and burn. What's the author's estimate of the probability of this happening? About 50%. - -Geoff Walker

Based in Silicon Valley, Geoff Walker is a consultant with Walker Mobile. Geoff, who hovers on the border between marketing and engineering, is currently focused on pen-enabled mobile products. He can be contacted at geoff.walker@att.net.

Processor	Transmeta TM5600 @ 600MHz
OS	Windows XP with pen layer on top
Memory	192MB DRAM
Display	24-bit color 1024 x 768 polysilicon TFT
Digitizer	FinePoint Innovations active RF
Storage	2.5-inch 6GB hard disk
Size	Approx. 8.5 x 11 x 0.9 inches
Weight	Approx. 3.0 pounds
Power	Li-Ion, 40Wh (4 hours)
Interface	USB, IEEE-1394. video out, audio I/O
Housing	Magnesium
Price	TBD
Announced Vendors	Compaq, Fujitsu, Sony, Toshiba, Acer